Gardener

(Job Role)

Qualification Pack: Ref. Id. AGR/Q0801
Sector: Agriculture

Textbook for Class XI

विद्यया ऽमृतमश्नुते
एन सी ई आर टी
NCERT

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

ISBN 978-93-5292-140-9

First Edition

May 2019 Vaishakha 1941

PD 5T SU

₹ 155.00

Printed on 80 GSM paper with NCERT watermark

Published at the Publication Division by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110016 and printed at.....??

OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016 **Phone : 011-26562708**

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bengaluru 560 085 **Phone : 080-26725740**

Navjivan Trust Building
P.O.Navjivan
Ahmedabad 380 014 **Phone : 079-27541446**

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114 **Phone : 033-25530454**

CWC Complex
Maligaon
Guwahati 781 021 **Phone : 0361-2674869**

Publication Team

Head, Publication Division : *M. Siraj Anwar*

Chief Editor : *Shveta Uppal*

Chief Production Officer : *Arun Chitkara*

Chief Business Manager : *Bibash Kumar Das*

Production Officer : *Abdul Naim*

Cover and Layout

DTP Cell, Publication Division

Foreword

The National Curriculum Framework–2005 (NCF–2005) recommends bringing work and education into the domain of the curricular, infusing it in all areas of learning while giving it an identity of its own at relevant stages. It explains that work transforms knowledge into experience and generates important personal and social values, such as self-reliance, creativity and cooperation. Through work, one learns to find one's place in the society. It is an educational activity with an inherent potential for inclusion. Therefore, an experience of involvement in productive work in an educational setting will make one appreciate the worth of social life and what is valued and appreciated in society. Work involves interaction with material or other people (mostly both), thus, creating a deeper comprehension and increased practical knowledge of natural substances and social relationships.

Through work and education, school knowledge can be easily linked to learners' life outside the school. This also makes a departure from the legacy of bookish learning and bridges the gap between the school, home, community and workplace. The NCF–2005 also emphasises on Vocational Education and Training (VET) for all those children, who wish to acquire additional skills and seek livelihood through vocational education after either discontinuing or completing their school education. VET is expected to provide a 'preferred and dignified' choice rather than a terminal or 'last-resort' option.

As a follow-up of this, the NCERT has attempted to infuse work across the subject areas and also contribute in the development of the National Skill Qualification Framework (NSQF) for the country, which was notified on 27 December 2013. It is a quality assurance framework that organises all qualifications according to levels of knowledge, skills and attitude. These levels, graded from one to ten, are defined in terms of learning outcomes, which the learner must possess regardless of whether they are obtained through formal, non-formal or informal learning. The NSQF sets

common principles and guidelines for a nationally recognised qualification system covering schools, vocational education and training institutions, technical education institutions, colleges and universities.

It is under this backdrop that Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, a constituent of NCERT, has developed learning outcomes based modular curricula for vocational subjects from Classes IX to XII. This has been developed under the centrally sponsored scheme of Vocationalisation of Secondary and Higher Secondary Education of the Ministry of Human Resource Development.

This textbook has been developed as per the learning outcomes based curriculum, keeping in view the National Occupational Standards (NOS) for the job role and to promote experiential learning related to the vocation. This will enable the students to acquire necessary skills, knowledge and attitude.

I acknowledge the contribution of the development team, reviewers and all institutions and organisations, which have supported in the development of this textbook.

The NCERT welcomes suggestions from students, teachers and parents, which would help us to further improve the quality of the material in subsequent editions.

HRUSHIKESH SENAPATY
Director
National Council of Educational
Research and Training

New Delhi
June 2018

About the Textbook

Agriculture is an important part of India's economy, which accounts for about 18 per cent of the country's GDP and occupies almost 43 per cent of its geographical area. The Agriculture Industry employs a large number of people in the organised and unorganised sector. The requirement of skilled workforce in this sector is increasing by the day. The various job roles, such as Gardener, Floriculturist — open cultivator, Floriculturist–protected cultivator, Tuber Crop Cultivator, Microirrigation Technician, Solanaceous Crop Cultivator, etc., are in demand in different states of India.

The job role of a 'Gardener' is important in agriculture. It is related to landscaping and garden activity. The Gardener performs basic operations related to the preparation of the growing medium, seedbed, planting, transplanting, and taking care of plants and planting material. The person is also responsible for tending lawns, trees, shrubs and ground covers. The person needs to be aware of the soil and nutrition requirement of plants, pests and diseases and their control, tools and equipment, garden components, and styles and features of a garden. The Gardener needs to acquire skills in grafting, cutting, budding, training, pruning, weeding and indoor gardening. The person must know the use of basic tools and hand-powered machines, such as pruner, cutter, lawn mower, etc.

The textbook for the job role of Gardener has been developed to impart knowledge and skills through hands-on-learning experience, which forms a part of experiential learning. Experiential learning focuses on the learning process of an individual. Therefore, the learning activities are student-centred and not teacher-centred.

The textbook has been developed with the contributions and expertise provided by subject and industry experts, and academicians for making it a useful and enriching teaching–learning resource material for students. Care has been taken to align the content of the textbook with the National Occupational Standard

(NOS) for the job role so that the students acquire the necessary knowledge and skills as per the performance criteria mentioned in the respective NOS of the Qualification Pack (QP). The textbook has been reviewed by experts so as to make sure that the content is not only aligned with the NOS but is also of high quality. The NOS for the job role of Gardener covered in this textbook is as follows:

- AGR/N0801 Nursery Management and Propagation of Plant Material

The task covers nursery management, propagation techniques, tools and equipment, and some other operations.

Unit 1 of this textbook gives an introduction to floriculture and its importance, present status and prospects of floriculture in India, classification of ornamental plants, etc. Unit 2 focuses on nursery and its importance, growing media, nursery bed preparation, seed sowing and planting material. Unit 3 gives an insight into plant propagation, which includes sexual and asexual propagation, vegetative propagation techniques — cutting, layering, grafting and budding. Unit 4 talks about garden tools and equipment. It deals with the implements used for the preparation of land, and tools and equipment used in gardening. Unit 5 deals with soil management and field preparation. It focuses on the types of soil and their properties, soil reclamation, field preparation and special practices followed in the field.

I hope this textbook will be useful for teachers and students, who opt for this job role. Suggestions for improving this textbook are welcome.

Rajiv Kumar Pathak
Professor
Department of Agricultural
and Animal Husbandry
PSSCIVE, Bhopal

Textbook Development Team

Members

Ajay Kumar Tiwari, *Senior Scientist*, Indian Council of Agricultural Research, Indian Institute of Seed Science, Mau, Uttar Pradesh

Ajit Kumar, *Assistant Professor*, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand

Ashutosh Mishra, *Professor* and *Head*, College of Horticulture, Jhalawar, Rajasthan

Gaurav Sharma, *Assistant Professor*, Department of Floriculture and Landscape Architecture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh

Prabhat Kumar, *Senior Scientist*, Indian Agricultural Research Institute, Pusa, New Delhi

Pundlik Maroti Nimje, *Principal Scientist* (Retd.), Central Institute of Agricultural Engineering, Bhopal, Madhya Pradesh

R.L. Mishra, Retd. *Project Coordinator* (Floriculture), Indian Agricultural Research Institute Pusa, New Delhi

Sunil Prajapati, *Consultant* (Horticulture), Department of Agricultural and Animal Husbandry, PSSCIVE, Bhopal, Madhya Pradesh

Uadal Singh, *Assistant Professor*, PSSCIVE, Bhopal, Madhya Pradesh

V.S. Raju Danturluri, *Senior Scientist*, Indian Agricultural Research Institute, Pusa, New Delhi

Vivek Kumar Tripathi, *Associate Professor* and *Head,* Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh

Y.D. Khan, *Full-time Teacher*, Tulsa Bai Kawal Junior College, Patur, Akola, Maharashtra

Member-Coordinator

Rajiv Kumar Pathak, *Professor,* Department of Agricultural and Animal Husbandry, PSSCIVE, Bhopal, Madhya Pradesh

ACKNOWLEDGEMENTS

The Council expresses its gratitude to all members of the Project Approval Board (PAB) and officials of the Ministry of Human Resource Development (MHRD), Government of India, for their cooperation in the development of learning outcomes based curricula and courseware for various job roles in different sectors.

We are also thankful to officials of the National Skill Development Agency (NSDA), National Skill Development Corporation (NSDC) and the Ministry of Skill Development and Entrepreneurship for their support.

Rajesh Khambayat, *Joint Director*, PSSCIVE, Bhopal, is appreciated for his support in the development of this textbook.

The contributions of our colleagues at the Department of Curriculum Studies (DCS), NCERT, and members of the textbook review team — Saroj Yadav, *Professor* and *Dean* (Academic), NCERT, and Ranjana Arora, *Professor* and *Head*, DCS, are duly acknowledged. Thanks are also due to S. Chandra, Former *Additional Director General*, Indian Council of Agricultural Research (ICAR), New Delhi; Sunita Farkya, *Professor*, and Pushp Lata Verma, *Assistant Professor*, Department of Education in Science and Mathematics, NCERT, for reviewing the textbook.

The images used in the textbook have been sourced from the Creative Commons License and Vivek Kumar Tripathi, *Associate Professor*, Department of Horticulture, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. They have been selected with care and diligence to impart a clearer understanding to learners. Care has been taken not to violate any copyright issue. The images are meant for educational purpose and are being provided for the personal use of students and teachers.

Gratitude is also due to Publication Division, NCERT, for transforming the manuscript into an attractive textbook. Special thanks are due to Sweta Jha, *Editor* (Contractual) for copyediting the manuscipt. Pavan Kumar Barriar, *DTP Operator*, Publication Division, NCERT, and Hari Darshan Lodhi, *DTP Operator* (contractual) are acknowledged for flawless layout and design of the textbook.

Contents

Gandhiji's Talisman

I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test:

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it? Will it restore him to a control over his own life and destiny? In other words, will it lead to Swaraj for the hungry and spiritually starving millions?

Then you will find your doubts and your self melting away.

M K Gandhi

Unit 1

Introduction To Floriculture

Introduction

Ornamental plants and flowers are associated with our civilisation since time immemorial. The first evidence of *pipal* as an ornamental plant comes from the seal of Mohen-jo-daro. Another example during the same period, depicting the use of an ornamental plant resembling weeping willow, comes from the seals of Harappa. There has been a mention of flowers and gardens in our ancient classic literature too.

Although loose flowers were cultivated for domestic uses like making of *veni*, *gajra*, garlands, etc., and for various celebrations, such as marriage, birthday, religious offerings and other social gatherings, cultivation of cut flowers on commercial scale for domestic and export purposes is of recent origin in our country.

Floriculture is an important branch of horticulture, which deals with cut or loose flowers, ornamental plants, such as foliage plants, trees, shrubs, climbers, palms, bamboo, cacti and succulents, dried flowers, essential oils and landscape gardening. Gardening, an important part of the floriculture business, has aesthetic value and is becoming a necessity for pollution-free environment in cities.

Floriculture

Floriculture is a branch of horticulture that deals with the cultivation, processing and marketing of ornamental plants vis-à-vis landscaping of small or large areas, and maintenance of gardens so that the surroundings may appear aesthetically pleasant.

Floriculture includes annual (seasonal), biennial and perennial ornamentals, such as cacti and other succulents, bromeliads, trees, shrubs, climbers, bulbous plants, lawn and ornamental grasses, bamboos, orchids, palms, cycads, foliage, bedding, pot and house plants, cut and loose flowers, fillers, ferns, seed and bulb production of ornamentals, dried flowers or plant parts, and other value-added products, such as extraction of essential oils, edible pigments, and their marketing vis-à-vis making and maintenance of gardens.

The Floriculture Industry in India comprises flower production and trade of flowers, nursery and potted plants, seeds and bulbs, nursery, plant rental services, propagation through tissue culture and essential oils extraction.

Importance and uses of floriculture

Floriculture is one of the most potential components of the Horticulture Industry, being important from aesthetic, social and economic points of view. It has the potential for generating employment opportunities round-the-year and earning foreign exchange. In many countries, different floricultural value-added products are the main export items from the agriculture sector.

Let us now look at the importance and uses of commercial floriculture.

Cut flowers

These flowers are harvested with stalk, especially for arrangement in vases, and are lasting. These constitute a major share of the total world trade in floricultural products. Important cut flower crops are rose, carnation, chrysanthemum, orchid, gerbera, lilium, anthurium, gladiolus, narcissus, bird of paradise, heliconia, anemone, ranunculus, tulip, calla lily, etc.

Cut flowers are used in the preparation of bouquets and floral baskets as corsages, flower arrangements and for decoration purposes.

Loose flowers

Loose flowers are plucked from plants without stalk just below the calyx. These are in great demand, especially in Asian countries, and used for making *veni*, *rangoli*, bracelets, hair adornments for women and garlands, for garden displays, religious offerings and decorative purposes. Loose flowers comprise rose, chrysanthemum, marigold, jasmine, tuberose, gaillardia, crossandra, barleria, *chandni*, *kaner*, hibiscus, spider lily and eranthemum.

Cut greens

Cut greens or cut foliages (leaves and stems), which are attractive in form, colour and freshness, are lasting and in great demand. These are used as fillers along with cut flowers in flower arrangements and elsewhere for increasing aesthetic value. These floral produce have various other uses in making attractive fresh floral designs and floral arrangements, such as bouquets, wreaths, decoration of house interiors, etc. Some of the cut foliages in demand are asparagus, ferns, *thuja*, *cupressus*, eucalyptus, etc.

Potted plants

Potted plants are of considerable commercial importance for instant gardening and for indoor, as well as, outdoor decoration. These can be easily carried to places, which need to be landscaped immediately. The potted plant industry is growing enormously. Potted plants may be either ornamental foliage or flowering. They are used for indoor decoration at homes, offices, commercial complexes, corporate offices, hotels, malls and other sites for various functions and events. The importance of these plants is increasing because with the growing population and lack of open spaces, one has to depend largely on potted plants for decorating their houses and surroundings. Some examples of potted plants are *aglaonema*, *aralia*, *azalea*, *begonia*, *calathea*,

NOTES

chlorophytum, croton, diffenbachia, dracaena, ferns, *ficus*, kalanchoe, maranta, money plant, etc.

Flower seed and planting material

There is a high demand for quality flower seeds, especially annual ornamentals and ornamental planting material. Different types of soil and climatic conditions in India enable seed production of practically all type of flowers. Flower seeds of annuals are produced in huge quantities for sale. A large number of bulbous plants, such as gladiolus, tuberose, amaryllis, dahlia, lilies, freesia, tulip, calla lily, etc., are multiplied and marketed.

Nursery

Nurseries are meant for multiplying and supplying plants and planting material, and by and large, providing guidance in the growing of ornamentals and maintenance of gardens. An ornamental plant nursery is a lucrative retail or wholesale business for the supply of various type of plants and planting material, such as nursery seedlings or prepared plants of trees, shrubs, climbers, seedlings of annuals and perennials, foliage plants, bulbous plants, cacti and succulents, palms, indoor plants, grasses, seeds, bulbs, etc.

Lawn

It is a green carpet for landscape. Lawn is a well-mown turf made in the field in front of a house or in garden. It is an integral part of the garden, providing a beautiful environment to onlookers and emitting oxygen to the environment as lungs do for the body. Lawn has aesthetic and recreational value too. It also provides a suitable background for flower beds, shrubbery border and specimen tree. It improves the monetary value of a property. In landscape designing and in the establishment of lawns or in sports like cricket, golf, hockey, tennis, etc., different type of grasses are used. The Turf Industry has recently got a boost due to government policies for encouraging various kind of sports.

Perfumes

The demand for natural floral extracts like perfumes from flowers is increasing by the day. Some flowers, such as rose, jasmine, screwpine (*kewra*) and tuberose are used for the extraction of essential oils for the preparation of perfumes or attar.

Colour pigments

Flowers are used to extract natural pigments. Carotenoids extracted from flowers are used commercially in the pharmaceutical industry, and as food supplements, animal feed additives and food colourants. Marigold petals are used as an important feed additive for poultry birds to add to the yellow colour of egg yolk as the petals are rich in carotenoid pigment. These are also used to prevent humans from dry eye and night blindness. A yellow coloured dye is extracted from chrysanthemum, which is used in food products and cosmetics. Orange-red edible dye is extracted from the arils of *Bixa orellana* (*sinduri*), which is used in cosmetics and medicines for coating.

Dried flowers

Plants of many species have flowers and foliages for a short period, and their availability is restricted to a particular time span. In the dry flower technique, flowers can be easily dried, preserved and processed to retain their beauty and everlasting character. Some flowers that are air dried and used as dry flowers include dahlia, larkspur, paper flower, annual chrysanthemum, marigold, straw flower, lotus pods, etc.

Combat pollution

Open spaces like parks and plants help check air pollution. Parks are considered as the lungs of cities. The greater use of plants improves our health and also beautifies the environment. Planting different type of plants helps in checking air, water and noise pollution, and prevents soil erosion. Trees provide shade and organic matter, which help improve the microclimate of an area. Parks and gardens also serve as recreation

Notes

spots and are known to have a positive effect on people's physical and mental health, apart from providing a peaceful atmosphere for meditation.

Aesthetic value

According to the *Oxford Advanced Learner's Dictionary*, 'aesthetic' is the perception of beauty and the study of its appreciation. 'Aesthetic value' may be described as the theory of the level of beauty of certain natural resources. It is the value or pleasure that anything of beauty gives to humans. Flowers have aesthetic importance in human life and are a symbol of purity, love and peace. Some common aesthetic values of flowers are as follows.

Psychological

Flowers, when given to an ailing person at home, hospital or rehabilitation centre, and to family members or friends, in general, give them peace and make them happy.

Landscaping

Landscaping refers to the treatment given to a piece of land in order to make it attractive and beautiful. Landscaping is becoming common as it beautifies an area, adds calmness and freshness to the surroundings, and increases the property value. It is important for offices, residences, educational institutes, supermarkets, etc., as it is the building's exterior that leaves the first impression on people. Parks and gardens offer a place to people to relax and enjoy the nature's beauty. A lawn is an integral part of a garden and is primarily laid for aesthetic purposes.

Indoor gardening

Growing plants inside a house is known as 'indoor gardening'. It not only makes the appearance of the interiors attractive but also improves the air quality.

Flower arrangement

Flower arrangement is the aesthetic and artistic form of flower display, which refreshes and relaxes the mind,

and provides a means of livelihood to the arranger. Cut flowers are used for different type of flower arrangements. Flower arrangements can be done on various occasions, such as weddings, birthdays, etc. When flowers are used as a centrepiece in a vase, they add beauty to the table and the entire room.

Present status of floriculture in India

Due to change in lifestyles and increase in the per capita income of people, the demand for floriculture has increased substantially. At present, it has become one of the profit-making trades because of constant rise in the demand of flowers and its products.

- As per the National Horticultural Database, the major flower producing States are Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal Maharashtra, Madhya Pradesh, Gujarat and Haryana.
- The various fields of revenue generation in floriculture includes cut flower production, loose flower production, dry flower, nursery, potted plants, seed industry, extraction of essential oils and value-added products.
- Several seed companies have established production units in major flower growing States to meet the demand of flower seeds.
- Seasonal flowers and seed production is an established business in Punjab, Karnataka and Maharashtra.
- The Government of India has set up six agri-export zones for floriculture in Maharashtra, Sikkim, Tamil Nadu (two zones), Uttarakhand and Karnataka.
- The United States, Germany, the United Kingdom, the Netherlands and the United Arab Emirates are the major countries, which import floricultural produce to India. The Agricultural and Processed Food Products Export Development Authority is responsible for the export, promotion and development of floriculture in India.

Prospects of floriculture in India

Since time immemorial, India has a tradition of growing flowers. In our country, it is considered as a high

growth industry. Export-oriented flower production has increased due to the government's policies. The scopes of floriculture in India are as follows:

- The opportunities for floriculture are increasing due to various uses of flowers in aesthetic sense, urbanisation and substantially increased purchasing power of people.
- The demand for floricultural plants and their produce, such as bouquet, garland, *veni* and value-added products like dry flowers and potpourris is increasing by the day. They are required in various functions and celebrations.
- Strategically and geographically, our country is well located between major flower markets, i.e., Europe and East Asia.
- The diverse agro-climatic conditions in the country enable the growth of all type of flowers in one season or the other.
- Landscaping has become an integral component of urban horticulture, which apart from adding aesthetic value to a place, protects the environment, reduces air and noise pollution, and promotes ecotourism.
- Lawn establishment and maintenance, a lucrative enterprise, has become an integral part of landscaping. It requires skilled, as well as, unskilled human resources.
- In light of climate change, the scope of turf or lawn grasses, vertical gardening, roof gardening, etc., is on rise.
- Increasing industrialisation and depleting agricultural land have opened avenues for production and marketing of potted plants. These have also opened avenues for plant rentals for interior decoration in hotels, corporate houses, etc.
- The Nursery Industry is coming up as a flourishing enterprise, giving high returns. There is a demand for high quality flower seeds, including F1 hybrids.

- Protected or hi-tech cultivation of cut flowers has a great future in our country. Here, one can increase the area under intensive flower production to increase floricultural exports.
- Extraction of essential oils, natural dyes, and pharmaceutical and naturaceutical compounds from flower plants is also an important activity, and is emerging as a lucrative business.

Classification of ornamental plants

Ornamental plants can be classified in the following manner.

Based on life span

Annuals

Plants, which complete their life cycle — from seed germination to seed production in one growing season, are called 'annuals'. They complete life cycle — seed germination, growth, flowering, seed formation and die in one growing season or year. They require replanting every season. They are mostly grown through seeds and are commonly called 'seasonal', for example China aster, coreopsis, gomphrena, marigold, petunia, tithonia, verbena, zinnia, etc.

Biennials

These are plants that complete their seed-to-seed life cycle in two seasons or years. Usually, most of the temperate seasonals are biennial in nature as they complete vegetative growth in one season or year and flowering to seed formation in another season or year, such as amaranthus, celosia, hollyhock, pansy, snapdragon, etc. These require replanting.

Perennials

These are plants having a life cycle that is more than two years. These produce seeds or flowers every year once the bearing starts. They do not require replanting. Perennials are, usually, categorised into two groups.

Woody perennials

These comprise most of the trees, shrubs and vines, which have woody stems and branches, such as *Cassia siamea, C. fistula, Peltophorum, Cassia biflora, Lawsonia alba, Hibiscus rosa-sinensis, Petrea volubilis, Quisqualis indica, Vernonia eleagniaefolia, etc.*

Herbaceous perennials

These include plants with soft and herbaceous (non-woody) main stalk, such as anthurium, bird of paradise, geranium, gerbera, heliconia, pelargonium, periwinkle, portulaca, perennial balsam, sweet violet, viola, etc.

Based on season of growth

Winter season annuals

Winter season annuals are hardy. These can grow during the rigours of winters and withstand low temperatures. The seeds of annuals are sown in September-October and the seedlings are transplanted during October-November. Examples are candytuft, antirrhinum, larkspur, nasturtium, pansy, petunia, phlox, sweet sultan, verbena, etc.

Summer season annuals

These annuals are grown during the summer season and can bear high temperatures to produce flowers. The seeds are sown in February–end or the beginning of March, and the seedlings are transplanted in the end of March or April. Examples are cosmos, gaillardia, gomphrena, kochia, portulaca, sunflower, tithonia, zinnia, etc.

Rainy season annuals

These are grown in the rainy season and can produce flowers under high humidity and rain as compared to other annuals. The seeds are sown in June and the seedlings are transplanted in July. Examples are amaranthus, balsam, celosia, cock's comb, gaillardia, etc.

Based on market value

Loose flowers

Loose flowers are harvested without stalk. Examples are barleria, bedding dahlia, calotropis, chrysanthemum (spray type), *chandni*, crossandra, eranthemum, gaillardia, jasmine, *kamini*, *kaner* (yellow and red), lotus, marigold, rose (fragrant *desi* type), shoe flower (*hibiscus*), sunflower, tuberose, water lily, etc. They are used for making *rangoli*, *gajra*, *veni*, garlands, and offered for worship at home, as well as, religious places.

Cut flowers

Cut flowers are fresh flowers, flower buds or spikes harvested along with their stalks attached to the flowers, the length of stalks being specified to individual flowers. Examples of cut flowers are alpinia, anthurium, antirrhinum, bird of paradise, carnation, freesia, gerbera, gladiolus, gypsophila, heliconia, iris (bulbous), lupins, narcissi, orchid, rose (improved varieties), scabiosa, statice, tuberose, watsonia, etc. They are mostly used for bouquets and for vase arrangements.

Flowers yielding value-added products

They are used as raw material in industries for the extraction of essential oils and also for preparing edible products, such as *gulkand*, rose water and pigments as natural colours. They are also used as dry flowers, such as acroclinum, jasmine, marigold, rose, etc.

Based on plant type

Herbaceous

Lilium, verbena, viola, etc.

Shrubs

Bougainvillea, jasmine, lawsonia, hamelia, nyctanthes, rose, tecoma, etc.

Trees

Gulmohar, *palash*, *amaltas*, *kadamb*, pride of India, etc.

Climbers and creepers

Adenocalymma, antigonon, Rangoon creeper, *madhulata*, petrea, thunbergia, etc.

Based on mode of propagation

Bulbous plants

Lily, narcissus, tuberose, tulip, etc.

Cormous plants

Crocus, gladiolus, tritonia, watsonia, etc.

Rhizomatous plants

Canna, hedychium, iris, lotus, etc.

Tuberous plants

Begonia, dahlia (root tuber), etc.

Practical Exercise

Activity

Identify common flowers and ornamental plants.

Material required: Pen, pencil, practical notebook, herbarium file, etc.

Procedure

- Visit a nearby nursery, garden or flower market.
- Collect the specimen of various ornamental plants or flowers available there.
- Identify and list the collected flowers.
- Maintain a herbarium record or paste flower images on the practical notebook.
- Classify the flowers on the basis of their life cycle, season of growth and growth behaviour.

Check Your Progress

A. Fill in the Blanks

1. Plants with soft and non-woody main stalk are known as _____ perennials.
2. Trees, shrubs and vines come under _____ perennials.

3. Plants that complete their life cycle in one year are known as _____.
4. Plants that complete their life cycle (seed-to-seed) in two seasons or two years known as _____.
5. The Government of India has set up _____ agri-export zones for floriculture.
6. Plants grown inside a house known as _____ plants.
7. A _____ is an integral part of a garden.
8. Nurseries are meant for multiplying and supplying _____ material.
9. Cut greens or green foliage are used as _____ with cut flowers in flower arrangement.

B. Multiple Choice Questions

1. Floriculture is a branch of horticulture that deals with the _____.
   (a) processing of vegetables (b) planting crop
   (c) production of fruits (d) cultivation of flowers
2. Cut flowers are harvested _____.
   (a) with stalk (c) without stalk
   (b) with whole plant (d) with leaves
3. The perception of beauty and study of its appreciation is called _____.
   (a) aesthetic value (c) cosmetics
   (b) pharmaceuticals (d) cultivation

C. Subjective Questions

1. Describe the following:
   (i) Floriculture
   (ii) Cut flowers
   (iii) Cut greens
2. Describe the prospects of Indian floriculture.
3. Describe lawn and state its importance.
4. What is indoor gardening?
5. Give two examples of the following ornamentals:
   (i) Shrubs
   (ii) Trees
   (iii) Annuals
   (iv) Herbaceous perennials

NOTES

D. Match the Columns

A	B
1. Annuals	(a) China aster
2. Biennials	(b) Hollyhock, pansy
3. Perennials	(c) *Cassia fistula,* Hibiscus *rosa- sinensis*
4. Rhizomatous plants	(d) Canna, iris, lotus
5. Cormous plants	(e) Crocus, gladiolus
6. Tuberous plants	(f) Lily, tuberose, tulip

Gardener Class-11 Unit-1

A. Fill in the Blanks

1. Plants with soft and non-woody main stalk are known as _____ perennials.
2. Trees, shrubs and vines come under _____ perennials.
3. Plants that complete their life cycle in one year are known as _____.
4. Plants that complete their life cycle (seed-to-seed) in two seasons or two years known as _____.
5. The Government of India has set up _____ agri-export zones for floriculture.
6. Plants grown inside a house known as _____ plants.
7. A _____ is an integral part of a garden.
8. Nurseries are meant for multiplying and supplying _____ material.
9. Cut greens or green foliage are used as _____ with cut flowers in flower arrangement.

B. Multiple Choice Questions

1. Floriculture is a branch of horticulture that deals with the _____.
   (a) processing of vegetables (b) planting crop
   (c) production of fruits (d) cultivation of flowers
2. Cut flowers are harvested _____.
   (a) with stalk (c) without stalk
   (b) with whole plant (d) with leaves
3. The perception of beauty and study of its appreciation is called _____.
   (a) aesthetic value (c) cosmetics
   (b) pharmaceuticals (d) cultivation

C. Subjective Questions

1. Describe the following:
   (i) Floriculture
   (ii) Cut flowers
   (iii) Cut greens
2. Describe the prospects of Indian floriculture.
3. Describe lawn and state its importance.
4. What is indoor gardening?
5. Give two examples of the following ornamentals:
   (i) Shrubs
   (ii) Trees
   (iii) Annuals
   (iv) Herbaceous perennials

D. Match the Columns

A	B
1. Annuals	(a) China aster
2. Biennials	(b) Hollyhock, pansy
3. Perennials	(c) *Cassia fistula,* Hibiscus *rosa- sinensis*
4. Rhizomatous plants	(d) Canna, iris, lotus
5. Cormous plants	(e) Crocus, gladiolus
6. Tuberous plants	(f) Lily, tuberose, tulip

Unit 2

Nursery Management

Introduction

Nursery is a place where planting material, such as seedlings, saplings, cuttings, etc., are raised, propagated and multiplied under favourable conditions for transplanting in prepared beds. The availability of quality and true-to-type planting material is the prerequisite of successful and remunerative ornamental crop production. Setting up of a nursery is a long-term venture, and requires planning and expertise.

In a nursery, plants are nurtured by providing them with optimum growing conditions to ensure germination. Nursery saves considerable time for the raising of the next crop.

Among flower crops, majority of the annuals are propagated by seeds and require a nursery for raising the seedlings. Herbaceous perennials need nurseries for sowing of seeds and planting of cuttings for rooting and establishment. Woody perennials are grown from seeds for multiplying the rootstocks from cuttings, layers and through grafts to perpetuate the same genetic properties.

171107CH02

Session 1: Nursery and Its Importance

Nursery

It is an area, in which new saplings are raised and nourished until they are ready for sale or transplanting at a permanent place in a field. Raising of seedlings in a nursery is important for various reasons.

Importance of nursery

- It is possible to grow and maintain a large number of plants per unit area.
- Small and expensive hybrid seeds can be raised more effectively due to better care and management.
- When seeds are sown in seedbeds, their germination percentage increases and the vigour of the seedlings also improves.
- The management of seedlings can be done in a better way with minimum care, cost and maintenance as the nursery area is small.
- Manipulation of growing conditions for plants becomes easy.
- Better and uniform crop growth can be obtained in the main field by selecting vigorous and healthy seedlings.
- Off-season sowing of seeds becomes possible, which ultimately results in fetching more returns.
- The seed requirement of nursery raised crops is less as compared to direct seed sowing of the same crop due to better management.
- Sowing seeds in a nursery allows additional time for doing preparatory tillage in the main plot. Harvesting of the previous crop can also be prolonged, if needed.
- Management of insect-pests, diseases and weeds is easy in a nursery.

Selection of the nursery site

Several factors are responsible for the selection of a suitable nursery site. Some important considerations are as follows:

Location

A nursery must be located in a pollution-free environment—away from brick kilns, smoke-emitting industries and rough motorised roads as dirt and dust settle on plants, covering the foliage, which not only reduces the photosynthetic efficiency of plants but also gives them a dull look. It must be ensured that the nursery site gets adequate sunlight. However, care must be taken that the plants are protected against severe heat.

Topography of land

The topography of land at the nursery site must be even. If it is undulating, it must be levelled. In hilly areas, it may be divided into levelled terraces.

Soil

The soil must preferably be loam or sandy loam with large quantity of organic matter. The pH of the soil must be near neutral (6.5–7.5). It must have adequate water retention capacity and aeration.

Water

The quality of water used in a nursery is important for the growth of plants. Saline and polluted water must not be used. It must be ensured that there is adequate water supply for irrigation. Besides, the nursery must be located near a water source so that there is no water scarcity at any time in the course of raising plants.

Drainage

The nursery site must have adequate drainage facility and be free from waterlogging. Water must not stagnate at any time.

Transportation

The nursery site must be accessible by road. It must not be far from potential markets so that there is no damage to the seedlings during transportation.

Labour

As nursery work is labour-intensive, the nursery site must have enough number of labourers.

Protection from animals

The nursery area must be protected by enclosures so as to prevent damage to the plants by stray animals.

Market needs and size

Market plays an important role in the success of nursery business. Various type of inputs like seeds, fertilisers, pesticides, fungicides, plant growth regulators, poly bags, agricultural implements, different type of spare parts and other miscellaneous items required in the nursery must be available in the nearby market. The nursery must be located near the city or an area from where people can purchase the plants. Alternatively, a mechanism to explore domestic and international markets must also be worked out for the success of nursery business.

Types of nursery

Nurseries are classified on the basis of duration, plants produced and structures used.

On the basis of duration

Temporary nursery

This type of nursery is developed only to fulfil seasonal requirements or a targeted project. Such a nursery is, usually, small in size and is set up for a short period after which it is abandoned. Temporary nurseries are mostly used for raising seedlings of vegetables and flower crops. Such nurseries are found near the main planting area.

Features

- It is constructed for a short period and is small in size.
- Intensive manuring and fertilisation is not necessary in such a nursery as it is constructed at a site rich in humus.
- As it is located near a planting site, the distance between the nursery and the actual planting site is less.
- No major transportation is required, and if any, the cost is less.

- Special supervision is not required in the maintenance of such a nursery. However, security aspects must be taken care of.

Advantages

- Mortality or injury due to shock of lifting and transportation of seedlings is negligible due to less distance between the nursery and actual planting site.
- Initial investment in a temporary nursery is less as compared to a permanent one.

Disadvantage

Because of its temporary nature, basic facilities like irrigation may not be adequate. Therefore, special arrangements need to be made in order to keep the plants and seedlings in healthy condition.

Permanent nursery

In this type of a nursery, the plants are nourished and kept for a longer period of time till they are sold out or planted permanently in a field. The area covered under such a nursery is larger than a temporary nursery and it has all features that are required in a permanent nursery.

Some of the important cultural operations carried out in the permanent nursery throughout the year are as follows:

- It requires a large area and must be well connected by road.
- Such type of a nursery requires intensive management and supervision.
- High initial cost is involved in the establishment of such a nursery.
- Permanent nursery comprises office, store, mother blocks, nursery beds, protected structures, irrigation source, electricity, transportation facilities, packing yard, manure, cattle and machinery shed.

Advantages

- Greater range of planting stocks, such as seedlings, grafted plant, budded plants, layers, rooted cuttings, etc., are available.

- Being permanent in nature, it becomes a perpetual source for the supply of planting material for many years.
- Being concentrated at one place, its supervision and management is better due to the availability permanent staff.
- The initial production cost is reasonable but profits go up in the long run.

Disadvantages

- The initial investment cost is high.
- The transportation cost is more.
- Such a nursery needs intensive labour management.
- It must be backed by a large market for the sale of plants and seedlings.
- It requires skilled human resource round the year.

On the basis of plants produced

Ornamental nursery

Seedlings, rootstock and scion material of ornamental plants are raised and conserved for further use in such a nursery. It includes mother blocks of ornamental plants, which are used in layering, as well as, producing scion material for budding and grafting. The raised and flat beds of the nursery are occupied by seedlings of various annuals, perennials and rootstocks of ornamentals. A separate block of the nursery consists of vegetative and reproductive phase of bulb and tuber crops. Cuttings of different climbers and creepers are also planted here for rooting. An ornamental nursery also houses many indoor and outdoor potted plants. The blocks of seedlings of cut and loose flowers, seasonal, bonsai, climbers and creepers are managed individually here.

Vegetable nursery

Planting material like seedlings of vegetables, rooted cuttings (asparagus and sweet potato), rhizomes (ginger), tubers (potato) and bulbs (onion and garlic) are raised and conserved in such a nursery.

Fruit plant nursery

In this nursery, seedlings and cuttings of rootstocks, budded plants, grafts, layers and cuttings of fruit trees, such as mango, lychee, *ber*, *bael*, guava, sapota, etc., are raised and conserved. This nursery has mother blocks of different fruit crops, which are used as scion material.

Forest nursery

Different species of trees and climbers planted in forests and used in 'social forestry', for example plantation along roads, gram panchayat land, gardens, etc., are mostly propagated by seeds. In short, social forestry refers to forests or plantations set up by communities and tribes. Rootstock of different forest plant species and mother plants are raised in a forest nursery. Seedlings of big trees like margosa, gulmohar, *amaltas*, *kanchan*, tamarind, *amla* (gooseberry), oak, eucalyptus, etc., are commonly found in a forest nursery.

On the basis of structure used

Open field nursery

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

Hi-tech nursery

Such a nursery is established under protected structures. The protected structures in which the nursery can be successfully raised are as follows.

Thatched roof: In this type of nursery, a thatched roof is constructed over the nursery beds, which protects the seedlings from damage caused by extreme wind, rain, heat, etc.

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

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

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

Nursery bed

It refers to a land, which is made free from weeds, stumps, stones, pebbles, etc., and is used for sowing of seeds to raise seedlings and multiplication of different species of plants through asexual means.

Preparation of the nursery bed

Nursery beds can be prepared in three different ways.

Sunken bed

- The soil of the seedbed needs to be sterilised by soil solarisation or with chemicals to avoid contamination by pests and diseases.
- The soil of the nursery bed is thoroughly mixed with rotten farmyard manure.
- This type of nursery bed is prepared in dry and windy areas.
- In dry areas, the bed is kept 10–15 cm below the ground level, which helps in conserving water.
- Sunken bed facilitates the deposition of irrigation water or rainwater for a longer time.
- In case of water scarcity, this type of bed helps to conserve the moisture.

- Such a bed can be easily irrigated during dry season.
- A sunken bed provides protection to the seedlings during high wind conditions as they are covered.

Level bed

- The soil of the seedbed must be sterilised by soil solarisation or with chemicals to avoid contamination by pests and diseases.
- After soil preparation, the recommended dose of manure and fertilisers is mixed in the nursery bed.
- For efficient management, the whole area is divided into uniform size of small beds.
- Usually, a flat bed is 1-metre wide and has length according to the slope of the field.
- Irrigation channels are prepared between the rows of the beds through which each bed is connected. These also act as drainage channels in case of heavy rain or excess irrigation.
- Such a bed is prepared during non-rainy season (summer and winter) so that there is no waterlogging.
- Adequate drainage provision is made and preference for sandy or sandy loam soil is given when preparing a flat bed.

Raised bed

- Such a nursery bed is prepared during the rainy season.
- The land is levelled and made free of weeds, stumps, stones, pebbles, etc.
- The soil of the nursery bed is thoroughly mixed with 5–10 kg per sqm rotten farmyard manure.
- This type of bed is prepared about 15 cm high from the ground level. The width is kept at 1–1.5 m and length 3–5 m. This enables adequate drainage during rains and checks water stagnation.
- A space of 3–4 cm is left between two beds in order to carry out cultural practices smoothly.

NOTES

Precautions to be taken during the preparation of nursery bed

A nursery bed needs to be prepared carefully so that uniform and healthy seedlings are obtained for planting. The following precautions must be taken while preparing a nursery bed.

- The nursery bed is, generally, used to germinate sown seeds or for rooting of cuttings planted in the soil. Besides nutrition, sufficient moisture and aeration are important factors that affect seedling growth.
- The nursery bed must be prepared in fertile soil rich in organic matter content, having adequate drainage and aeration. Soil having more water retention capacity does not need frequent irrigation.
- Excess irrigation in sunken or flat bed may lead to rotting of seeds, seedlings and damping-off incidence. Watering of the bed depends on the type of soil. Sandy soil needs frequent watering.
- Soil-borne infections caused by nematodes, insect-pests and pathogens may be avoided by treating the soil in different feasible ways.
- Generally, the width of the nursery bed must not be more than 1 metre and the length must be according to the slope of the soil, so that when irrigated, the water reaches every corner of the bed and the whole bed gets irrigated.
- Since the seedlings are tender and prone to heat shock, the beds must be prepared at a site receiving partial shade. In tropical and subtropical India, direct sunlight facing site must be avoided.

Soil treatment

Soil or any planting medium used in the nursery may be contaminated by various pests. The presence of pests in the medium causes huge losses to the crop in the nursery, and the infection caused by the pests may be carried to the field through seedlings or adhering medium on the roots. It is, therefore, advocated that the medium used for the nursery must be free from infections. The different methods adopted for soil treatment are as follows.

Soil solarisation

It is an environment-friendly method to control soil-borne plant pathogens, including bacteria, fungi, nematodes, insect-pests and weeds. Solar energy increases the temperature of the soil, which helps control various soil-borne pathogens. The most appropriate time for soil solarisation is May–June when the temperature reaches 47 ºC or above. This treatment causes physical, chemical and biological changes in the soil.

Procedure

- Dig soil at a site where seedbeds are to be prepared.
- Remove all weeds, stumps, stones, pebbles, etc., from the soil.
- Crush the clods and bring it to fine tilth.
- Level the plot for preparing seedbeds.
- Irrigate the site thoroughly and cover it with a black polythene film of 200 gauge for 5–6 weeks during summer as wet soil conducts heat better than dry soil and makes soil organisms vulnerable to being killed by heat generation.
- Make the covering airtight by covering the margins with compressed wet mud to check the loss of moisture and prevent the entry of air from beneath the polythene sheet.
- The nursery bed may be prepared at the treated site or soil may be used for filling pots or poly bags.

Formalin solution treatment

- Formalin solution is used to sterilise the soil. It is prepared by adding 2.5 ml commercial grade formaldehyde per litre of water and the soil is drenched @ 45 litre of solution per m^2 to saturate the top soil surface up to a depth of 15–20 cm.
- The drenched area is covered with a polythene sheet of 200 gauge so that the fumes of formalin penetrate into the soil to kill the pathogens.
- The polythene cover is removed after 48 hours.
- The soil is raked so that the fumes of formaldehyde gas escape from it.

NOTES

- If poly-house, soil is treated with formalin, the doors and side covers of the poly-house must be opened to allow formaldehyde gas to escape.
- The bed is kept open for 7–10 days prior to seed sowing. It must be ensured that there are no fumes of formaldehyde gas prior to seed sowing.

Soil treatment by fungicide

- Fungicides like *captan* or *thiram* @ 5 g/m^2 are used to control soil-borne pathogens.
- These fungicides can also be used as soil drench by preparing a solution of 2.5–3 per cent and drenching @ 4–5 litre/m^2.

Soil treatment by insecticide

- Insecticide, such as *chloropyriphos* @ 2 ml/litre of water is applied to a depth of 15–20 cm in the soil to kill insects, including ants, white ants and their eggs, nematodes, etc.

Use of bio-agents

- Certain biological agents like *trichoderma* are used to control soil-borne pathogens.
- Bio-agents @ 10–25 g/m^2 are mixed in the soil, and after 2–3 days, the seeds are sown.

Seed treatment

To keep the seeds free from pathogens, fungicides like *captan, thiram* or *carbandazim* are applied @ 2.5–3 g/kg seed, and mixed thoroughly in the seeds to disinfect the surface of the entire seed lot.

Mother block

Various plant parts, such as bud, branch, etc., are used as propagating material for vegetative propagation. The plants from which the plant parts are collected for propagation are known as 'mother plants'. To get healthy and true-to-type planting material, it is mandatory that the mother plants are maintained. Thus, it is necessary to establish the mother plant block. Progeny tree, which is

true-to-type in nature, healthy, free from diseases and insect-pests, and is high yielding in nature, and stock plants are maintained in the mother block area of the nursery. An adjoining block can maintain healthy disease-free rootstocks, which can be used in propagation.

Practical Exercises

Activity 1

Demonstrate soil solarisation technique.

Material required: Water, harrow and polythene film of 200 gauge

Procedure

- Plough the land thoroughly with the help of a harrow during May–June.
- Prepare the seedbed by making it free of weeds, stumps, stones, pebbles, etc.
- Level the soil, irrigate and cover it with a black polythene film of 200 gauge for 5–6 weeks during summer.
- The side margin of the polythene film must be buried in the soil using wet soil (compressed mud) to check the loss of moisture and prevent the entry of air from beneath the polythene film.

Activity 2

Prepare a raised nursery bed.

Material required: Seedbed, spade, seeds, rotten farmyard manure, *khurpi*, watering can, mulching material (dried leaves)

Procedure

- Select a plot, which is sterilised by soil solarisation technique or with chemicals.
- Level the land and make it free from weeds, stumps, stones, pebbles, etc.
- The soil of the nursery bed is thoroughly mixed with 5–10 kg per sqm of rotten farmyard manure.
- Prepare drainage channels to drain out excess water.
- Prepare seedbeds about 15 cm high from the ground level. The width is kept 1–1.5 m and the length 3–5 m.
- A space of 30–40 cm is left between two beds in order to carry out cultural practices smoothly.
- The treated seeds are sown width-wise in lines.
- Cover the seedbeds with mulching material and water them lightly using a watering can having a fine nozzle.

Check Your Progress

A. Fill in the Blanks

1. Nursery is a place where planting _____ are raised.
2. A nursery must be located in _____ environment.
3. Temporary nursery is developed to fulfil _____ requirements.
4. Sunken beds are prepared in _____ and windy areas.
5. Raised beds are prepared about _____ high from the ground level.
6. Soil _____ is an environment-friendly method for controlling soil-borne pathogens.

B. Multiple Choice Questions

1. For seed treatment _____ is a suitable fungicide.
   (a) *carbandzim* (b) monocrotophos
   (c) copper (d) zinc
2. The soil for a nursery should preferably be_____.
   (a) clayey (b) sandy
   (c) sandy loam (d) black
3. The nursery must be free from _____.
   (a) waterlogging (b) organic matter
   (c) fertiliser (d) irrigation water
4. A _____ type of nursery protects seedlings from extreme weather conditions.
   (a) thatched roof (b) shade-net
   (c) poly-tunnel (d) None of the above
5. The type of nursery bed prepared during the rainy season is _____.
   (a) sunken (b) raised
   (c) flat (d) furrow

C. Subjective Questions

1. Describe different types of nursery.
2. What criteria will you follow while selecting a nursery site?
3. Describe the precautions to be taken during the preparation of a nursery bed.

D. Match the Columns

A	B
1. Bio-agent	(a) soil sterilisation
2. *Thiram*	(b) Protection to seedlings during high wind
3. Sunken beds	(c) Initial cost is high
4. Formalin	(d) Seed treatment
5. Permanent nursery	(e) *Trichoderma*

SESSION 2: GROWING MEDIA

Growing medium

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

Functions of growing medium

- It supplies nutrients, air and water to the roots of plants.
- It retains necessary water in the soil, while excess is drained out.
- It provides physical support to plants.
- It facilitates maximum root growth.

Characteristics of growing medium

- The medium must have adequate aeration, drainage and water-holding capacity.
- It must not be too heavy to lift.
- The medium must be slightly acidic to neutral, i.e., pH of 6–6.5 being satisfactory in most cases.
- It must be free of weeds, pests and pathogens.
- It must be easily available.
- It must not be too expensive.

Types of growing medium

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

Fig. 2.1: Garden soil

Garden soil

Light and sandy loam soil must be used as growing medium, while silty or clayey soils are not preferred due to poor aeration and stickiness. The soil contains both organic and inorganic matter. When the soil is used as a medium, it may contain disease-causing pathogens, along with weed seeds, which is a serious problem in growing crops. The soil is easily available and comparatively a cheaper medium used in a nursery (Fig. 2.1).

Fig. 2.2: Sand

Sand

Large particle size makes this medium more porous, aerated and well-drained. The water-holding capacity of this medium decreases with an increase in the size of the particles. The usual size of sand is 0.05–2 mm. Quartz sand is a useful growing medium but it lacks in nutrient content. It is relatively inexpensive and heavy. Generally, it is mixed with soil and used as a well-drained porous medium (Fig. 2.2).

Compost

Compost is formed due to the decomposition of organic matter. Leaves, grass clippings, bagasse, litter, wood waste, rice husk, sawdust and farmyard manure are some of the common ingredients used for preparing compost. Compost contains nutrients that plants need for growth. Vermicompost is a supplement that is added to a growing medium.

Sphagnum moss

Commercial sphagnum moss is a dehydrated by-product of bog plants of genus *Sphagnum*. Commonly used moss grass is comparatively light in weight, acidic in reaction, sterile in nature and has sufficient water-holding capacity. Hence, it is commercially used as a rooting medium in air layering (Fig. 2.3).

Fig. 2.3: Sphagnum moss

Peat

Peat consists of residues from marsh swamp and organic nitrogen. It helps in fast vegetative growth and is commonly used for growing newly rooted cuttings or newly germinated seeds (Fig. 2.4).

Fig. 2.4: Peat

Coir peat or coco peat

Coir peat is obtained from coir's fibre dust. It is acidic in nature and has a pH of about 5. It has a high water retention capacity (Fig. 2.5).

Vermiculite

Vermiculite is chemically hydrated magnesium aluminum iron silicate. It is produced by heat treatment of mica. It is porous in nature and light in weight. It has adequate water-holding capacity (Fig. 2.6).

Perlite

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

Sawdust

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

Fig. 2.5: Coco peat

Fig. 2.6: Vermiculite

Plant bio-regulators

These are compounds that are organic in nature but other than nutrients. These promote, inhibit or otherwise modify physiological processes in plants even when used in small amounts.

Type of plant bio-regulators

(i) Auxins	:	IAA; IBA; NAA; 2, 4D; 2, 4, 5T
(ii) Gibberellins	:	GA_3
(iii) Cytokinins	:	Kinetin, aminopurine
(iv) Ethylene	:	Ethrel (Ethephon)
(v) Inhibitors	:	Melic hydrazide (MH), ABA, 2, 3, 5 Triiodobenzoic acid (TIBA)
(vi) Retardants	:	Cycocel Chlormequat Chloride (CCC), alar, phosphon-D, B–Nine, etc.

Classes of plant growth regulators

Auxins

In plants, auxins are synthesised in the apical portion of stem and root. Auxins control growth through cell enlargement and influence developmental responses, such as apical dominance. Indole acetic acid (IAA), Indole butyric acid (IBA), Naphthalene acetic acid (NAA), and 2, 4-Dichlorophenoxyacetic acid (2, 4D) are some examples of auxins (Table 2.1).

Cytokinins

Cytokinins help transport amino acids in plants. They promote cell division and senescence. Examples are kinetin and benzyladenine.

Gibberellins

These control cell division and elongation in plant shoots. Gibberellic acid (GA_3) is an example.

Ethylene

Ethylene is a gaseous hydrocarbon and known as 'ripening hormone', e.g., ethephon, ethrel.

Abscisic acid (ABA)

Abscisic acid is, generally, considered as a growth inhibitor because of its effects on growth inhibition or senescence. It causes metabolic activities in plants, such as abscission of leaf, response to environmental stress, fruit ripening, etc.

Biological effects or physiological role of plant bio-regulators (PBRs)

Auxins

- Apical dominance
- Cell expansion
- Shoot and root growth
- Parthenocarpy
- Tropism

Gibberellins

- Cell growth
- Flower induction
- Fruit set and development
- Seed development and germination
- Parthenocarpy

Cytokinins

- Cell division
- Anti-ageing or anti-senescence effect
- Anti-stress effect
- Gall or nodule formation

Ethylene

- Senescence
- Fruit ripening
- Abscission
- Environmental stress

Abscisic acid

- Seed development
- Growth control
- Water stress
- Abscission

Growth retardants

- Reduce plant height
- Improve resistance to environmental stresses
- Reduce water consumption

Application of PGRs

Growth regulators may be applied in powder or paste form or as spray solution. It applied at low concentrations, i.e., in parts per million (ppm) (one milligram in one litre of water gives 1 ppm solution).

Table 2.1: Application of PGRs in flower crops

S. No.	Name of PGR	Crop	Concentration (ppm)	Effect on plants
1.	**Auxins**			
(i)	**IAA or NAA**	Dahlia	100–200	Delays flowering
		Orchids	90–100	Promotes root growth
			2	
(ii)	**IBA**	Bougainvillea	1000–2000	Increases shoot length
		Geranium	200	Induces rooting
2.	**Cytokinins**	Orchids	500	Enhance shoot growth
3.	**GA_3 (Gibberellic acid)**	Antirrhinum	25	Induces early flowering
		Chrysanthemum	100–400	Increases plant height, internodal length and flower stalk length
		Dahlia	100–150	Induces flowering and weight
		Gladiolus	100–200	Improves corm yield
		Petunia	500	Improves germination percentage
		Rose	100–400	Improves stem length and quality
		Tuberose	100–500	Improves bulb yield and rooting
4.	**Ethrel**	Gladiolus	500–1000	Breaks corm dormancy
5.	**Ethephon**	Carnation	600–800	Promotes branching
6.	**Benzyladenine**	Chrysanthemum	600–1000	Breaks apical dominance
7.	**B-Nine (Daminozide, Alar, Kylar)**	Geranium	1000–2000	Increases adventitious roots
		Carnation	4000	Induces early flowering Improves flower quality
8.	**MH**	Bougainvillea	1000–2000	Encourages compact bushy growth
9.	**CCC (Cycocel)**	Marigold	3000	Causes uniform and bushy growth, more branching
		Carnation	100	Induces flowering and more flower yield

Practical Exercises

Activity 1

Prepare potting media.

Material required: Sand, soil, rotten farmyard manure, pot, spade

Procedure

- Collect the required ingredients.
- Measure the volume of sand, soil and farmyard manure (FYM) as per need.
- Mix sand, soil and FYM thoroughly.
- Store the potting media in a shady place away from direct sunlight.
- Make a heap of the potting mixture for future use.

Activity 2

Identify different type of growing media.

Material required: Sand, compost, coir peat, vermiculite, perlite, sawdust, practical file, etc.

Procedure

- Collect different type of growing media available nearby.
- Identify and label them.
- Write the use of each type of growing media.

Check Your Progress

A. Fill in the Blanks

1. Compost is formed due to the decomposition of _____ matter.
2. Natural mineral of volcanic origin, which is light in weight, is known as _____.
3. Sand is a useful growing medium but it _____ in nutrient content.
4. Substrate that is used to grow plants is commonly called _____ medium.

B. Multiple Choice Questions

1. The soil that must be used as growing medium is _____.

   (a) clayey (b) sandy loam
   (c) red soil (d) acidic

2. Sphagnum moss is commercially used as a rooting medium in _____.

   (a) air layering (b)budding
   (c) grafting (d) cutting

3. Organic compound, which promotes or inhibits the growth of the plant, is known as _____.

   (a) PGR (b) nitrogen
   (c) boron (d) vermicompost

C. Subjective Questions

1. Describe the types of growing medium used in a nursery.
2. Describe the characteristics of a potting material.
3. What is the role of PGR in flower crops?

D. Match the Columns

A	B
1. Sphagnum moss	(a) Coconut husk
2. Coco peat	(b) Sufficient water-holding capacity
3. Auxins	(c) Supply nutrient
4. Potting media	(d) Apical dominance

SESSION 3: SOWING OF SEEDS AND PLANTING MATERIAL

Methods of seed sowing

Broadcasting

In this method, seeds are broadcast on nursery beds, after which the beds are covered with sieved farmyard manure (FYM) or decomposed compost. However, this method has disadvantages too, such as the seeds cannot be placed at a desired place and comparatively more quantity of seeds is required.

Line sowing

It is an appropriate method of sowing seeds in a nursery. Sowing in lines improves germination and quality of seedlings. In this method, each seed gets independent space, and grows healthy and vigorously. Here, the diseased seedlings and weeds can be easily managed.

Procedure

On a leveled bed, shallow trenches of certain depths are made with the help of a stick width-wise at adequate spacing. This depends on the size of the seeds. Small seeds are sown at shallow depths and low spacing

between rows and vice versa. The seeds are, generally, sown at a depth of 3–4 times of its diameter. They are placed singly in rows. Small seeds are mixed with sand for even distribution. The trenches are then covered with fine soil. The beds require light irrigation from sowing to transplanting by means of a fine rose can. Mulching of seedbeds by polyethylene sheet, paddy straw, etc., helps in quick and uniform germination of seeds. Mulches must be immediately removed after germination.

Seed sowing in plug-trays (pro-trays)

High-value and hybrid seeds are preferred to be sown in plug-trays (pro-trays) instead of open field nursery beds. Pro-trays are made of soft plastic having shallow plugs. These plugs are filled with planting medium. Coco peat, a by-product of the coir industry having high water-holding capacity, is commonly used as a medium in pro-trays.

Procedure

In this technique, plugs are filled with coco peat. Depressions of 0.5 to 1 cm are made at the centre of the plugs with the help of fingertips for sowing the seeds. One seed is sown in each plug. The seeds are placed in the depressions and covered with coco peat.

Fig. 2.7: Seed sowing in plug-trays

Fig. 2.8: Seed sowing by machine in plug-trays

These pro-trays are covered with a polythene sheet and kept like that for few days or till germination starts. After germination, the polythene sheet is removed and water is sprinkled with a fine nozzle can. Annual seeds are commonly sown in pro-trays filled with coco peat or other growing media.

Precautions taken during seed sowing and planting

During seed sowing

- The seeds must be healthy and free from infection.
- Small seeds are sown after being mixed with sand for equal distribution.
- The seeds must be sown at the right depth.
- The seeds must be sown at adequate spacing to avoid overcrowding. It also ensures that the seedlings get sufficient nutrients, water, sunlight and air. Besides, the soil must neither be too dry nor too wet to avoid drying or rotting of the seeds or seedings.

During planting

- Healthy and uniform seedlings must be selected and planted late in the afternoon at recommended spacing, followed by watering.

- The seedlings must be treated with fungicides to avoid soil-borne infections.
- Transplanting must not be carried out in dry, hot, sunny, windy and humid conditions.

Potting, de-potting and re-potting

Pots

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

Potting mixture

The potting mixture must be light in weight and have adequate water-holding capacity. It must allow drainage and supply adequate nutrients to plants. The mixture needs to be free from insect-pests and soil-borne pathogens. For ferns and bulbous plants, the mixture needs to be highly porous in nature, comprising coarse sand, light garden soil and leaf mould. Neem cake and bonemeal may also be used in small quantities as nutrients.

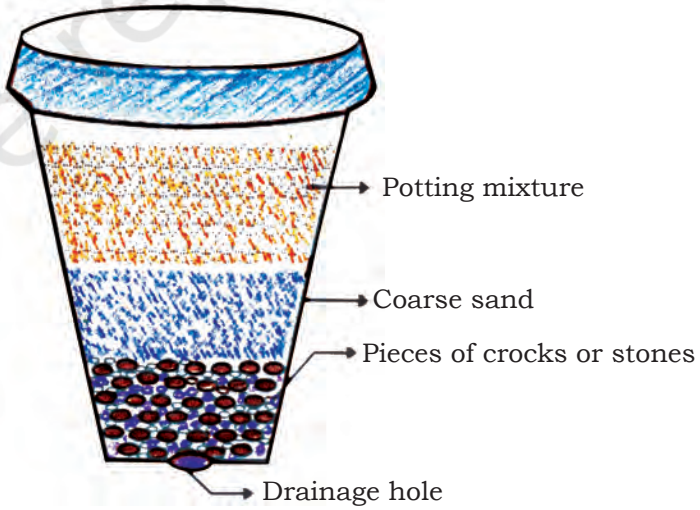


Fig. 2.9: Potting mixture

Potting of rooted cutting and young seedlings: 1 or 2 part sand + 1 part loamy soil + 1 part peat moss or leaf mould

Potting general container grown nursery stock: 2 part sand + 4 part loamy soil + 2 part peat moss or leaf mould + 1 part rotten FYM

Potting

Potting is the process of planting new plants in pots containing suitable mixture for their growth and establishment. It is a simple operation but requires a certain degree of skill and practice. The following points must be taken care of while potting a plant.

- The size of the pot must be suitable to set the plant.
- Before filling the pots, crocks of 3–5 cm must be placed at the drainage hole to avoid clogging, followed by a 5–8 cm layer of coarse sand.
- The pot is filled with the potting mixture, leaving 2.5 cm from the rim, for holding water.
- The pot can now be used for sowing seeds, potting of plants or cuttings.
- For planting, a healthy and well-rooted plant is carefully dug out from a nursery bed.
- The plant is placed with the ball of earth in the centre of the pot.
- Fill potting mixture all around the ball of earth, and press it firmly and uniformly. Care must be taken that the ball of earth is not pressed too hard as it will break and damage the roots.
- Water the plant with a fine nozzle can immediately after planting.
- Place the potted plant in a cool and shady place for establishment.
- Staking is also provided, depending on the plant type, to support the plant.
- Deciduous house plants are planted in February–March, while evergreens are planted in July–August.

De-potting

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

Procedure

The pot needs to be watered before de-potting. The pot is lifted by the right hand palm spread over the top of the soil, holding the stem between the second and third finger, and the thumb along the side of pot. The pot is then turned upside down. If necessary, a gentle tap is given on the rim of the inverted pot against a solid base or on the edge of bench to loosen the earth ball. The whole earth ball with the intertwining roots of the plant will come out as a single piece and kept outside carefully. Before transferring the plant to a new pot, the lower old and finer roots along with some old potting mixture are removed (Fig. 2.10).

Fig. 2.10: De-potted plant

Re-potting

The first step in re-potting is de-potting. A de-potted plant needs to be re-potted in a fresh pot. For better growth of house plants, re-potting and transplanting of the established plants are done once in a year or two, depending on the type of plants and their growth habit. Re-potting is done when the plants have become pot-bound or overgrown, and also the potting mixture has become devoid of essential nutrients, resulting in poor growth of the plants. Depending on the plant type, it is done in February–March or September–October. During re-potting, the old potting mixture is replaced and the overgrown roots are pruned.

Procedure

- Prune the plant lightly before re-potting to remove excess shoot growth.
- All adhering crocks along with some amount of the old mixture must be carefully removed from the base of the earth ball.
- Decayed, dead, dried, twisted and unwanted roots are removed with a sharp knife or secateurs.

Fig. 2.11: Plant with earth ball

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

Application of manures and fertilisers

Types and methods of manure application

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

Bulky manures

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

Concentrated manures

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

Fertiliser application

Time of application

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

Application of solid fertilisers

Broadcasting

Basal application: Depending on the crop, broadcasting of fertiliser is carried out prior to sowing or planting just before the last ploughing is carried out in a field.

Top dressing: When fertilisers are broadcast in a standing crop, it is known as 'top dressing'. In this method, usually, nitrogenous fertilisers and micronutrients are applied in a dense sown flower crop.

Placement

Place the fertiliser in prepared soil before sowing, irrespective of the position of the seeds. There are three types of fertiliser placement.

Plough furrow or single band placement: The application of fertilisers in narrow bands beneath and by the side of crop row or furrow is called 'band placement'. This is done during the process of ploughing. This method can be adopted:

(i) in case of low fertility of soil.
(ii) when the fertiliser reacts with soil constituents, leading to the fixation of nutrients.
(iii) in places where volatilisation loss is high.

In single band placement, fertilisers are applied on the side of the planted row. Double band placement happens when the fertiliser is applied in two bands, i.e., on both sides of the planted rows.

Deep placement: It is, generally, practised for the application of nitrogenous and phosphatic fertilisers and in fields. It is commonly recommended in dry land agriculture.

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

Application of liquid fertilisers

Foliar application

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

Fertigation

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

Care and management of nursery plants

Handling of plants

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

Shading

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

Thinning

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

Watering

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

Weeding

Weeding refers to the removal of all unwanted plants (weeds) from the nursery. Periodic removal of weeds is beneficial for the growth and development of seedlings as it prevents competition with the main plants for sunlight, water, air and nutrients. It also acts as secondary host for insect-pests and disease-carrying organisms. Thus, the nursery area must be kept free from weeds. Hand weeding and hoeing are the most common practices to remove weeds. To control a large number of weed species, pre-emergence herbicides can also be sprayed just after the sowing of seeds.

Hardening of seedlings

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

Staking

Staking is a practice to support plants growing straight and saving them from bending or lodging. This is done at a time when the plants are not too tall. It saves the plants from being blown over due to wind and rain, and also because of the weight of its stems when in bloom. It is useful in potted plants, as well as, grafted and budded plants. Bamboo is the most

common plant where staking is used. Other than this, the branches of shrubs and trees, i.e., neem, *subabool*, *phalsa*, eucalyptus, etc., can also be used for this purpose.

De-shooting

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

Disbudding

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

Pinching

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

Pruning

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

Common diseases in nursery plants

Damping-off

It is a common and serious disease in nursery plants, which can even cause their death. Damping-off is

a pre-emergence and seedling disease caused by fungi, such as *Pythium*, *Phytopthora*, *Rhizoctonia* and *Fusarium*. These fungi attack at the time of seed germination. In this disease, girdling takes place near the base of the seedlings and the infected seedlings collapse due to rotting in the collar region. Damping-off is favoured by high humidity and damp soil surface, coupled with hot and cloudy weather, vis-a-vis, dense planting. One of the best preventive measures is to maintain a dry soil surface, which helps reduce the sowing density and thins out the seedlings, leading to improved aeration. Other methods include treating the nursery bed either by soil solarisation or soil sterilisation with formalin @ 2 per cent, drenching with Copper oxychloride @ 2g/l or seed treatment with thiram or *carbendazim* @ 3g/kg.

Wilt

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

Leaf spot

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

Insect-pests in nursery

Nursery plants are tender and vulnerable to attack by various insect-pests. Various insect-pests, which infest the nursery plants are given in Table 2.2.

Table 2.2: Common insect-pests in nursery

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

Practical Exercises

Activity 1

Demonstrate seed sowing in plug-trays.

Material required: Plug-trays (pro-trays), potting mixture, seeds and fine nozzle can

Procedure

- Clean the pro-trays. Make sure that the drainage holes of the pro-trays are not blocked.
- Fill the pro-trays with coco peat.
- Make small depressions (0.5 cm) at the centre of the plugs with fingertips for the sowing of seeds.
- One seed is sown per cell and is covered with coco peat.
- Cover the pro-trays with a polythene sheet and keep it like that for few days or till germination starts.
- After germination (5–6 days), the polythene sheet is removed and water is sprinkled on the plug-trays with a fine nozzle can.

Activity 2

Demonstrate the potting of ornamental plants.

Material required: Pots, crocks, potting mixture, *khurpi*, watering can and towel

Procedure

- Select a pot as per the requirement of your plant.
- Before filling the pot, crocks of 3–5 cm must be placed at its drainage hole to avoid clogging.
- Fill the pot with 5–8 cm layer of coarse sand, leaving 2.5 cm from the rim for holding water.
- Carefully dig out a healthy and well-rooted cutting or plant from the nursery bed and place it with the ball of earth in the centre of the pot.
- Fill the potting mixture all around the ball of earth, and press it firmly and uniformly.
- Water the plant with a fine nozzle can immediately after planting.
- Place the potted plant in a cool shady place for its establishment.
- Staking is also provided, depending on the plant type, for support.

Check Your Progress

A. Fill in the Blanks

1. Line sowing an appropriate method of seed sowing in a _____.
2. _____ pots are the most popular as they are easily available, highly porous and cheaper.
3. The first step in re-potting is _____.
4. Evergreen house plants are planted in the month of _____.
5. Watering the plant must be done _____ after planting.
6. Generally, _____ seed rate is required if seeds are sown by broadcast method.

B. Multiple Choice Questions

1. High value annual seeds are, generally, sown _____.

   (a) by broadcasting (b) in line sowing

   (c) in pro-trays (d) in pots

2. The common growing medium in plug-trays is _____.

   (a) coco peat (b) sand

   (c) vermiculite (d) soil

3. Removal of plants from pots for planting is called _____.

(a) re-potting (b) de-potting

(c) potting (d) None of the above

4. Application of fertilisers through irrigation water is known as _____.

(a) surface application (b) sub-surface application

(c) fertigation (d) top dressing

5. _____ is the most common disease in a nursery.

(a) Powdery mildew (b) Damping-off

(c) Leaf spot (d) Blight

C. Subjective Questions

1. Discuss the care and maintenance of nursery plants.
2. Describe different methods of fertiliser application.
3. What do you mean by potting and re-potting? Describe their procedure.
4. What are the common insect-pests in a nursery?

D. Match the Columns

A	B
1. Top dressing	(a) Done before transplanting
2. Foliar application	(b) Water soluble fertiliser
3. Weeding	(c) Fertilisers are broadcast on standing crop
4. Hardening	(d) Practised in orchard crop
5. Ring placement	(e) Removal of unwanted plants

Gardener Class-11 Unit-2 Session-1

A. Fill in the Blanks

1. Nursery is a place where planting _____ are raised.
2. A nursery must be located in _____ environment.
3. Temporary nursery is developed to fulfil _____ requirements.
4. Sunken beds are prepared in _____ and windy areas.
5. Raised beds are prepared about _____ high from the ground level.
6. Soil _____ is an environment-friendly method for controlling soil-borne pathogens.

B. Multiple Choice Questions

1. For seed treatment _____ is a suitable fungicide.
   (a) *carbandzim* (b) monocrotophos
   (c) copper (d) zinc
2. The soil for a nursery should preferably be_____.
   (a) clayey (b) sandy
   (c) sandy loam (d) black
3. The nursery must be free from _____.
   (a) waterlogging (b) organic matter
   (c) fertiliser (d) irrigation water
4. A _____ type of nursery protects seedlings from extreme weather conditions.
   (a) thatched roof (b) shade-net
   (c) poly-tunnel (d) None of the above
5. The type of nursery bed prepared during the rainy season is _____.
   (a) sunken (b) raised
   (c) flat (d) furrow

C. Subjective Questions

1. Describe different types of nursery.
2. What criteria will you follow while selecting a nursery site?
3. Describe the precautions to be taken during the preparation of a nursery bed.

D. Match the Columns

A	B
1. Bio-agent	(a) soil sterilisation
2. *Thiram*	(b) Protection to seedlings during high wind
3. Sunken beds	(c) Initial cost is high
4. Formalin	(d) Seed treatment
5. Permanent nursery	(e) *Trichoderma*

Gardener Class-11 Unit-2 Session-2

A. Fill in the Blanks

1. Compost is formed due to the decomposition of _____ matter.
2. Natural mineral of volcanic origin, which is light in weight, is known as _____.
3. Sand is a useful growing medium but it _____ in nutrient content.
4. Substrate that is used to grow plants is commonly called _____ medium.

B. Multiple Choice Questions

1. The soil that must be used as growing medium is _____.

   (a) clayey (b) sandy loam
   (c) red soil (d) acidic

2. Sphagnum moss is commercially used as a rooting medium in _____.

   (a) air layering (b)budding
   (c) grafting (d) cutting

3. Organic compound, which promotes or inhibits the growth of the plant, is known as _____.

   (a) PGR (b) nitrogen
   (c) boron (d) vermicompost

C. Subjective Questions

1. Describe the types of growing medium used in a nursery.
2. Describe the characteristics of a potting material.
3. What is the role of PGR in flower crops?

D. Match the Columns

A	B
1. Sphagnum moss	(a) Coconut husk
2. Coco peat	(b) Sufficient water-holding capacity
3. Auxins	(c) Supply nutrient
4. Potting media	(d) Apical dominance

Gardener Class-11 Unit-2 Session-3

A. Fill in the Blanks

1. Line sowing an appropriate method of seed sowing in a _____.
2. _____ pots are the most popular as they are easily available, highly porous and cheaper.
3. The first step in re-potting is _____.
4. Evergreen house plants are planted in the month of _____.
5. Watering the plant must be done _____ after planting.
6. Generally, _____ seed rate is required if seeds are sown by broadcast method.

B. Multiple Choice Questions

1. High value annual seeds are, generally, sown _____.

   (a) by broadcasting (b) in line sowing
   (c) in pro-trays (d) in pots

2. The common growing medium in plug-trays is _____.

   (a) coco peat (b) sand
   (c) vermiculite (d) soil

3. Removal of plants from pots for planting is called _____.

(a) re-potting (b) de-potting
(c) potting (d) None of the above

4. Application of fertilisers through irrigation water is known as _____.

(a) surface application (b) sub-surface application
(c) fertigation (d) top dressing

5. _____ is the most common disease in a nursery.

(a) Powdery mildew (b) Damping-off
(c) Leaf spot (d) Blight

C. Subjective Questions

1. Discuss the care and maintenance of nursery plants.
2. Describe different methods of fertiliser application.
3. What do you mean by potting and re-potting? Describe their procedure.
4. What are the common insect-pests in a nursery?

D. Match the Columns

A	B
1. Top dressing	(a) Done before transplanting
2. Foliar application	(b) Water soluble fertiliser
3. Weeding	(c) Fertilisers are broadcast on standing crop
4. Hardening	(d) Practised in orchard crop
5. Ring placement	(e) Removal of unwanted plants

Unit 3

Plant Propagation

Introduction

Plant propagation, in simple words, may be defined as multiplication or reproduction of plants. Commercialisation of crops leads to the development of various techniques and procedures of plant propagation. Each technique has its own merits and demerits.

Each plant responds differently to different methods of propagation. Various techniques of propagation have been developed with the objective to have uniformity in crops, early bearing, increased production, resistance against pests and diseases, and introduce certain characters in new generation. These objectives have made plant propagation interesting and challenging.

Propagation of plant is the involvement of science and art in a skillful way. Basic knowledge and skill of it can be a better source of income through commercial nurseries. It helps in maintaining the plant stock and preserving endangered (extinct) species.

Plants can be propagated by sexual and asexual means. Sexual means includes propagation by seeds,

while asexual propagation is based on the utilisation of vegetative parts of plants for raising new ones. Vegetative parts of plants like shoots, leaves, roots, stem, buds and underground parts are used in different ways for reproducing new plants. The most common asexual propagation methods include cutting, layering, grafting and budding, which need specialised skill and are done differently in different plants.

Growing of tissues in controlled conditions is an advance and recent method of vegetative propagation. It is known as 'tissue culture'. It is a highly specialised technique of propagation. By using this technique, a large number of true-to-type virus-free saplings can be produced in a short span.

What is a seed?

A seed is a ripened ovule developed after fertilisation. It consists of an 'embryo' and stored food material, both of which are enclosed in a special covering known as 'seed coat'. Plants germinate from seeds when they are provided with favourable growing conditions.

TYPES OF PROPAGATION

Sexual propagation

Propagation or multiplication of plants by seeds is known as 'sexual propagation'. Seeds are formed as a result of successful fertilisation and combination of parental gametes. It is an old and easy method and is widely used for the propagation of crops like ornamental annuals, vegetables, medicinal and fruit plants, such as papaya.

Merits of sexual propagation

- Plants propagated by seeds live longer, are vigorous and more resistant to biotic (insect-pests and diseases) and abiotic stresses (environmental conditions).
- It is an easy, simple and convenient method of plant propagation.

- Some plants like papaya, marigold, chilli, capsicum, tomato, etc., cannot be propagated by asexual method.
- It is the only means of creating genetic diversity of plants.
- New varieties and cultivars of ornamental and vegetable crops can be developed only by this method.
- A large number of rootstocks for budding and grafting purpose is also raised by this method.
- Seeds can be transported easily and stored for a longer time using this method.

Demerits of sexual propagation

- Sexually propagated plants show variations and are not genetically true-to-type to the mother plants.
- Plants that are propagated through seeds have long gestation period, which results in delayed flowering and fruiting.
- Plants grow vigorously and cause obstruction in intercultural practices like harvesting and spraying.
- Advantages offered by rootstocks and scion as in asexual propagation cannot be exploited through sexual method.
- Crop species, which do not produce seeds like pineapple, banana, strawberry, fig, jasmine, hibiscus, bougainvillea, etc., cannot multiply by this method.

Asexual propagation

It is also called 'vegetative propagation'. The vegetative parts of a plant like leaf, stem, root or their modified forms are used for propagation. Most of the horticultural crops are commercially propagated by vegetative or asexual method of propagation.

Merits of asexual propagation

- Many fruit and ornamental plants that do not produce seeds are multiplied by this method.

- Plants propagated by asexual propagation are true-to-type genetically.
- By top working (using budding and grafting), old and economically low productive fruit plants can be converted into superior ones.
- Advantages offered by rootstocks and scion can be exploited through asexual method.
- Maturity is uniform and the plant gives quality yield.
- Plants propagated by asexual method are small in size, so spraying of chemicals and harvesting are easy.
- This method enables noble plant production, e.g., different colours of flowers in a single rose plant and different types of mangoes in one mango plant can be produced through asexual method only.

Demerits of asexual propagation

- By vegetative propagation, new varieties cannot be developed.
- It requires specialised skills, so it is an expensive method of propagation.
- The life span of asexually propagated plants is short as compared to sexually propagated ones.
- These plants are more prone to biotic and abiotic stresses.

Session 1: Plant Propagation by Cutting

Cutting

Cutting is a detached vegetative part of a plant, which on separation and planting is able to regenerate the missing parts and develop itself into a new plant. It is an inexpensive and quick method of propagation. A large number of uniform plants can be produced using few parent plants. It does not involve specialised skills. The method is named after the part of plant used for cutting, e.g., stem, root and leaf.

Stem cutting

Based on the age and maturity of shoots detached for vegetative propagation, stem cuttings is of four types.

(i) Hardwood cutting
(ii) Semi-hardwood cutting
(iii) Softwood cutting
(iv) Herbaceous cutting

Hardwood cutting

Such a cutting is taken from woody plants. Mostly, deciduous plants are propagated by this method. One-year old mature branch is cut into pieces of suitable sizes and planted in the rooting medium, e.g., rose, grapes, fig, pomegranate, bougainvillea, *tabernaemontana, lagerstroemia*, *jasminum,* hibiscus, etc.

Fig. 3.1: Hardwood cuttings

Procedure

- Select branches of one-year old healthy plants, having pencil thickness. Cut the branches into 10–15 cm long cuttings.
- Long cuttings are used to raise rootstocks for fruit trees. Each cutting must have at least 4–5 dormant vegetative buds. Leaves and thorns, if present, are completely removed. This checks transpiration loss.
- A slanting cut is given at the base of the cuttings just below the node and a straight upper cut is given away from the top bud.
- The cut portion will help identify the planting position. Slanting cut at the base is given so that a large area of the cuttings is in contact with the rooting medium for inducing roots.
- The secretion of hormones at the bud near the cut portion induces rooting. Straight cut at upper end reduces transpiration loss, which can be inhibited by the application of wax.
- The cuttings are planted slant-wise in a nursery bed or small poly bags for growing plants. Callus tissues form the cambium layer and rooting takes place in this region. The best season for planting the cuttings is monsoon for evergreen plants and November–February for deciduous plants. Cuttings can be planted in greenhouse or poly-house for better results.

Fig. 3.2: Semi-hardwood cuttings

Semi-hardwood cutting

A semi-hardwood cutting is taken from 4 to 9-month old shoots of current season woody plants. Most ornamental foliage plants like croton, *acalyphas, aralias, diffenbachia, russelia, cestrum, nerium,* etc., are propagated by semi-hardwood cuttings.

Procedure

Semi-hardwood cuttings are prepared from branches having pencil thickness. The length of these cuttings varies from 7.5 to 15 cm. The cuttings must have at least 4–5 dormant vegetative buds. Some leaves are retained as they help in preparing food by photosynthesis. Large leaves are reduced in size by cutting. A slant basal cut is given just near the vegetative bud and a straight top cut must be given away from the bud. The slant cut helps to expose more area of the cambium layer, which helps in more water absorption and callus formation. The upper straight cut minimises exposure to the atmosphere, which reduces transpiration loss from the cuttings. It is useful to dip the top of the cuttings in wax to check transpiration and infections. Dipping the base of the cuttings before planting in IBA @ 5000 ppm induces early rooting. The cuttings are planted in slanting position so that their maximum base is in contact with the rooting medium. The planting season for semi-hardwood cuttings is monsoon. Commercially, such cuttings are rooted under mist spray or fog.

Fig. 3.3: Softwood cuttings

Softwood cutting

Such a cutting is taken from herbaceous or succulent plants. Shoots of 2 to 3-month old plants are selected for softwood cuttings. Examples are *alternanthera*, *coleus*, *duranta*, *clerodendrum*, etc.

Procedure

Softwood cuttings are prepared from tender but mature branches. The length of these cuttings varies from 10–12 cm. Tender shoots do not have sufficient food material. Hence, all leaves present on the shoots are retained for photosynthesis. The cutting material are gathered early in the morning and must be kept moist by keeping them in a wet cloth. Sandy loam medium is the best for planting softwood cuttings.

Herbaceous cutting

Such a cutting is taken from herbaceous plants. Shoots of 1 to 2-month old plants are selected for herbaceous cuttings. Examples are chrysanthemum, *iresine*, *pilea*, dahlia, petunia, carnation, marigold, etc.

Procedure

Herbaceous cuttings are made from tender succulents, especially the leafy part of the stems of herbaceous plants. Terminal, measuring 8–12 cm, of a healthy shoot is cut and the basal leaves are removed, leaving the upper leaves undisturbed. The cuttings once detached must not desiccate at the cut and are rooted well under mist. The application of auxins promotes the regeneration of adventitious roots. Sandy loam medium is the best for planting herbaceous cuttings.

Fig. 3.4: Herbaceous cuttings

Leaf cutting

Selection of cutting

Plants with thick fleshy leaves having buds are propagated by leaf cutting. Vegetative buds are present in the notches of leaf margin (*bryophyllum*) or on the vein (*begonia rex*). Leaf blade or pieces of it with bud are put on the rooting medium under favourable conditions. In case of black raspberry, the leaf blade, along with petiole and a short piece of the stem with

Fig. 3.5: Propagation through leaf (bryophyllum)

attached axillary buds, are kept in the medium for rooting. Plants like snake plant (*senseveria*), blackberry, *rhododendron and bryophyllum* are propagated by this method.

Practical Exercise

Activity

Prepare hardwood cutting.

Material required: Branch of bougainvillea, secateurs or sharp cutter, rooting hormone IBA, nursery bed

Procedure

- Select a healthy bougainvillea plant.
- Now, select a matured branch of last season growth of bougainvillea and separate it from the plant.
- Remove the leaves over it without damaging the buds.
- Leave one or two petioles at 5–10 cm distance on the branch.
- Cut the branch into cuttings of 10–15 cm length with at least 3–4 buds on each cutting.
- Make a slanting sharp cut at the bottom just below the node and avoid crushing the stem.
- Dip the basal portion in rooting hormone like IBA of requisite concentration.
- Plant the stem cutting upright or in slanting position in rows in the sand bed at a distance of 10 cm between rows, as well as, within the rows.
- Keep the newly planted cuttings in partial shade until new shoots sprout from the buds.
- Keep the cuttings moist at all times by providing them with adequate air circulation and sunlight.
- After sufficient rooting, transfer the cuttings into a polythene bag or pot.

Check Your Progress

A. Fill in the Blanks

1. Multiplication or reproduction of plants is called _____.
2. Plants that do not produce seeds are propagated by _____.
3. Growing of tissues in controlled conditions is known as _____.
4. The process of reproduction of plants by seeds is called _____ propagation.
5. Plants propagated by _____ live longer.

6. Sexually propagated plants show _____.
7. Plants propagated through seeds have _____ juvenile phase.
8. Vegetative propagation is also called _____ propagation.
9. Bougainvillea is propagated by _____.

B. Multiple Choice Questions

1. *Bryophyllum* is propagated by _____.
   (a) root cutting (b) stem cutting
   (c) leaf cutting (d) seeds
2. Jasminum is propagated by _____.
   (a) root (b) stem
   (c) leaf (d) seed
3. Asexually propagated plants _____.
   (a) are true-to-type (b) bears late fruit
   (c) live longer (d) have large canopy
4. Hardwood cutting is, generally, used in _____ branch.
   (a) one-year old (b) two-year old
   (c) three-year old (d) four-year old

C. Subjective Questions

1. Differentiate between sexual and asexual propagation.
2. Write the advantages and disadvantages of sexual propagation.

D. Match the Columns

A	B
1. Cutting	(a) *Coleus*
2. Seed	(b) Leaf cutting
3. Softwood cutting	(c) Detached vegetative part of plant
4. *Bryophyllum*	(d) Sexual propagation

Session 2: Plant Propagation by Layering

Layering

It is an attached method of propagation. In this method, roots are allowed to develop on the covered portion of the stem while still being attached to the mother plant. After the emergence and development of the roots, this portion is separated from the mother plant and allowed to grow as a new plant on its own root stem. Such root stem is known as 'layer'.

Types of layering

(i) Simple layering
(ii) Compound or serpentine layering
(iii) Trench layering
(iv) Mound layering or stooling
(v) Air layering

Simple layering

In simple layering, a partial tongue-like cut is given on a branch. The branch is then bent to the ground and the treated portion is covered with soil, keeping the top or terminal portion exposed. The layered branches produce roots in weeks and are ready for transplanting in a nursery after detaching them carefully. Examples are jasmine, *ixora*, *clerodendron*, *pyrostegia*, etc.

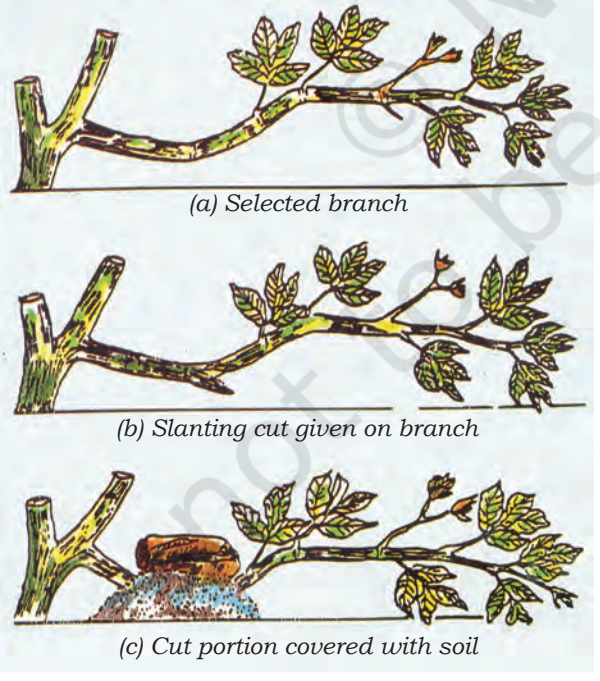


Fig. 3.6 (a–c): Simple layering

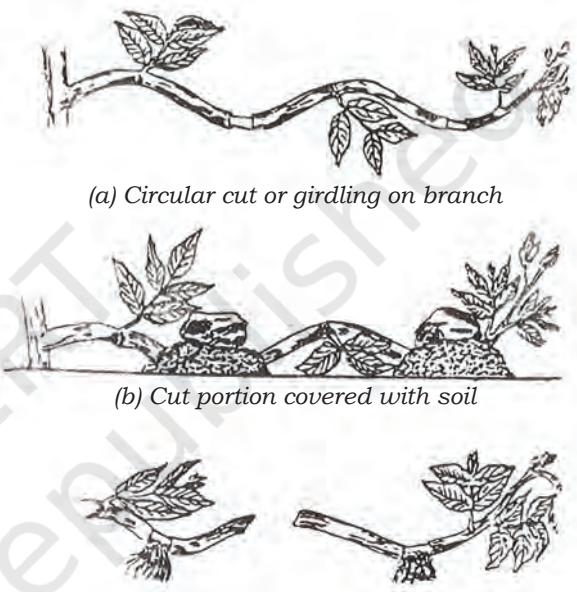
Procedure

Select one-year old healthy, flexible, long un-branched shoot near the ground level. Remove leaves of the selected shoot, retaining some at the top. The retained leaves prepare food through photosynthesis. Bend down the shoot so that some part of it touches the ground. At that portion, generally, 15–30 cm away from the terminal end, a sharp slanting inward cut of 2–3 cm is given. A small matchstick is inserted in the cut to keep the slit open. Bend down the branch and cover the cut part with soil. Keep some weight or stone over the buried part so that it is not pulled upward, and remains

in the same position. A stake is fixed near the layered branch and the branch operated upon is tied with it. Water the layered portion regularly. After 3–4 weeks, rooting starts at the operated portion and this can be indicated by sprouting buds on the shoot. After this, the layer is separated from the mother plant and planted in a new place.

Compound or serpentine layering

Compound layering is similar to simple layering, except the branches are alternately covered and exposed along their length. The branches must be longer so that they can be layered at several places. This method is followed in plants like bougainvillea, jasmine, clematis, muscadine grape and wisteria.



(a) Circular cut or girdling on branch

(b) Cut portion covered with soil

(c) Branch prepared for planting

Fig. 3.7 (a–c): Compound or serpentine layering

Procedure

One-year old healthy and flexible long shoot near the ground is selected for compound layering. The selected stem is placed in soil in a way that the nodes at certain distance are covered under the soil and the intermediate internodes are exposed. Remove leaves from the selected branch but retain few leaves at the top. Give two circular cut around the bark about 2.5–4 cm wide. Remove the bark of the operated portion (girdling). Apply rooting hormone to the girdled portion and cover it with soil. The same branch is operated at 3–4 places at certain distance in the same way. The growing shoots, which emerge from the covered portion of the branch, are separated from the mother plant for planting in a nursery.

Trench layering

Trench layering is primarily used in fruit plants. Covering the shoots with soil results in etiolation, so it is also known as 'etiolation layering'. New shoots arise from the length of the burried branches. After rooting, individual shoots are separated from the mother plant. This method is followed in apple, cherry, pear, jasmine and rhododendron.

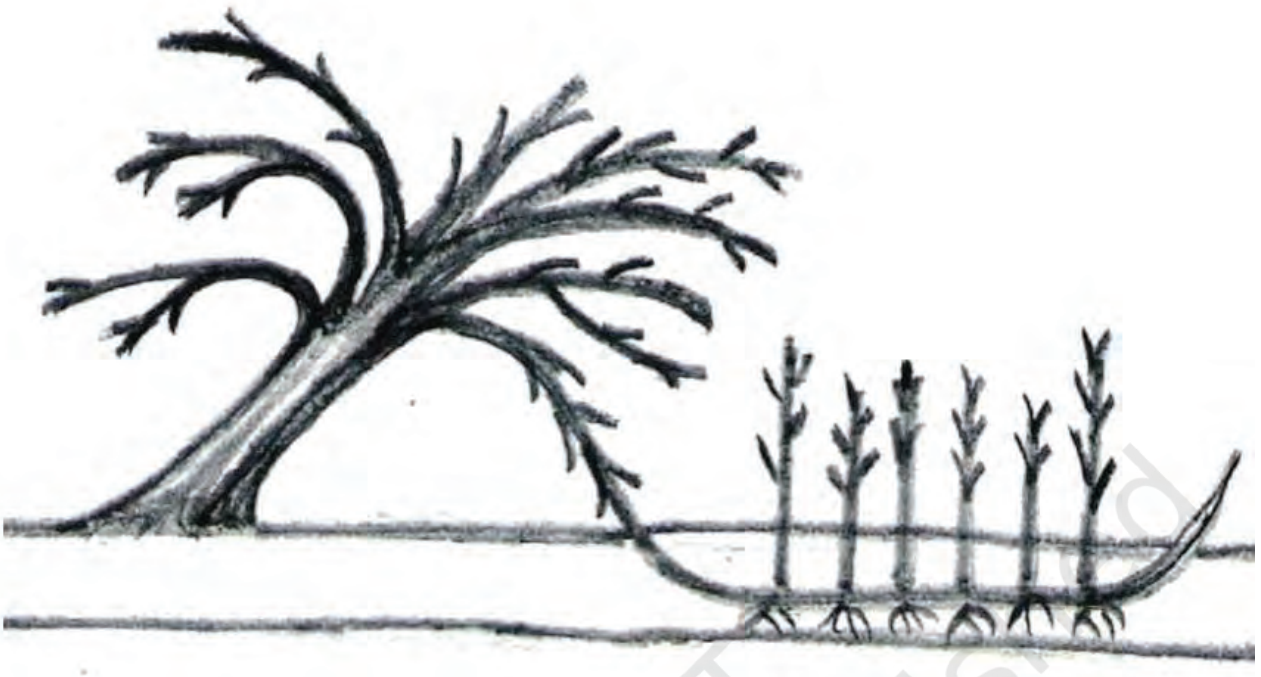


Fig. 3.8: Trench layering

Procedure

One-year old healthy and flexible long shoot near the ground is selected. The selected stem is placed in a shallow trench in a way that the middle portion of it is buried. Remove leaves from the branch but retain few leaves at the top. Cover the whole branch with moist soil 5–10 cm deep. The terminal portion is left exposed to manufacture food and hormones for the developing plants. After some weeks, shoots arise from the nodes, which are covered by soil. The covering of the shoots with soil results in etiolation of the shoots and helps in rooting. Individual shoots with roots (layers) are separated from the mother plant and planted in a nursery.

Mound layering or stooling

This method is followed in plants whose branches are firm and difficult to bend. The selected plant must be at dormant stage at the time of layering.

Procedure

Cut back the upper portion of the plant 2.5 cm above the ground level. After few days, new shoots will emerge. When the shoots grow to a height of 7–15 cm and

become little sturdy, place loose soil around them so that they are half buried. When the shoots attain a height of 20–25 cm, again add soil around them so that they are half buried. Water the heaped soil regularly. It will take 3–4 months to get the layers. Cut the rooted layers close to the base from the mother plant and plant it in a nursery. Examples are apple, guava, currant, gooseberry, pear, etc.

Fig. 3.9 (a–e): Mound layering or stooling

Air layering

It is also known as 'gootee'. Examples are *Ficus elastica*, *Callistemon*, croton, monstera, citrus fruits, lychee, philodendron, pomegranate, etc.

Procedure

Select healthy, vigorously growing aerial branch having pencil-size thickness. The selected branch must be of the past growing season. Girdle the selected branch up to 2–3.5 cm wide just below the node 15–30 cm back from the tip of the shoot. A strip of the bark from the girdled portion is removed. Scrap the girdled portion, which helps in the removal of phloem tissues and prevents formation of bark at the girdled portion. Excessive moisture from sphagnum moss is squeezed out before placing it over the cut portion. A piece of polyethylene film is carefully wrapped around the branch so that the sphagnum moss is completely covered. Both the ends of the polyethylene film are made airtight by tying

them with strings. The layer is removed from the parent plant when roots are observed through the transparent polyethylene film. It takes 2–3 months for rooting. Rainy season is the best for air layering.

Practical Exercise

Activity

Demonstrate simple layering.

Material required: Sharp knife, stone pieces or hooks or pegs, polythene bags, secateurs and matchstick

Procedure

- Select one-year old healthy and flexible long un-branched shoots near the ground level.
- At a distance of 15–30 cm back from the tip, make a sharp slanting inward cut and insert a matchstick.
- Bend the shoot gently to the ground so that the cut part can be inserted into the soil.
- Cover the rooting region with soil.
- Keep a stone on the part covered with soil in order to retain the layer in place.
- Drive a vertical stake to the soil by the side of the layered branch.
- Tie the branch to the stake with a gunny thread.
- Water the layered portion regularly till rooting starts.

Check Your Progress

A. Fill in the Blanks

1. In _____ layering, a partial tongue-like cut is given on a branch.
2. Layering is an _____ method of propagation.
3. Vigorously growing _____ branch is used for air layering.
4. In mound layering, cut back the plant at _____ cm above the ground level.

B. Multiple Choice Questions

1. Plant propagated through air layering is _____.
   (a) croton (b) gaillardia
   (c) jasmine (d) rose
2. Air layering is also known as _____.
   (a) gootee (b) simple layering
   (c) compound layering (d) None of the above

3. In trench layering, the whole branch buried in soil is up to _____cm deep.
   (a) 1–2 (b) 3–4
   (c) 5–10 (d) 12–15
4. The same branch is operated at 3–4 places at certain distance in _____ layering.
   (a) trench (b) simple
   (c) air (d) compound

C. Subjective Questions

1. Write the procedure of compound layering.
2. Discuss in detail the process of air layering.

D. Match the Columns

A	B
1. Air layering	(a) Plant must be at dormant stage
2. Circular removal of bark	(b) Apple
3. Mound layering	(c) Girdling
4. Trench layering	(d) Serpentine layering
5. Compound layering	(e) Gootee

SESSION 3: PLANT PROPAGATION BY GRAFTING

Grafting

The method of joining parts of two plants in a manner that they form a unit and function as one plant is known as 'grafting'.

Advantages of grafting

- Plants propagated by grafting are true-to-type, and bear flowers and fruits early.
- The plants can be multiplied and preserved by grafting.
- Local variety of older plants can be improved to superior variety by top working.
- Wounded or damaged tree trunks can be repaired by special grafting methods.
- Rootstock has an influence on resistance, vigour and quality of grafted plants.

- Certain rootstocks, which are tolerant to saline and alkaline soils and other adverse conditions, can be used for grafting.

Disadvantages of grafting

- It requires specialised skill.
- It is an expensive method of propagation.
- New varieties cannot be developed by grafting.
- Plants produced through grafting are short lived as compared to plants propagated by seeds.
- When contaminated tools or propagation material are used in grafting, newly propagated plants may also get infected.

Rootstock

The part of the graft that provides root system to the grafted plant is known as 'rootstock'. It is, normally, raised by seeds in the seedbed, and then, transplanted in the nursery bed for budding and grafting. Rootstocks are also raised in pots and polythene bags.

Characteristics of rootstock

- Adaptable to local climatic conditions
- Resistant to adverse climatic and soil conditions
- Resistant or tolerant to pests and diseases
- Propagates easily
- Compatible with scion
- Promotes early healing and formation of cambium layer

Raising of rootstock

Generally, rootstocks are raised by seeds (mango and citrus fruits), or sometimes, by cuttings (rose). Seeds are sown or cuttings are planted on raised beds or in poly bags for raising rootstocks. After the germination of seeds or rootings of cuttings, the seedling rootstocks are transplanted in poly bags or nursery beds. Once they reach the stage of growth, they are used as rootstocks for grafting or budding. Sometimes, the rootstocks are not of the same species, e.g., for grapes (*Vitis vinifera*), the rootstock used is a related species *Vitis berlandieri.*

Scion

The upper portion of graft combination taken from the desired plant to be multiplied is known as 'scion'.

Characteristics of scion

- Scion wood must be of the previous season but not from more than one-year old plant.
- Flowering shoots or shoots from where the harvesting is recently done must be avoided.
- Healthy and well-developed vegetative buds must be selected.
- The scion or bud sticks must be selected from known performing orchard trees.

Selection of scion

- The mother plant must be vigorous, high yielding, true-to-type and free from undesirable bud mutation and viral diseases.
- It is advisable to collect scion from grown-up trees.
- It must be preconditioned by defoliating the branch before it is used for budding or grafting. Defoliating helps the buds to swell.

Methods of grafting

Grafting methods can be grouped into the following.

Scion attached method

In this method, the scion shoot is not detached from the mother plant until the union takes place. After the successful union of the scion and rootstock, the scion is separated in gradual cut from the mother plant. For making the grafting handy, the rootstock is grown in a container or polythene bag. This method is followed in plants, in which successful graft unions are difficult to obtain. 'Approach grafting' is a type of scion attached method. It is classified into two types.

- Sliced approach grafting
- Tongue grafting

Approach grafting

Approach grafting is also known as 'inarching'. The main feature of approach grafting is that two

independent self-sustaining plants are grafted together. After the successful union of the graft, the scion plant is detached below the graft union from the mother plant and the top of the rootstock plant is removed above the graft. This method is useful for plants, in which successful graft unions are difficult to obtain. This method is, usually, performed for plants growing in a container, as well as, big trees. In the latter case, the rootstock seedling is brought near the scion branch by erecting a platform.

Selection of grafting material

Approach grafting can be done in two ways, and accordingly, their names are given as 'sliced approach grafting' and 'tongue approach grafting'. In both the methods, the success of grafting depends on the thickness of the scion and rootstock. Both must be compatible and comfortable at the union. The rootstock and scion must be of almost the same thickness. Select the scion branch on the mother plant of desired characteristics.

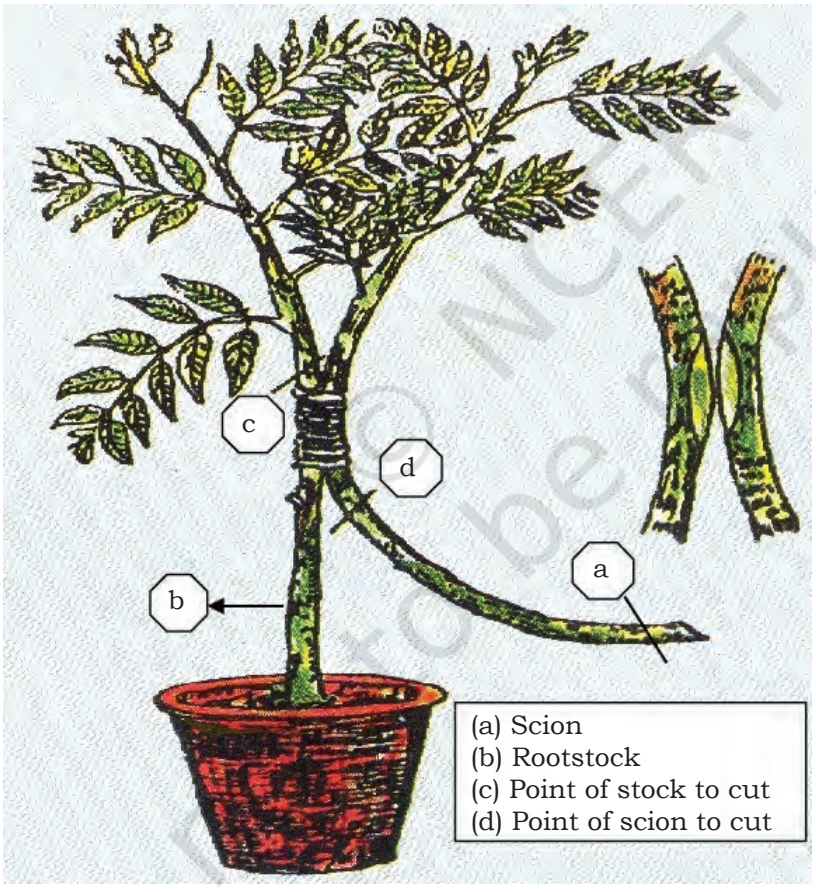


Fig. 3.10: Approach grafting (inarching)

Sliced approach grafting

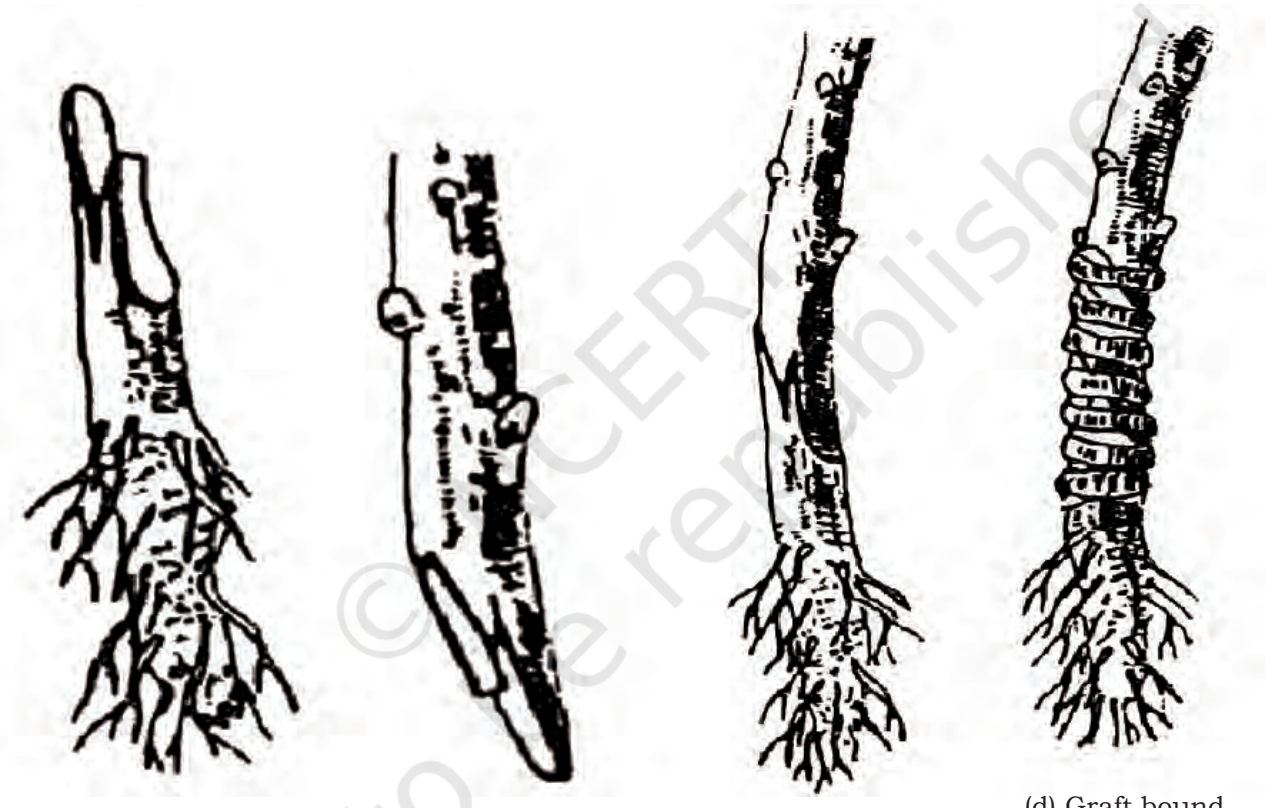
Procedure

- Bring the selected rootstock and scion close together.
- Find out the most comfortable point of contact.
- At the point of contact, a thin slice of wood along with a 2.5 to 5-cm long bark from the rootstock and the scion is removed.
- The operated size must be uniform on both the stems of the rootstock and the scion.

- The cut surfaces are then brought together so that they cover each other completely by overlapping. Press them firmly together and tie them with a waxed string or polythene tape, so that water does not enter.
- After successful union, head back the rootstock above the union and cut the scion below the union, e.g., mango, guava, sapota, etc.

Tongue grafting

This method differs from the former as cuts are given on both the scion and rootstock.



(a) Root portion (b) Prepared portion (c) Fitted graft (d) Graft bound with tape

Fig. 3.11 (a–d): Tongue grafting

Procedure

- Bring the selected rootstock and scion close together.
- Find out the most comfortable point of contact.
- Remove a slice of wood along with a 2.5 to 5-cm long bark from the rootstock and scion.

- A second slanting partial cut downward on the stock and upward on the scion is made, producing a thin tongue-like structure of the same size on the stem of the stock and the scion.
- Insert the scion in the stock so that these tongue cuts interlock.
- All operated portions must be in contact with each other.
- Tie the operated portions.

Scion detached method

This method is a more popular method of grafting and comparatively easier to perform. Besides, the rate of success of plant propagation is more in this case. In this method, the scion is first detached from the mother plant, and then, inserted or tied on the rootstock. The types of scion detached method are:

- Veneer grafting
- Side grafting
- Wedge or cleft grafting
- Stone or epicotyl grafting
- Whip or splice grafting
- Bark grafting

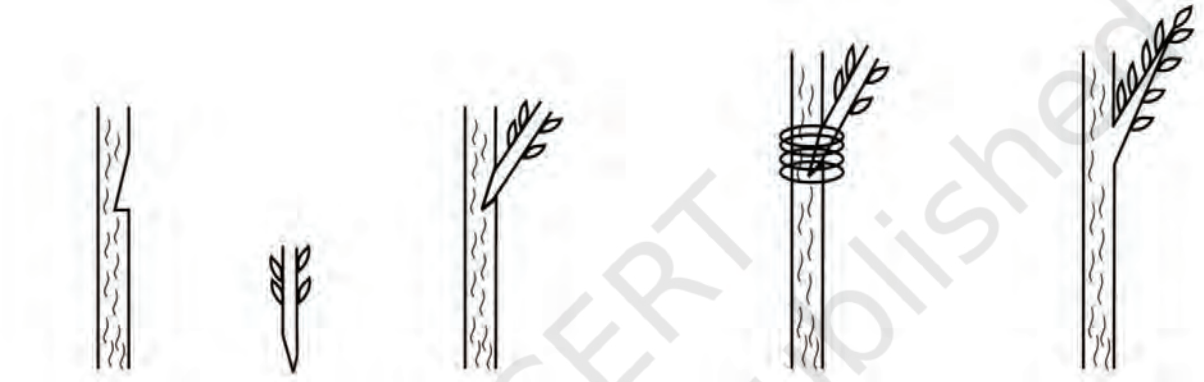
Veneer grafting

It is a simple and economical method of grafting. It the most ideal method for establishing in situ orchards and top working of old unproductive orchards. The best time in north India for veneer grafting is March–April and July–August. Mango, cashew and peach are commercially propagated by this technique. Veneer grafting differs from side grafting. In this, the vertical flap of the stock is completely removed and a slanting cut is given on one side of the scion.

Procedure

- A shallow 3 to 5-cm long downward cut is made on the selected rootstock.
- At the base of the first cut, a short inward and downward cut is made that intersects the first cut.
- In between both the cuts, remove the piece of wood along with the bark by making a small notch in the rootstock.

- The scion is operated with a matching long cut on one side and a short cut on the opposite side is given at the base.
- Insert the scion and fix it in the rootstock. Care must be taken to ensure that the cambium layer matches at least one side of the cut surface.
- Wrap and tie the scion and rootstock firmly.
- Cut back the rootstock above the union after successful union.
- This method is used for grafting conifers, deciduous trees and shrubs.



(a) Prepared stock (b) Prepared scion (c) The scion is inserted in the stock (d) Wrapped scoin and stock (e) Prepared plant

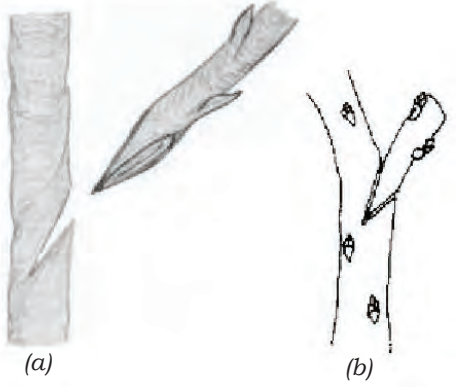
Fig. 3.12 (a–e): Veneer grafting

Side grafting

In this method, the operated scion is inserted into the side of the established rootstock, which has more girth than the scion, e.g., hibiscus.

Selection of material

- A rootstock of 2.5 cm diameter is selected.
- The scion needs to have 3–5 buds and must be about 7.5 cm long.
- The scion must be comparatively thinner than the rootstock.



(a) (b)

Fig. 3.13 (a–b): Side grafting

Procedure

- Use a sharp knife for cutting the scion.
- On the stem of the rootstock, a slanting downward and inward cut of about 2.5–5 cm deep is made.

- A wedge of the same size (2.5–5 cm) of the scion is prepared by two slanting cuts oppositely towards the base.
- The scion is then inserted into the operated rootstock.
- Pour wax and make the operated portion waterproof.
- Wrap and tie the grafted portion to keep it intact.
- After the graft is complete, cut the stock above the union.

Cleft grafting

It is comparatively a simple and an easy method of grafting, which is widely used in fruit trees, e.g., mango, jackfruit, *bael*, *amla*, etc.

Selection of material

- The scion must be a terminal shoot with 3–5 buds.
- It must be of the current season and in active growth.
- The scion shoot is defoliated about two weeks ahead of being separated from the mother plant.
- This will help accumulate food in the shoots. As a result, the buds on the shoots become swollen.
- As compared to the rootstock, the thickness (diameter) of the scion may be the same or less.

Procedure

- The rootstocks of required plant species are raised in poly bags.
- The seedling of the suitable rootstock, which is 4 to 5–month old is selected.
- Head back the rootstock.
- A sharp vertical downward cut of 3–5 cm is made in the centre of the stem.
- Two slanting cuts of the same length (3–5 cm) as in the rootstock are given on the sides towards the base on the scion shoot.
- This will give a wedge-shaped appearance to the scion stick.
- The wedge-shaped scion is inserted in the split of the rootstock.
- Insert the scion in a way that it matches the cambium layer at least on one side with the stock.

- Tie the grafted portion firmly in position with a polythene tape.
- After successful union, the terminal buds of the scion begin to sprout.
- Loosen or remove the polythene tape to allow the shoot to grow normally.
- It is better to stake the newly grafted plant.

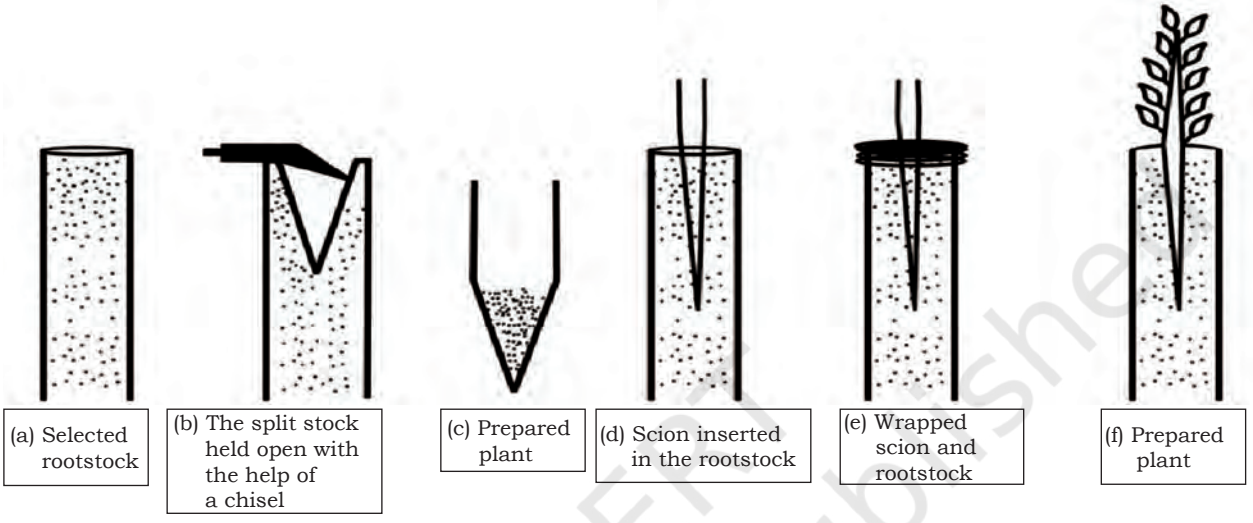


Fig. 3.14 (a–f): Cleft grafting

Stone or epicotyl grafting

This method is commonly adopted for the rapid multiplication of mango plants. In this method, stones (seeds) are sown in polythene bags or moist sand bed and covered with 5 to 7-cm layer of leaf mould for germination. When the seedlings are about 15 days old, they are taken out and grafted indoor.

Selection of material

- Young mango seedlings with copper coloured leaves (15 days old) are used as rootstocks.
- Young (current season growth) 3 to 4-month old shoot with pencil thickness is selected as the scion on the mother plant.
- The scion must have 4–5 terminal (apical) buds.
- Defoliate the selected shoot 15 days prior to grafting.
- Defoliation makes the buds swollen and induces early sprouting.

Procedure

- A wedge in the scion is made at the base by giving two slanting cuts of 5 cm.
- Head back the stock by giving a straight horizontal cut.
- From the centre of the stock, give a 5-cm long vertical cut downward.
- Insert the wedge-shaped scion in the split portion of the stock so that the operated portion is in full contact.
- Tie the graft firmly with a polythene strip. The successful graft sprouts and new shoots emerge. Such grafts are ready for planting within one year, e.g., mango.

Whip or splice grafting

It is the oldest method of grafting. This method is used in fruit trees like apple, pear, walnut, etc.

Selection of material

Select one-year old rootstock. The rootstock and scion must be of uniform thickness. The scion must be 10 to 15 cm long having 4–5 swollen buds. The rootstock must be in active growth phase and sap-flowing condition. It is mostly performed in early spring season.

Procedure

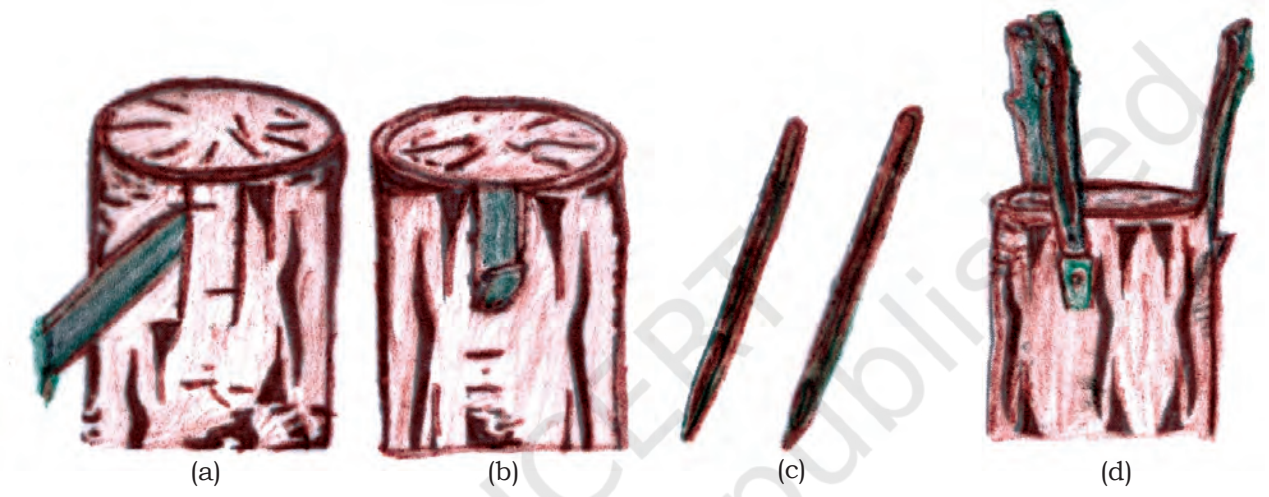
- Head back the rootstock terminally.
- Give a slanting cut of 2.5–5 cm downwards from the top.
- Operate similarly but reversely on the scion.
- On the scion, a slanting cut of the same size is given from the base upward.
- The cuts on both the stock and scion need to be smooth.
- Put the operated portions on each other so that they form a single stem.
- Wrap the union with a polythene tape or a special nursery tape.
- The tape must be removed after the graft has healed, else the growth is restricted around the union, and such plants break due to the force of wind.

Bark grafting

A plant graft made by slitting the bark of the stock and inserting the scion beneath it is called 'bark grafting'. It is commonly used in top working.

Selection of material

- The bark of the rootstock must be in sap-flowing condition.
- The scion must be in dormant condition.
- The scion must be 10–13 cm long and have 3–5 dormant buds.



(a) Remove the bark

(b) Flap of the bark opened to receive scion

(c) Prepared scion

(d) Insert the scion into the rootstock

Fig. 3.15 (a–d): Bark grafting

Procedure

First method

- A vertical cut of 3–5 cm is made in the bark of the stub of the rootstock.
- To prepare wedge shape of the scion, a 3 to 5-cm long cut is made at the end of the scion, followed by another cut on the opposite side of the first cut.
- Slightly lift the bark of the rootstock of the cut portion.
- Insert the wedge-shaped scion into the rootstock and cover it with the bark of the rootstock.
- After grafting, the exposed cut surfaces of the stub and scion are covered with wax.
- Several scions may be used for grafting on a single stock, according to the width of the stub.

Second method

- Two cuts of 5 cm are made on the bark of the stub and the bark is lifted.
- At the base of the scion, a 5-cm long slanting cut is given.
- On the opposite side of the first cut, a slanting cut of 1.5 cm is made so as to form a wedge.
- The operated scion is inserted in the loose bark of the rootstock.
- Care must be taken to have a long cut of the scion towards the wood of stem and wedge at the base.
- After grafting, the exposed portion must be waxed.

Grafting for special purposes

Grafting for special purposes is done for quality improvement and repair. Grafting is done on established plants to improve their quality, e.g., side grafting and top working. It is also done to rejuvenate old or injured trees, for example bridge grafting.

Bridge grafting

This method is used for repairing wounds in trees made by implements, frost, rodents or diseases. In this grafting, the bark of a tree is damaged, resulting into girdling. A completely girdled tree will die. Bridge grafting repairs girdling.

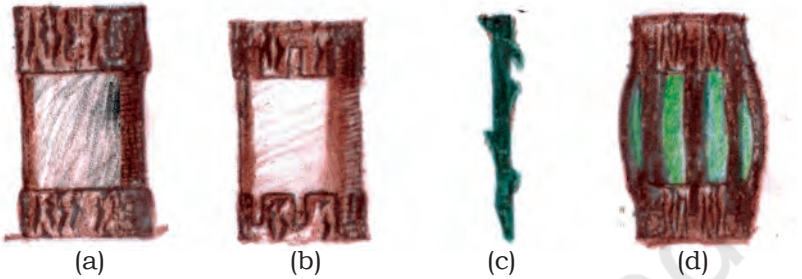
Selection of material

- The rootstock must be in sap-flowing condition.
- The scion comprises one-year old dormant shoots of 6–12 mm in diameter.
- The number of scion sticks depends upon the size of the wound to be repaired.
- The selected scion may be of the same or a compatible plant.

Procedure

- Trim the wounded area by removing the dead bark.
- The cuts are made in the bark at the top and bottom of the wound at 5 to 7.5 cm distance.
- Long slanting cuts are given on the scion at the top, as well as, bottom.

- Both the cuts must be on the same side.
- A sharp wedge of scion is made by an additional short, slanting cut opposite to the first.
- Prepare the required number of scions in the same way.
- Buds on the scion(s) are removed.
- The operated portion of the scion is inserted in each slot of the bark on the rootstock in a way that the wedge remains under the flap of the bark at each end.
- The scions must be put in upright position. The graft unions at top to bottom are waxed.



(a) Remove the bark from the rootstock

(b) Prepared rootstock

(c) Prepared scion

(d) Insert the scion into the prepared rootstock

Fig. 3.16 (a–d): Bridge grafting

Top working

Top working is a method of grafting by which inferior or older plants are rejuvenated into superior or new ones. Top working is, generally, adopted in plants with long leaves. It is suitable for plants like apple, avocado, citrus fruits and vegetable, mango and shrubs or vines. Top working can be done by top grafting or top budding. For top working, cleft, whip, wedge or side grafting methods can be used, according to the suitability of a plant. Top working is, usually, done during spring.

Selection of material

- Prepare the rootstock and scion by any of the above suitable method.
- Usually, 3–5 scaffold branches must be used for rejuvenation in top working.
- In frame working, the secondary scaffold branches are used for grafting.
- The branches to be worked with must be well-distributed around the trunk.
- The branches must be 3–10 cm in thickness.
- Scion sticks of the desired cultivar with 7–10 dormant buds are selected.

Precautions

- Observe the progress of the branches of a top worked tree every 3–5 days.
- Cracks developed in the wax coating must be re-waxed.
- Whitewash the trunk to avoid sunburn.
- The scion must also be protected from the Sun by keeping the graft in shade.
- New shoots developing from scions are tied to stakes to avoid breaking off due to winds.
- New growth on older branches and trunk must be removed from time-to-time.
- The top worked trees must be regularly irrigated and manured.

Practical Exercises

Activity 1

Demonstrate veneer grafting.

Material required: Rootstock and scion of mango plant, grafting knife and grafting tape

Procedure

- Select a one-year old healthy rootstock of a mango plant.
- Select the scion of desired variety having 3–5 buds and about 7.5 cm in length.
- Make 2.5 to 5-cm long shallow cut on the rootstock downwards, and at the base of the first cut, a short inward cut is made. Then, remove the bark and wood.
- Make a cut of the same size on the scion and a very short cut at the base of the scion opposite to the long cut.
- Insert the scion and fix it into the stock.
- Wrap and tie the grafted portion with a polythene tape to keep the union intact.
- After the graft is completed, cut the stock above the union.

Activity 2

Demonstrate cleft grafting.

Material required: Rootstock, scion, grafting knife, grafting tape, etc.

Selection of material

- The scion must be taken from the terminal shoot of current season growth with 3–5 buds.

- The scion shoot is defoliated about two weeks ahead of separation from the mother plant.

Procedure

- Raise the rootstock of the required plant in a poly bag.
- Select 4 to 5-month old suitable rootstock and cut the terminal portion (head back).
- A sharp vertical straight downward cut of 3–5 cm is given at the centre of the stem.
- Two slanting cuts of the same length (3–5 cm), as in the rootstock, are given on the scion shoot at the opposite side towards the base.
- Insert the scion in a way that it matches the cambium layer at least on one side with the stock.
- Tie the grafted portion firmly with a polythene tape.
- After successful union, the terminal buds of the scion begin to sprout.
- Loosen or remove the polythene tape to allow the shoot to grow normally.
- Stake the newly grafted plant.

Check Your Progress

A. Fill in the Blanks

1. Rooted plant on which scion is grafted is called _____.
2. Desirable plant containing dormant buds is called _____.
3. Joining parts of two plants together so as to enable them to function as one plant is known as _____.
4. In _____ grafting, two independent self-sustaining plants are grafted together.
5. In _____ grafting, two cuts are given on both the scion and rootstock.

B. Multiple Choice Questions

1. Veneer grafting is appropriate for_____.
   (a) mango (b) guava
   (c) lemon (d) pomegranate
2. Older and inferior plant can be rejuvenated through _____.
   (a) hardwood cutting (b) approach grafting
   (c) veneer grafting (d) top working

3. Rootstock and scion are required in _____.
   (a) layering (b) grafting
   (c) cutting (d) gootee
4. Epicotyl grafting is also called _____ grafting.
   (a) stone (b) cleft
   (c) wedge (d) whip grafting
5. Top working can be done by _____.
   (a) top grafting (b) stone grafting
   (c) veneer grafting (d) tongue grafting

C. Subjective Questions

1. Describe cleft grafting.
2. How does the union of rootstock and scion take place?
3. What is top working?
4. What is approach grafting?
5. Enlist the characteristics of rootstock.
6. Write the procedure of stone grafting.

D. Match the Columns

A	B
1. Scion detached method	(a) Approach grafting
2. Epicotyl grafting	(b) Raised by seeds
3. Scion attached method	(c) Bark grafting
4. Rootstock	(d) Mango

SESSION 4: PLANT PROPAGATION BY BUDDING

Budding

Budding is the process of inserting a single mature scion bud into the stem (rootstock) in a way that results into a union and continues to grow as a new plant. It is also a type of grafting.

Types of budding

There are many methods or techniques of inserting bud into the rootstock. Some of the common methods are as follows.

T–budding

Since a 'T'-shaped incision is made for bud insertion on the rootstock, it is called T–budding. T–budding is also called 'shield budding' as the bud used for insertion is in the shape of a 'shield'. It is widely used for propagating fruit trees and ornamental plants. In this method, the rootstocks of compatible plants are raised in beds or poly bags.

One-year old rootstock of a healthy and vigorous growth is selected. A T-shaped cut is made at a height of 15–25 cm from the ground level on the rootstock with the help of a sharp knife. Also, a vertical cut, extending up to 2.5–3.75 cm is given on the bark in the internodes. At the top of this vertical cut, another horizontal cut is given in such a way that the two cuts resemble the shape of 'T'. Now, the bark of the cut portion is loosened. The bud from the desirable plant is selected. The shield-shaped bud along with the woody chip is removed from the scion stick. The bud is inserted in the T-shaped cut in the stock. After the insertion of the bud with the help of a budding knife, the bud and stock are firmly wrapped with a polyethylene strip, exposing the bud. The bud sprouts within a month. Examples are rose, apple, pear, peach, apricot, cherry, sweet orange, etc.

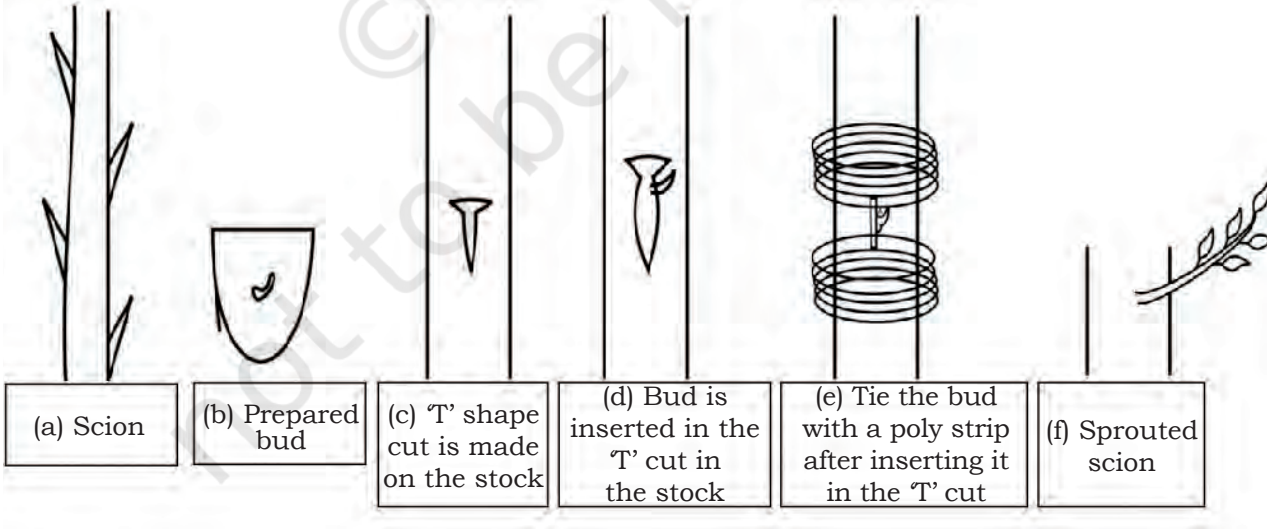


Fig. 3.17 (a–f): T–budding or shield budding

Patch budding

A rectangular patch of bark, measuring 2.4×1.5 cm (length and width), is completely removed from the internodes of the stock plant. A similar patch of bark with a healthy bud is removed from the scion bud stick. This patch is placed on the cut portion of the stock and wrapped with a polyethylene strip, keeping the bud exposed. This type of budding is useful for the propagation of plants having a thick bark. Examples are *amla*, mango, *jamun*, rubber, etc.

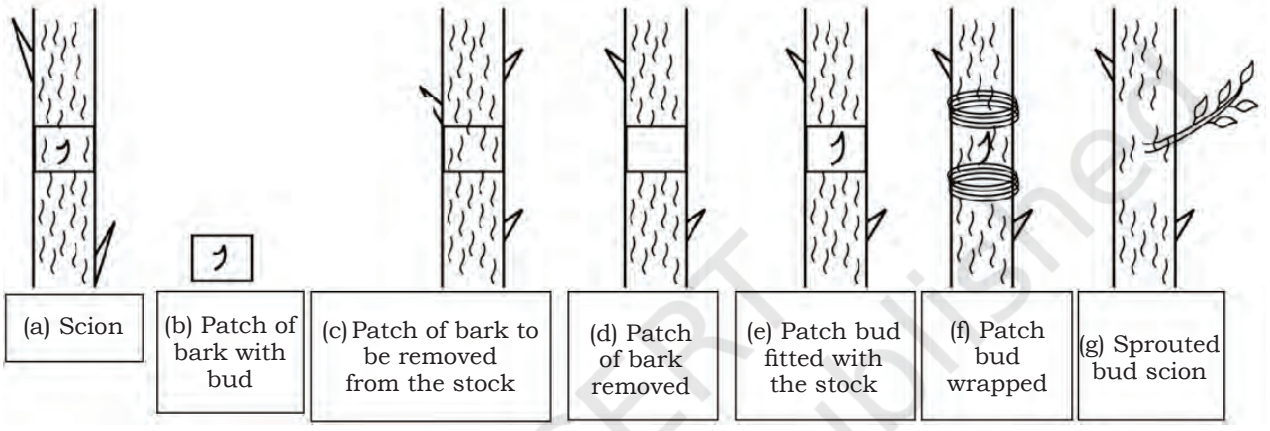


Fig. 3.18 (a–g): Patch budding

Ring budding

In this method, a bark of approximately 3–6 cm wide in ring form is removed from the stock. The same dimension of bark with a healthy bud is removed from the scion bud stick and placed on the stalk. After placing the ring in position, tie it with a polythene strip, keeping the bud exposed, e.g., *ber* and cherry.

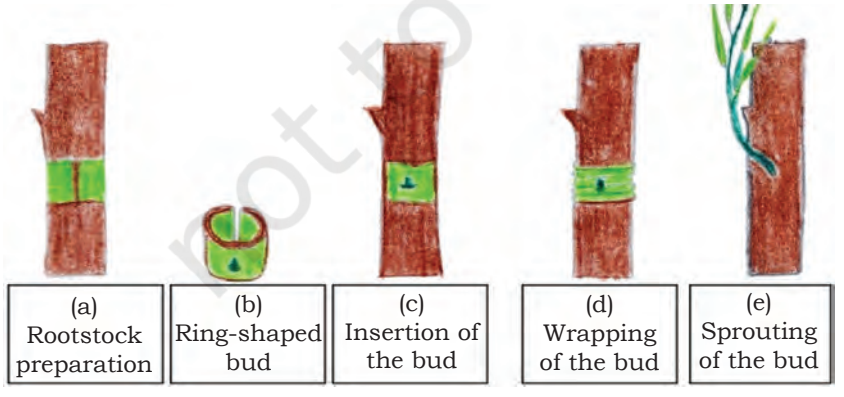


Fig. 3.19 (a–e): Ring budding

Flute budding

This is a slight modification of ring budding. Instead of removing the complete ring, a narrow portion of the bark about 1/8 of its circumference is left on the stock. A similar

portion of the scion is removed along with the bud and is fitted on the cut portion of the stock. The bark of the stock and bud are tied with a polyethylene strip, exposing the growing point e.g., *ber*.

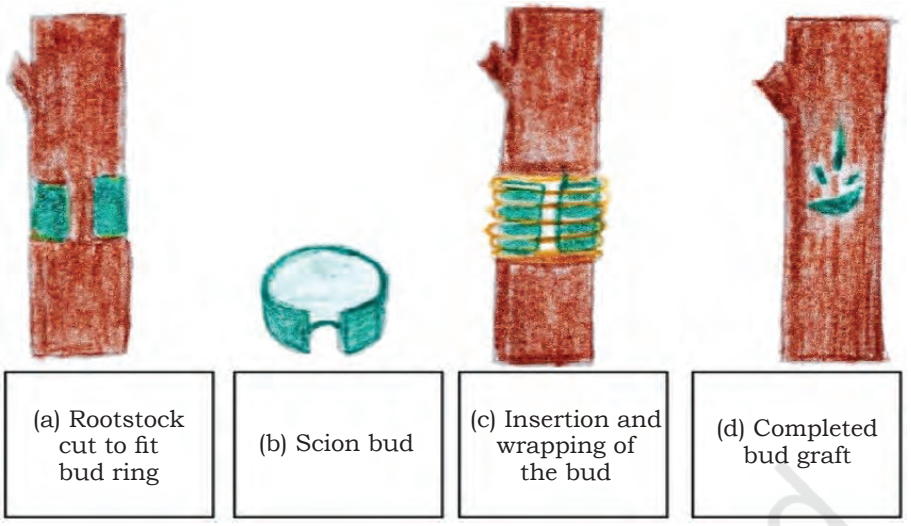


Fig. 3.20 (a–d): Flute budding

Forkert budding

In forkert method, a horizontal cut at the internodes of the selected rootstock is given at a distance of 20–25 cm above the ground level. Two vertical cuts from either ends of the horizontal cut, extending downwards, are taken and a flap of the bark is pulled out, exposing a rectangular woody portion of about 2.5×5 cm on the rootstock. A rectangular piece of bark of the same size along with a matured bud is removed from the bud stick with the help of a budding knife. This piece of bark is then shifted over the exposed

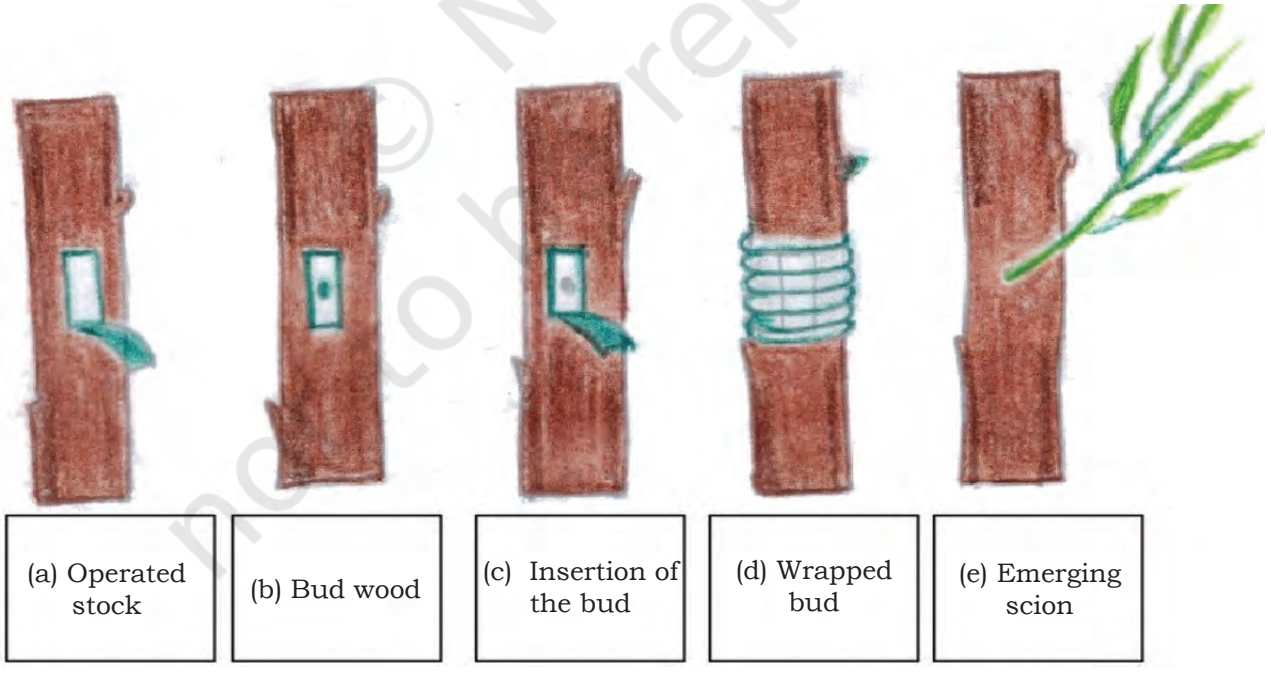


Fig. 3.21 (a–e): Forkert budding

portion on the rootstock. The flap of the bark is loosened and tied to its original position, covering the scion bud fitted inside. After three weeks, the polyethylene strip is removed and the flap of the bark is pulled out for observation. If the bud shows sprouting signs, the flap is removed by giving a horizontal cut on the downside. Then, the polyethylene strip is wrapped, keeping the growing point exposed. The bud sprouts within 3–5 weeks of budding operation. Examples are cashew nut, jackfruit, mango, etc.

Chip budding

This method is followed when the bark is thin and cannot be removed easily. In this method, a piece of thin bark, along with some wood piece, is removed between two nodes of the rootstock, and the same size of chip, which is similar in shape and is collected from the scion, is placed on the rootstock. This is mostly practised in February–March. Fruits like apple, grapes and pear can be propagated through this technique.

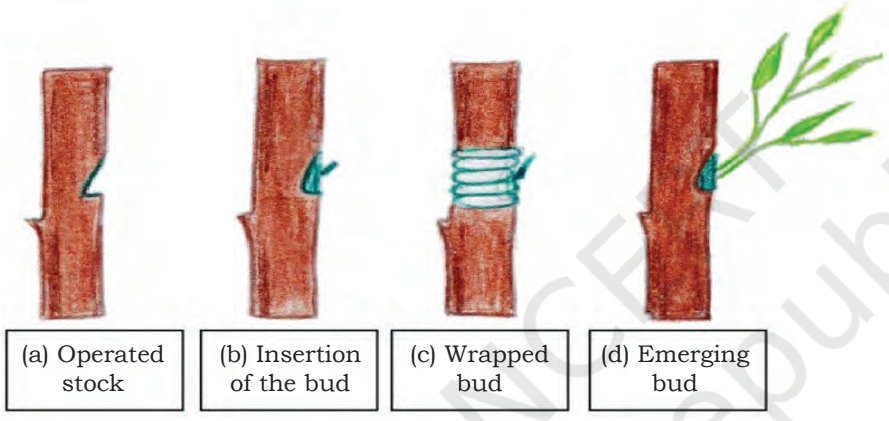


Fig. 3.22 (a–d): Chip budding

Tissue culture

It is a technique for growing plant tissues isolated from the parent plant in an artificial medium and controlled environment over a prolonged period under aseptic conditions. It is used on commercial scale in gerbera, orchid, banana, carnation, anthurium, etc. It is based on the phenomenon of 'totipotency' of a cell, which denotes the capacity of a plant cell to regenerate into a full-fledged plant having different organs.

Callus is produced on explant *in vitro* due to wounding and growth substances, either endogenous or supplied exogenous in the medium. For the collection of explants, plant parts, such as stem, root or leaves

can be used. After disinfestation, they are induced to form 'callus'. Examples are banana, papaya, gerbera, carnation, rose, orchid, etc.

Plant propagation by specialised organs

Specialised organs are modified stems or roots, developing above the ground surface or underground, which may be used for multiplication of plants. In horticulture, bulbous ornamentals include bulbs, corms, tubers, tuberous roots and rhizomes.

Bulb

Bulb is a specialised underground structure having a flat basal stem and surrounded by fleshy scales, e.g., onion, tuberose, amaryllis. Structurally, bulbs are tunicated and non-tunicated. In tunicated bulbs, the outer layer of scales is converted into dry membranous covering, which gives protection, e.g., onion, tuberose, amaryllus, tulip, etc. Non-tunicated bulbs do not possess the enveloping dry covering and are represented by lilium.

Corm

Corm is an underground modified solid or compressed stem oriented vertically in the side having nodes and buds, e.g., gladiolus, crocus, etc.

Tuber

It is an underground storage organ having special swollen modified stem or roots, e.g., root tuber like dahlia, caladium, dioscorea, Jerusalem artichoke, etc; and stem tuber like begonia, potato, etc.

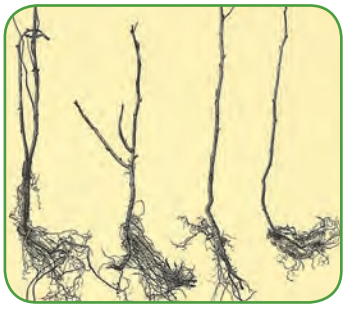
Rhizome

A modified stem of some plant growing horizontally just below the ground surface, e.g., *canna*, ferns, ginger, iris, etc.

Runner

It is a modified stalk, which is creeping in nature, produced in the leaf axil and grows out from the parent plant. It grows horizontally along the ground, where roots are produced at the nodes, which can be used

(a) Runner (chlorophytum)



(b) Sucker

(c) Rhizome (canna)

(d) Corm (gladiolus)

(e) Bulb (tuberose)

(f) Root tuber (dahlia)

Fig. 3.23 (a–f): Plant propagation by specialised organs

to produce new plants, e.g., *doob* grass, strawberry, *chlorophytum,* etc.

Sucker

It is a special shoot arising from the root or stem portion of a plant below the ground level, e.g., chrysanthemum (stem), *Clerodendron splendens* (root suckers), anthurium, etc.

Tuberous root

It refers to a swollen tuberous growth that functions as a storage organ. Examples are *satavar*, dahlia, *chlorophytum*, etc.

Practical Exercise

Activity

Demonstrate T–budding.

Material required: Secateurs, budding knife, rose rootstock, scion and budding tape

Procedure

- Select and prepare a rootstock with the help of secateurs.
- Make a 'T' shape cut with the help of a budding knife.
- Gently open the bark of the rootstock with the help of a bud opener.
- Prepare the bud with the help of a budding knife.
- Insert a shield bud into the 'T' cut.
- Wrap this portion with a polythene strip.

Check Your Progress

A. Fill in the Blanks

1. The art of inserting a scion bud into rootstock is known as _____.
2. T–budding is also known as _____ budding.
3. Lilium is propagated by _____.
4. Dahlia and caladium are propagated by _____.
5. A slight modification of ring budding is known as _____ budding.

B. Multiple Choice Questions

1. Chlorophytum is propagated by _____.
   (a) runners (b) suckers
   (c) rhizomes (d) tuberous roots
2. T-budding is mostly practised in _____.
   (a) cherry (b) lilium
   (c) sweet potato (d) rose
3. In general, the age of a rootstock must be _____ old.
   (a) one-year (b) two years
   (c) three years (d) four years
4. Chip budding is applicable when the bark of a plant is _____.
   (a) thick (b) thin
   (c) rough (d) smooth

5. Multiplication of a plant in controlled environment under aseptic condition is known as _____.

   (a) tissue culture (b) protected culture

   (c) hydroponic (d) soilless culture

C. Subjective Questions

1. What is budding?
2. Describe the procedure of T-budding

D. Match the Columns

A	B
1. Ring budding	(a) *Doob* grass
2. Sucker	(b) Tulip
3. Tunicated bulb	(c) Lilium
4. Runner	(d) Chrysanthemum
5. Non-tunicated bulb	(e) *Ber*

Gardener Class-11 Unit-3 Session-1

A. Fill in the Blanks

1. Multiplication or reproduction of plants is called _____.
2. Plants that do not produce seeds are propagated by _____.
3. Growing of tissues in controlled conditions is known as _____.
4. The process of reproduction of plants by seeds is called _____ propagation.
5. Plants propagated by _____ live longer.
6. Sexually propagated plants show _____.
7. Plants propagated through seeds have _____ juvenile phase.
8. Vegetative propagation is also called _____ propagation.
9. Bougainvillea is propagated by _____.

B. Multiple Choice Questions

1. *Bryophyllum* is propagated by _____.
   (a) root cutting (b) stem cutting
   (c) leaf cutting (d) seeds
2. Jasminum is propagated by _____.
   (a) root (b) stem
   (c) leaf (d) seed
3. Asexually propagated plants _____.
   (a) are true-to-type (b) bears late fruit
   (c) live longer (d) have large canopy
4. Hardwood cutting is, generally, used in _____ branch.
   (a) one-year old (b) two-year old
   (c) three-year old (d) four-year old

C. Subjective Questions

1. Differentiate between sexual and asexual propagation.
2. Write the advantages and disadvantages of sexual propagation.

D. Match the Columns

A	B
1. Cutting	(a) *Coleus*
2. Seed	(b) Leaf cutting
3. Softwood cutting	(c) Detached vegetative part of plant
4. *Bryophyllum*	(d) Sexual propagation

Gardener Class-11 Unit-3 Session-2

A. Fill in the Blanks

1. In _____ layering, a partial tongue-like cut is given on a branch.
2. Layering is an _____ method of propagation.
3. Vigorously growing _____ branch is used for air layering.
4. In mound layering, cut back the plant at _____ cm above the ground level.

B. Multiple Choice Questions

1. Plant propagated through air layering is _____.
   (a) croton (b) gaillardia
   (c) jasmine (d) rose
2. Air layering is also known as _____.
   (a) gootee (b) simple layering
   (c) compound layering (d) None of the above
3. In trench layering, the whole branch buried in soil is up to _____cm deep.
   (a) 1–2 (b) 3–4
   (c) 5–10 (d) 12–15
4. The same branch is operated at 3–4 places at certain distance in _____ layering.
   (a) trench (b) simple
   (c) air (d) compound

C. Subjective Questions

1. Write the procedure of compound layering.
2. Discuss in detail the process of air layering.

D. Match the Columns

A	B
1. Air layering	(a) Plant must be at dormant stage
2. Circular removal of bark	(b) Apple
3. Mound layering	(c) Girdling
4. Trench layering	(d) Serpentine layering
5. Compound layering	(e) Gootee

Gardener Class-11 Unit-3 Session-3

A. Fill in the Blanks

1. Rooted plant on which scion is grafted is called _____.
2. Desirable plant containing dormant buds is called _____.
3. Joining parts of two plants together so as to enable them to function as one plant is known as _____.
4. In _____ grafting, two independent self-sustaining plants are grafted together.
5. In _____ grafting, two cuts are given on both the scion and rootstock.

B. Multiple Choice Questions

1. Veneer grafting is appropriate for_____.
   (a) mango (b) guava
   (c) lemon (d) pomegranate
2. Older and inferior plant can be rejuvenated through _____.
   (a) hardwood cutting (b) approach grafting
   (c) veneer grafting (d) top working

3. Rootstock and scion are required in _____.
   (a) layering (b) grafting
   (c) cutting (d) gootee
4. Epicotyl grafting is also called _____ grafting.
   (a) stone (b) cleft
   (c) wedge (d) whip grafting
5. Top working can be done by _____.
   (a) top grafting (b) stone grafting
   (c) veneer grafting (d) tongue grafting

C. Subjective Questions

1. Describe cleft grafting.
2. How does the union of rootstock and scion take place?
3. What is top working?
4. What is approach grafting?
5. Enlist the characteristics of rootstock.
6. Write the procedure of stone grafting.

D. Match the Columns

A	B
1. Scion detached method	(a) Approach grafting
2. Epicotyl grafting	(b) Raised by seeds
3. Scion attached method	(c) Bark grafting
4. Rootstock	(d) Mango

Gardener Class-11 Unit-3 Session-4

A. Fill in the Blanks

1. The art of inserting a scion bud into rootstock is known as _____.
2. T–budding is also known as _____ budding.
3. Lilium is propagated by _____.
4. Dahlia and caladium are propagated by _____.
5. A slight modification of ring budding is known as _____ budding.

B. Multiple Choice Questions

1. Chlorophytum is propagated by _____.
   (a) runners (b) suckers
   (c) rhizomes (d) tuberous roots
2. T-budding is mostly practised in _____.
   (a) cherry (b) lilium
   (c) sweet potato (d) rose
3. In general, the age of a rootstock must be _____ old.
   (a) one-year (b) two years
   (c) three years (d) four years
4. Chip budding is applicable when the bark of a plant is _____.
   (a) thick (b) thin
   (c) rough (d) smooth
5. Multiplication of a plant in controlled environment under aseptic condition is known as _____.
   (a) tissue culture (b) protected culture
   (c) hydroponic (d) soilless culture

C. Subjective Questions

1. What is budding?
2. Describe the procedure of T-budding

D. Match the Columns

A	B
1. Ring budding	(a) *Doob* grass
2. Sucker	(b) Tulip
3. Tunicated bulb	(c) Lilium
4. Runner	(d) Chrysanthemum
5. Non-tunicated bulb	(e) *Ber*

Unit 4

Garden Tools and Equipment

Introduction

A Gardener needs different kind of tools and equipment for carrying out various horticultural operations. In olden days, garden tools were made of bones, wood, stones and metals. However, with the advancement of science and technology, the use of metals like copper, steel and iron has led to the development of various kinds of garden tool and equipment like hand cultivator, tractor, lawn mower, harrow, spade, secateur, garden fork, sprinkler, rake, pruning saw, spray pump, grass shear, budding-cum-grafting knife, etc.

These tools and equipment can be categorised as 'hand tools' and 'power equipment'. Hand tools are less expensive than power equipment. They often serve multiple purposes, and are easier to use in small spaces. Power equipment require fuel, electricity or battery for functioning. They help make labour-intensive tasks easier. These tools and equipment, designed to perform different operations, help in carrying out day-to-day farm tasks efficiently, easily, timely and economically. These have revolutionised farming and gardening worldwide.

Hence, it is necessary to choose the appropriate tool for performing a task effectively and timely.

TILLAGE

Tillage is the most important operation, in which physical manipulation of soil is done with tools and implements in order to obtain favourable conditions for plant growth. The harder surface soil is dug out to a certain depth, and the resulting big clods are broken down to make the soil fine, smooth and compact. This facilitates weed eradication, removes crop residues, helps in water infiltration, promotes aeration, and permits root penetration and development. Different operations, such as ploughing and levelling of field soil, harrowing, etc., are also performed under tillage operation. In soil, a tilth appears when it is soft, friable and aerated. All these activities involve the use of different tools and equipment. The selection of an equipment depends on its efficiency and size of the holding.

IMPLEMENTS USED FOR LAND PREPARATION

Ploughing is the initial operation that involves breaking of hard soil surface, uprooting previous crop residues and pulverising the soil. Different type of ploughs can be used for ploughing. Mouldboard, disc, rotary and sub-soil ploughs are some of the implements designed for breaking soil.

Mouldboard plough

It is made up of carbon steel or steel alloy, whose base is of a right-angle triangle. The size of a mouldboard plough is measured by the width of the furrow that is opened by the plough. Generally, it can open a furrow of about 20 cm and above. It may throw furrow slices only on one or two sides of the motion.

Disc plough

It consists of moving circular steel discs of varying sizes. The size of discs includes its diameter and thickness. Discs in different ploughs used are 50–90 cm

in diameter. The thickness of the discs may be 2.5 cm at the cutting edge and up to 40 cm towards the centre. Some discs are 7.5 cm at the edge, which are thickened to 20 cm towards the centre. Discs cut, turn and break furrow slices. The plough can work in sticky, as well as, hard and dry soils. It cannot be used when the soil surface is covered with weeds and bushes.

Sub-soil single arm (*Patashi*) plough

This plough is useful for heavy soils and consists of a single adjustable arm, having shear at the base. It breaks the hard pan developed below the soil surface. It improves drainage in water stagnant soils. It can be inserted up to 50 cm deep in the soil and is most suitable for making a trench of 5 to 7 cm wide.

Fig. 4.1: Disc harrow

Harrow

It is used for deep tillage of the soil by breaking up and smoothening the hard surface to provide a tilth of soil structure, which is suitable for the sowing of seeds. There are four kind of harrows viz., disc, tine (including spring-tooth), chain-disc and chain harrows.

Plank

Levelling of land and smoothening of the soil surface are the most important operations for sowing, planting and irrigation of crops. To perform these operations effectively and timely, different structures, such as level boards, *patela* or wooden plank are used. Levelling is, usually, done in two phases.

- While levelling higher sides, excess soil is dug out and spread over the lower areas to make the whole plot even.
- The second and more precise levelling is done after ploughing.

Cultivator

It is used to stir and loosen the soil, break clods and destroy weeds present the soil. Cultivator performs

Fig. 4.2: Cultivator

intermediary ploughing and harrowing. It also maintains tilth, aeration, prevents run-off and evaporation losses. Cultivators may be of shovel, disc and blade type. Tine and spike cultivators are used to bring the soil to fine tilth (Fig. 4.2).

Garden tools

Mower

A mower is used for cutting grass in lawns and fields. The discs or blades of the mower are made of high-carbon steel. These discs are mounted in spiral fashion on a centre shaft, which rotates at high speed and results in the cutting of field grass and weed plants. The rotating cutting blades, having spiral mounting, cause progressive cutting action across the anvil blade. The anvil blade is a flat blade sharpened at the edges and can be adjusted. In between the rotating sharp blades, grass and weed plants are trapped and cut due to shearing action. The machine also has front rollers for adjusting the height of the cut grass and a grass box at the rear to collect the cut grass while it is in operation. Rotating disc mowers are available with electric motors or are driven by engines.

Bill hook

It is a hook-shaped implement having single or double cutting edge, consisting of a curved blade attached with a plastic or wooden handle. It has a blade made of high-carbon steel and manganese steel. The blade's length is 13 cm and width 2 cm. Bill hook is used for cutting shrubs and lopping old or dead branches of a tree. It is used for carrying out heavy pruning operations (Fig. 4.3).

Fig. 4.3: Bill hook

Budding-cum-grafting knife

A budding-cum-grafting knife is a combination of two knives used for carrying out budding and grafting operations. It consists of two blades, one for carrying out budding and the other for

Fig. 4.4: Budding-cum-grafting knife

grafting. These knives are fixed to the ends of a handle. Both the knives are made of high-carbon or alloy steel. The knives are foldable into the handle. The length of the knife may be 6.5–7.5 cm and width 1.5 cm (Fig. 4.4).

Pruning or slashing knife

It is mostly used for removing unwanted and dense branches or twigs on plants. The knife made of carbon or alloy steel is tightly fit into the wooden or plastic handle. The tip of the knife is slightly hooked or curved for easy cutting or slashing small branches (Fig. 4.5).

Fig. 4.5: Pruning knife

Pruning shear

A pruning shear is meant for cutting branches, de-shooting, disbudding, cutting of scion sticks, defoliation of leaves from the sticks and topping-off small trees. Pruning shears are named according to the type and are single cut, double cut, parrot nose cut, roll cut, etc. A pruning shear has two blades, in which one is sharp, made of high-carbon or alloy steel, and another is blunt, made of copper and is used to support the cutting branch. Both of these are fitted to a handle each. The handles are made of mild steel, which are covered with plastic tubes. The branch to be cut is held in between the blades and the handles are pressed together.

Secateur

Secateur is meant for cutting branches, de-shooting, disbudding, cutting of scion sticks, defoliation of leaves from the sticks, topping-off small trees, etc. It is also useful in pruning pencil-thick branches and making cuttings for propagation (Fig. 4.6).

Fig. 4.6: Secateur

Hedge shear

It is used for performing various garden operations like pruning, cutting and trimming of hedge and shrubs, and making them look attractive. It consists

Fig. 4.7: Hedge shear

of two cutting blades with tongs. These are made of high-carbon steel in a single piece. The tongs are inserted for better grip in a wooden handle. The size of the shear is according to the size of the blades, varying from 15 to 30 cm in length and 0.8 cm in thickness (Fig. 4.7).

Grass shear

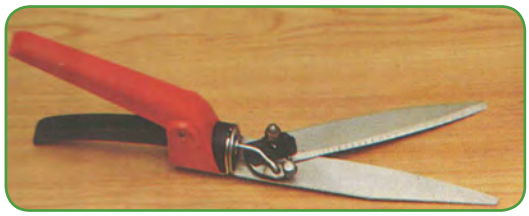


Fig. 4.8: Grass shear

Grass shear is used to maintain a lawn. It is used for trimming and side-dressing of the lawn. The most important part of a grass shear are the cutting blades, which are made of high-carbon or alloy steel. The blades are sharp at the cutting edges. These are joined to a 'V'-shaped spring steel handle, which always keeps the shearing blades open. Cutting takes place due to the shearing action of the blades. The length of the blade varies and is, usually, 15–20 cm (Fig. 4.8).

Spade

Fig. 4.9: Spade

It is made of cast iron and is used for digging or turning over the soil, making bunds in the field and small plots, etc., (Fig. 4.9).

Rake or garden rake

Fig. 4.10: Rake

It is used for breaking up the soil surface into a fine tilth, ready for sowing and collecting weeds and stones (Fig. 4.10).

Garden hoe

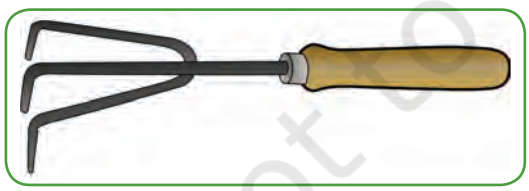


Fig. 4.11: Garden hoe

It is a long handle with a paddle and blade at the end. It is useful for cultivating the garden soil and carrying out weeding operations. There are different types of garden hoe made for specific uses (Fig. 4.11).

Khurpi

Fig. 4.12: Khurpi

It is made of cast iron with a wooden handle attached to one side. It is meant for

weeding, lifting of seedlings and plants in a nursery, transplanting plants in pots and field, and performing various other gardening operations (Fig. 4.12).

Sprayer

It is used for spraying insecticides, fungicides, herbicides, fertilisers and various other chemicals in a field. A variety of sprayers are available in the market to suit the requirements of different plants (Fig. 4.13).

Fig. 4.13: Sprayer

Watering can

It is used for watering seedbeds, nursery beds and potted plants to avoid washing off the soil and causing damage to young seedlings (Fig. 4.14).

Fig. 4.14 Watering can

Pruning saw

It is used to cut thicker branches of plants (Fig. 4.15).

Fig. 4.15: Pruning saw

Wheelbarrow

It can be used to move heavy things from one place to another, and also to collect trash in the garden (Fig. 4.16).

Fig. 4.16: Wheelbarrow

Hand cultivator

It is used for altering and loosening the soil without causing damage to the roots of plants in a garden or nursery (Fig. 4.17).

Fig. 4.17: Hand cultivator

Fig. 4.18: Tree purner

Tree pruner

It is used for pruning the shoots of trees, which are beyond reach from the ground level (Fig. 4.18).

Flower scissors or cutters

These are used for cutting flowers along with the stems. A flower scissor has two short blades with handles (Fig. 4.19).

Fig. 4.19: Flower cutter

Precautions to be taken when using tools and equipment

- Keep all tools and equipment out of children's reach.
- Handle them with care and follow the instructions given in the manual provided with the equipment.
- In case of an accident, immediately contact a doctor.
- Ensure that all equipment are functional.
- To avoid the spread of viral diseases, it is essential to clean the equipment before and after they are used in a field.
- During the spraying of insecticides, pesticides and fungicides, safety measures like putting on the mask, gloves, etc., must be followed.

Care and maintenance

- Clean the all equipment before and after use.
- Store all machinery and equipment in a dry place.
- Drain the tank and flush it with clean water, wash the pump nozzle before and after the use of a sprayer.
- Remove dust from the hopper of the duster and clean it with a cloth.
- Overhaul the machines regularly and replace the worn out parts. Grease and oil all moving parts of the machinery as per the requirement.
- Do not throw the nozzles of sprayers and delivery tubes of dusters on bare ground.
- Always keep all spare parts in the tool kit.
- Sharpen the blades of harrow, cultivators and cutters regularly.

Practical Exercises

Activity 1

Identify the implements used for land preparation.

Material required: Practical notebook, pencil, pen, garden implements, etc.

Procedure

- Identify and enlist the type of implements used for land preparation.
- Explain the use of each implement.
- Draw a diagram and show the different parts of the implements.

Activity 2

Identify various garden tools.

Material required: Garden tools, practical notebook, pencil, pen, etc.

Procedure: Visit a horticultural farm or shop to see the different type of tools and equipment used and note down the following information:

- Identify the different type of tools and equipment.
- Note down the use of each tool and equipment.
- Draw a diagram of each equipment.

Check Your Progress

A. Fill in the Blanks

1. Mouldboard plough can open a furrow of about _____ cm and above.
2. The disc in a disc plough is _____ cm in diameter.
3. Sub-soil single arm plough can be inserted up to _____ cm deep in the soil.
4. Ploughing and harrowing intermediary are performed by _____.
5. The tool used for grafting and budding is known as _____ knife.
6. Secateurs are useful in pruning pencil-thick branches and making _____ for propagation.
7. The implement consisting of two blades with tongs is identified as _____.
8. Grass shear is used for _____ and _____ of the lawn.

B. Multiple Choice Questions

1. An implement used for deep tillage of the soil by breaking up the hard surface is called _____.

   (a) harrow (b) plough

   (c) level board (d) rotavator

2. An implement used for levelling fields is _____.

   (a) harrow (b) cultivator
   (c) rotavator (d) plank

3. _____ is used for making bunds and small plots in fields.

   (a) Rake (b) Shovel
   (c) *Khurpi* (d) Spade

4. A tool used for collecting weeds and stones is _____.

   (a) spade (b) rake
   (c) *khurpi* (d) shovel

5. Moving heavy things from one place to another is the function of _____.

   (a) *khurpi* (b) hand hoe
   (c) wheelbarrow (d) shovel

6. Pruning the shoots of trees, which are beyond reach from the ground level, is done by _____.

   (a) pruning saw (b) tree pruner
   (c) secateurs (d) flower scissors

C. Subjective Questions

1. Describe the type of implements used for field preparation.
2. Write in brief on the following:
   i) Harrow
   ii) Cultivator
   iii) Grafting-cum-budding knife
   iv) Hedge shear
   v) Secateurs

D. Match the Columns

A	B
1. Bill hook	(a) Cutting flowers with stems
2. Pruning knife	(b) Application of fungicides
3. Hedge Shear	(c) Altering and loosening the soil
4. Secateurs	(d) Side-dressing of the lawn
5. Grass shear	(e) Making cuttings of propagation
6. Hand cultivator	(f) Trimming, pruning and cutting
7. Sprayer	(g) Removing unwanted twigs or branches
8. Scissors	(h) Heavy pruning operations

Gardener Class-11 Unit-4

A. Fill in the Blanks

1. Mouldboard plough can open a furrow of about _____ cm and above.
2. The disc in a disc plough is _____ cm in diameter.
3. Sub-soil single arm plough can be inserted up to _____ cm deep in the soil.
4. Ploughing and harrowing intermediary are performed by _____.
5. The tool used for grafting and budding is known as _____ knife.
6. Secateurs are useful in pruning pencil-thick branches and making _____ for propagation.
7. The implement consisting of two blades with tongs is identified as _____.
8. Grass shear is used for _____ and _____ of the lawn.

B. Multiple Choice Questions

1. An implement used for deep tillage of the soil by breaking up the hard surface is called _____.

   (a) harrow (b) plough
   (c) level board (d) rotavator

2. An implement used for levelling fields is _____.

   (a) harrow (b) cultivator
   (c) rotavator (d) plank

3. _____ is used for making bunds and small plots in fields.

   (a) Rake (b) Shovel
   (c) *Khurpi* (d) Spade

4. A tool used for collecting weeds and stones is _____.

   (a) spade (b) rake
   (c) *khurpi* (d) shovel

5. Moving heavy things from one place to another is the function of _____.

   (a) *khurpi* (b) hand hoe
   (c) wheelbarrow (d) shovel

6. Pruning the shoots of trees, which are beyond reach from the ground level, is done by _____.

   (a) pruning saw (b) tree pruner
   (c) secateurs (d) flower scissors

C. Subjective Questions

1. Describe the type of implements used for field preparation.
2. Write in brief on the following:
   i) Harrow
   ii) Cultivator
   iii) Grafting-cum-budding knife
   iv) Hedge shear
   v) Secateurs

D. Match the Columns

A	B
1. Bill hook	(a) Cutting flowers with stems
2. Pruning knife	(b) Application of fungicides
3. Hedge Shear	(c) Altering and loosening the soil
4. Secateurs	(d) Side-dressing of the lawn
5. Grass shear	(e) Making cuttings of propagation
6. Hand cultivator	(f) Trimming, pruning and cutting
7. Sprayer	(g) Removing unwanted twigs or branches
8. Scissors	(h) Heavy pruning operations

Unit 5

Soil Management and Field Preparation

Introduction

The word 'soil' has been used as a synonym with 'land' in Veda, Upanishada and other ancient Indian literature as early as 5000 BC. Great civilisations had fertile soils as one of the most important natural resources. However, destruction or mismanagement of soil has led to the downfall of such civilisations. Soil is a natural body, where plants grow. Healthy soil produces healthy crops.

Soil has different meanings to different individuals. For a farmer, soil is that surface layer of the Earth, which can be ploughed to raise crops for food, fibre and fodder for family and farm animals. For a civil engineer, soil provides foundation for the construction of buildings, roads, highways, etc. Soil health is important for sustainable crop production, and existence of flora and fauna. Exploitation, destruction and mismanagement of soil can lead to extinction of various plants and animals, including humans. Efforts must be made for the maintenance of soil health, which is important for the sustenance of life on Earth.

171107CH05

Session 1: Soil and Its Properties

Soil

The word 'soil' is derived from the Latin word *solum*. Soil is formed from weathered material of parental rocks. It contains minerals, organic matter, water and air in various proportions. These elements serve as nutrients to plants. Hence, soil serves as a medium for growing plants.

Definition

Soil may be defined as a dynamic natural body developed as a result of pedogenic processes that take place during and after the weathering of rocks, in which plants and other forms of life grow. Joffe (1949) defined soil as a natural body, consisting of minerals and organic constituents differentiated into horizons of variable depths, which differ from the material below in morphology, physical make-up, chemical properties and composition, and biological characteristics. It is, therefore, the upper loose layer of the earth crust, which is rich in nutrients and minerals on which plants grow and depend on for nourishment.

Soil genesis

Transformation of rocks into agricultural land is called 'soil formation' or 'soil genesis'. Weathered material of rocks further undergoes changes and results in the formation of agricultural land. It is a slow process. Five factors are responsible for soil genesis — climate, parent material, topography, plants and animals, life and time.

On an average, soil composition consists of minerals (45 per cent), organic matter (5 per cent), water and air, which are interchangeable (20–25 per cent each). Besides, a number of organisms thrive in soil. The organisms that thrive in soil include rodents, worms, insects, snails, snakes and microorganisms, such as fungi, bacteria, actinomycetes, algae, etc.

Importance of soil

- Soil provides essential nutrients to plants for growth and development.
- It supports the growing plants by firmly holding their roots.
- It holds moisture and water for long time.
- It serves as a habitat for a number of organisms, including microorganisms.
- It provides heat, air and water to organisms growing in or over it.
- It is the most important natural resource of a country.

Soil properties

Soil can be identified or classified according to various characteristics exhibited by it. The properties of soil are helpful in understanding the nature and kind of the soil. The properties of soil can be categorised as physical, chemical and biological.

Physical properties

Soil colour

Soil surfaces, generally, show black, yellow, red and gray hues. The colour of the soil is due to the parent rock, organic matter and minerals present in it. The colour of the upper layers of the soil may be different from its other layers. The colour of the soil is an indicator of the organic matter present in it, soil fertility, soil pH, drainage, aeration and organisms living in it. Munsell soil colour chart gives the values of degree, intensity and purity of soil colour.

Soil texture

It refers to the proportion of different size of particles (sand, silt and clay) that comprise soil. Soil, according to the particle size, can be classified as sandy, silty, loamy and clayey. Big size particles present in the soil are known as 'sand'. The diameter of sand particles is 0.2–2 mm. When the size of soil particles is between 0.2 and 0.002 mm, it is called 'silt'. Clay is the finest particle,

having a diameter of less than 0.002 mm. Loamy and clayey soils have adequate water-holding capacity and are more suitable for the cultivation of crops.

Porosity

Particles of different sizes are present in soil. When soil particles aggregate, some hollow spaces are formed between them. These inter-particle spaces in the soil are called 'pores', which help carry air and water to plants and other organisms growing in and over it. The quantity and size of pores show the 'porosity' of soil. Soil having big and large number of pores is called 'porous soil'. Such soil has adequate drainage and aeration capacity. Soil having small but more number of pores shows better water-holding capacity. Soil with small and less number of pores is called 'non-porous' soil. Such soil is water stagnant and is not suitable for cultivation.

$$\%\,\text{Pore space} = 100 - \frac{\text{Bulk density}}{\text{Particle density}} \times 100$$

Soil density

Soil consists of various particles. It has certain percentage of pore space through which air and water movement takes place. The density of soil denotes the weight of the soil per unit volume. It is of two types — particle density and bulk density.

Particle density: Particle density refers to the actual density of soil solids. It is defined as mass per unit volume of soil solid only. Particle density of soil gets decreased with increase in organic matter content of the soil. Mostly soils have particle density of about 2.65 g/cm^3.

Bulk density: It refers to weight per unit volume occupied by soil solids, as well as, pore space of the soil. It is expressed as grams per cubic centimetre (g/cm^3). Soils having low bulk densities have better physical conditions.

Soil consistency

Soil consistency is the potential of soil to change the shape or moulding when moist. It also ensures the

resistance of soil particles to crushing or pulverising action by implements when dry. Soil consistency helps in knowing the tilth. Knowledge about soil consistency is necessary to understand the soil texture in order to perform tillage operations.

Soil structure

Soil structure denotes varying shapes and arrangements of particles (sand, silt and clay) to form lumps or aggregates. Soil structure may be columnar, prismatic, blocky, platy laminar, granular or crumb. Soil structure can be modified by various soil management practices, such as tillage, manuring, liming, crop rotation, irrigation, etc.

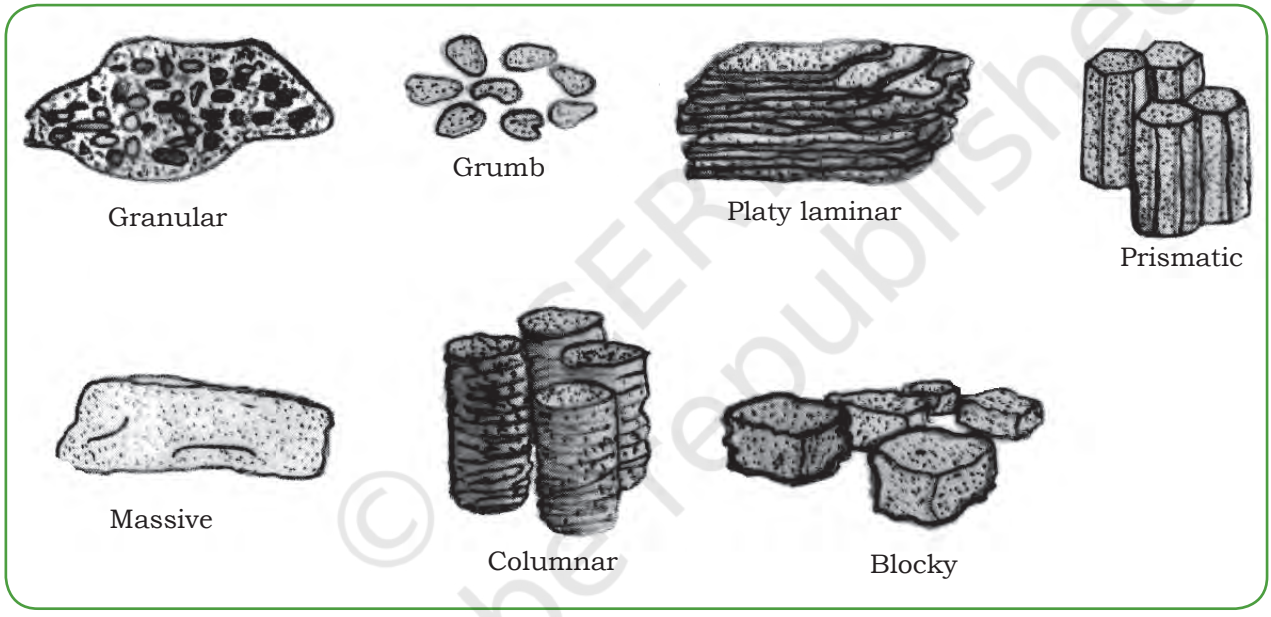


Fig. 5.1: Types of soil structure

Soil temperature

Soil temperature is regulated by the Sun and helps in the decomposition of organic material present in it. Various factors, such as colour, slope, moisture level and vegetation on the soil affect the soil temperature. Low, as well as, high soil temperature is harmful for crops. The growth of crops slows down as the temperature falls below 9 °C and ceases when it reaches 50 °C. Microorganisms present in the soil are active when the temperature is 27–32 °C.

Chemical properties

Chemical properties determine the fertility of soil. These are related to the ability of the soil to supply nutrients to plants growing on or under it. Chemical properties of soil depend on the chemical composition of soil particles. Chemical properties can be exhibited by soil pH, buffering capacity, electrical conductivity, nutrients released, cation exchange capacity, etc.

Soil pH or acidity of soil

Soil pH shows the potentiality of H^+ ions. It determines acidic or alkaline reaction of the soil. More hydrogen ion (H^+) concentration shows the acidic nature of soil, while the concentration of more hydroxyl (OH^-) ions represents its alkaline nature. Neutral condition is produced by an equal concentration of H^+ and OH^- ions. Slightly acidic soils are more suitable for plant growth. Maximum nutrients are available to crops when the pH ranges from 6.5 to 7. Soil pH can be measured by pH meter, pH paper method or pH scale. pH scale has a range of 0–14 with 7 as the neutral point, which indicates the equal concentration of H^+ and OH^- ions. As the value decreases, it indicates higher concentration of H^+ ions. Soils with minimum pH are more acidic in nature. Similarly, as the pH goes above 7, the alkaline reaction of the soil increases with the concentration of OH^- ions.

Some of the effects of soil pH on plant growth are:

- In general, soil pH of 6.5 to 7.5 is considered optimum for maximum availability of plant nutrients.
- Low pH (<6.0) results in an increase in aluminium content in the soil. Its excess may be toxic to plants.
- In general, the availability of toxic metals is more in acidic soils. This affects the activity of soil microorganisms.

Buffering capacity of soil

The capacity of soil that resists sudden change in its pH is called the 'buffering capacity' of soil. Change in pH may affect nutritional balance in the soil, as well as,

microbial activities in it. Carbonates, bicarbonates and phosphates act as buffering agents in soil. The buffering capacity of the soil also depends on clay and organic matter present in it.

Soil colloids

Soil colloids may be clay or humus. Clay found in soil is known as 'inorganic colloid', while humus is called 'organic colloid'. Soil colloids that are charged with negative ions (anions) will attract positively charged ions (cations). Cations are held by soil colloids. Cations with lower valency are replaced with ones having higher valency. For example, Na^+ in alkali soils are replaced by Ca^+ after the addition of gypsum. Cation Exchange Capacity (CEC) of the soil is higher if it has more clay and humus content. CEC is denoted in Cmol $kg^{-1}$of soil.

Cation Exchange Capacity (CEC)

It is a measure of the potential of a soil to hold cation nutrients, such as potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+) aluminium (Al^3+), iron (Fe^{2+}), manganese (Mn^{2+}), zinc (Zn^{2+}), hydrogen (H^+) and copper (Cu^{2+}). In simple words, CEC is the measure of the quantity of cations that can be adsorbed and held by the soil. Highly fertile soils, containing high organic matter, have more cation exchange capacity. Soil fertility increases with an increase in cation exchange capacity.

Biological properties

Different type of organisms and microorganisms thrive in soil. Mice, crabs, snails, earthworms, mites, millipedes, centipedes, fungi, bacteria, actinomycetes, protozoa and nematodes are commonly found in soil. They feed on plant residues. These organisms make channels and burrows in the soil, thereby, increasing aeration and enhancing the percolation of water due to their activities. Their excreta adds to the organic matter of the soil. Bacteria predominate neutral soils, while fungi are more in acidic soils. Moist and shady soils favour the growth of algae.

Soils of India

The soils of India can be classified into different groups, such as black, red, laterite, alluvial, saline, desert, alkaline, forest, hilly, and peaty and marshy.

Black soil

It is dark grey to black in colour and ranges from fertile to poor. The soil is rich in clay (montmorillonite) particles and has neutral to slightly alkaline reaction. The soil is rich in bases, lime and calcium. The pH of black soil is 7.2–8.5. The soil is deficient in nitrogen, phosphate and organic matter but rich in potash, calcium and magnesium. It is soft when wet but forms hard blocks when dry and develops deep cracks. Black soil ranges from heavy clay (ill-drained) to loams (well-drained). Black soil is predominant in Maharashtra, Madhya Pradesh, western Andhra Pradesh, southern Tamil Nadu and northern Karnataka.

Red soil

Such soil results from weathered material of metamorphic rocks. It is porous and friable neutral to acidic in reaction. Nitrogen, phosphate, lime and humus content are very low in this soil. It is found in parts of Tamil Nadu, Karnataka, north-east Andhra Pradesh, eastern parts of Madhya Pradesh, Bihar, West Bengal and Rajasthan.

Lateritic (laterite) soil

Laterite soil is formed in areas receiving high rainfall with alternating wet and dry spells. This soil is red to reddish-yellow in colour. Heavy rains cause leaching of bases and silica from the surface of the soil. The soil shows acidic character with pH of 5–6 and is poor in nitrogen, phosphorus, potash, magnesium and lime. Such soil is porous and well-drained with poor water-holding capacity. The soil is found in eastern Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Odisha, Assam and Ratnagiri district of Maharashtra.

Alluvial soil

Alluvial soil is ideal for horticultural crops. Such soil is found along rivers. It consists of material deposited by rivers during flood. The soil is productive but may be deficient in nitrogen, phosphorus and humus. The soil greatly differs in colour, texture, drainage, presence or absence of sodium salts, etc. It is suitable for the cultivation of vegetables, flowers and fruits. The soil is found in all States of India along the rivers. The Indo-Gangetic soil is the best example of alluvial soil in India.

Desert soil

Desert soil is sandy soil and is found in low rainfall areas. Such soil is alkaline in nature with high pH value and is unproductive. It is rich in soluble salts, and poor in nitrogen and organic matter content. The physical conditions of the soil are unfavourable as it has low water-holding capacity due to high sand content. Desert soil is found in parts of Rajasthan.

Forest and hilly soils

These are shallow soils of higher and lower elevation on the hills. These are stony and infertile for the production of crops. These are low in bases and slightly acidic in reaction.

Saline and alkaline soils

Saline soil shows white incrustation of salts (chlorides and sulphates of sodium, calcium and magnesium) on surface due to high evaporation during summers. It is also called 'white alkali soil'. Such soil is, generally, infertile and poor in drainage. Such soil is formed as a result of saline irrigation water and over-irrigation for a long time, which raises the water table of the soil. Alkaline soil is rich in carbonates and bicarbonates of sodium and is non-porous. It is also called 'black alkali' or '*Usar*' soil. Uttar Pradesh, Punjab, Haryana, Rajasthan, Kerala, coastal Odisha and Sunderban region of West Bengal contain large patches of such soils.

Peaty and marshy soil

This soil is highly acidic in nature and black in colour. Excessive wetness of the soil causes decay and degradation of dead vegetation, forming a layer of partially decomposed organic matter, resulting into peaty and marshy soil. Such type of soil is, generally, found in States like Tamil Nadu, parts of Bihar and Uttar Pradesh.

Practical Exercise

Activity

Identify the types of soil available in your area and grow some ornamental plants in them.

Material required: Different types of soil, tags, pots and ornamental plants

Procedure

- Collect different types of soil like sandy, silty, sandy loam and clayey available in your area.
- Identify the soil as per their texture and structure.
- Fill the pots with different types of soil.
- Plant ornamental plants in the pots and water them.
- Observe the water requirement and growth of the plants in different types of soil.

Check Your Progress

A. Fill in the Blanks

1. Soil is composed of _____ per cent minerals.
2. The size of the particles between 0.2 and 0.02 mm is known as _____.
3. The unit of bulk density is _____.
4. pH determines _____ or _____ reaction of the soil.
5. Soil fertility _____ with an increase in CEC.

B. Multiple Choice Questions

1. Humus is _____.
   (a) organic colloid (b) inorganic colloid
   (c) chemical (d) fertiliser

2. Black soil has _____.
   (a) neutral to acidic reaction
   (b) neutral to alkaline reaction
   (c) saline alkaline
   (d) None of the above
3. Red soil results from the weathered material of _____.
   (a) igneous rock (b) sedimentary rock
   (c) limestone (d) metamorphic rock
4. The soil ideal for horticultural crop production is _____.
   (a) black (b) red
   (c) alluvial (d) laterite
5. The factor that determines the ability of soil to change the shape or moulding when wet is known as _____.
   (a) soil consistency (b) soil pH
   (c) soil porosity (d) soil density

C. Subjective Questions

1. What is soil? Describe its physical properties.
2. Describe the types of soil found in India.
3. Write a short note on the following:
   (i) Soil pH
   (ii) Soil salinity
   (iii) Biological properties of soil

D. Match the Columns

A	B
1. Soil texture	(a) Ideal for horticultural crops
2. Clay	(b) Acidic soil
3. Low pH	(c) Finest soil particle
4. Soil	(d) Size of soil particles
5. Alluvial soil	(e) Holds roots and provides nutrition to plants
6. Saline soil	(f) Highly acidic and black in colour
7. Peaty and marshy soil	(g) High salt content

SESSION 2: SOIL RECLAMATION OR IMPROVEMENT

Soils that are more acidic, alkaline or saline in nature are not desirable for cultivation of crops. Such soils do not favour desirable nutrient supply to plants or support beneficial activities of microbes. Extreme agro-climatic conditions affect the physical, chemical and biological properties of such soils, and create an unfavourable environment within. Acidic soils are mostly found in areas receiving high rainfall, which causes leaching of bases or salts. Saline and alkaline soils are mostly found in arid and dry regions, where the rate of evaporation is high. Soluble salts from the lower layer of the soil come up and get accumulated due to the evaporation of moisture. These soils are not suitable for most crops as the crop yield is poor.

Causes of acidic soil

- Soils developed from acidic rocks like granite are acidic in nature.
- Heavy rains or irrigation leach down bases and lime deep within the soil, thereby, increasing soil acidity.
- Application of Ammonium sulphate and Ammonium chloride as fertilisers also causes increase in soil acidity.
- The decomposition of organic matter, present in the soil, by various microorganisms results in the production of organic acids, which may also increase soil acidity.

Effects of soil acidity on plants

- Soil acidity has a toxic effect on root tissues.
- It affects the permeability of cations from plant membranes.
- Soil acidity also changes the ratio between basic and acidic components within plants.
- It adversely affects beneficial soil microorganisms.
- Aluminium, manganese and iron are highly soluble in acid medium, and thus, become toxic.

- Soil acidity lowers calcium and potassium content in the soil.
- The availability of phosphorus, copper and zinc in the soil is affected due to soil acidity.
- Plant diseases are also more prevalent in acidic soils.

Correction of soil acidity

Soil acidity can be corrected by liming. Lime is applied into soil at the time of land preparation or in ploughed land. About 1,500 kg lime per hectare is required to raise the pH of the soil by one unit. Limestone, burnt lime or slaked lime can be used to correct the acidity of the soil. Lime increases phosphorus, nitrogen, potassium and molybdenum content in the soil.

Saline and alkaline soils

Saline soil

In such a soil, a white layer of salts is commonly seen on the surface. This is due to the presence of excess chlorides and sulphates of sodium, calcium and magnesium. It contains enough soluble salts to interfere with the growth of most crop plants. The presence of exchangeable sodium is less than 15 per cent and the pH is below 8.5. Electrical Conductivity (EC_e) is 4 dSm^{-1} or more at 25 °C.

Saline-alkaline soil

Such soil contains adequate quantity of soluble salts. Besides, exchangeable sodium is more than 15 per cent in the soil. The pH of saline-alkaline soil is 8.5 or more. The EC_e value is more than 4 dSm^{-1} at 25 °C.

Alkaline soil

Alkaline soil is poor in aeration and drainage. The pH of such soil is 8.5–10. The presence of exchangeable sodium is more than 15 per cent. EC_e value is less than 4 dSm^{-1} at 25 °C. The high sodium content present in the soil is often toxic for crop growth.

Causes of soil salinity

- Arid and dry conditions
- High water table
- Sloppy land that washes out salts in catchment areas
- Irrigation with saline water
- Poor drainage

Reclamation methods

- The application of gypsum (Calcium sulphate) is effective for the improvement of alkaline or sodic soil. It reacts with the exchangeable sodium present in the soil and converts it into Sodium sulphate. Sodium sulphate is leached out from the soil to reduce the soil pH.
- Saline soil can be improved by ensuring effective drainage system.
- Scrapping off surface salts from highly saline patches is beneficial for the soil.
- Use of acidifying fertilisers, e.g., superphosphate and Ammonium sulphate is also beneficial.
- Green manuring with *dhaincha*, sunhemp, *mung* bean, or addition of organic matter reduces the salinity of the soil.

Soil testing

Soil testing helps ascertain the status of various nutrients, soil fertility level, pH, etc. It is important to know the fertility status and physical properties of a soil for maximum production and rational soil management. A complete soil test programme essentially consists of three basic steps.

(i) Soil sampling
(ii) Soil testing
(iii) Soil test interpretation

Purposes of soil testing

- It helps evaluate and improve soil productivity.
- It helps determine the nature of the soil, i.e., alkaline, saline or acidic.

- It helps ascertain the use of fertilisers and manures, and their dosage in order to improve the fertility of the soil.
- It reveals the actual condition of the soil so that it can be improved with the application of nutrients and other management practices.

Soil sampling

Soil tests and their interpretations are based on the collection of soil samples and their analysis. Therefore, soil samples that are taken represent the whole field. To obtain information about the nutrient status of a soil, it is essential to follow the correct procedure of soil sampling.

Before sampling information regarding the cropping pattern, various management practices, variations along with the direction of slope, soil colour and texture must be noted down. Then, the field from where the sample is to be collected must be divided into different sections, according to variations in slope and texture, and separate samples must be collected from each section. By using various sampling tools, such as soil auger, soil tube, spade, etc., the sample must be collected from plough depth, i.e., 15 cm for normal agronomic crops and from deeper zones, i.e., 15–30 cm for deep-rooted and horticultural crops at different spots, and then, all must be mixed thoroughly. This composite soil sample is then spread on a clean sheet. It is divided into four equal parts. Two opposite quarters are rejected and samples from the other two are mixed. To obtain the desired size of the sample (500 g), the same procedure is repeated. Before sending the sample to a laboratory, it must be dried and put into plastic bags. The bags, containing the samples, must be labelled and sent to the nearest soil testing laboratory, along with an information sheet having the following details.

- Name and address of the farmer
- Identification mark or number of the field
- Date of sampling
- Local name of the soil, if any
- Colour of the soil (dry and moist)
- Type of land (unirrigated, irrigated or waterlogged)

- Source of irrigation (canal, well or tank)
- Depth of sampling
- Topography (level, sloppy or undulated)
- Crop rotation followed
- Previous crop
- Next crop to be taken
- Manures or soil amendments applied earlier
- Any other remark

The help of a village-level or extension worker can be taken to collect the soil samples and fill in the information sheet.

Sample analysis

The collected sample is analysed by using standardised method in a laboratory for the following parameters.

- pH (indicates whether the soil is acidic, alkaline or neutral in nature)
- Presence of total soluble salts (determined by EC, which indicates whether the soil poses any constraint to seed germination and subsequent crop growth)
- Lime and gypsum, if needed
- Organic carbon, which is a measure of nitrogen content in the soil
- Phosphorus content in the soil
- Potassium content in the soil

Soil test interpretations

Based on the soil analysis, data can be interpreted with the help of ratings as given in the following tables.

Table 5.1: Rating of soil on the basis of pH (1:2 soil–water ratio)

S. No.	Type of soil	Soil reaction (pH)
1.	Acidic	<6
2.	Normal to saline	6–8.5
3.	Tending to become alkaline	8.6–9
4.	Alkaline	>9

Table 5.2: Rating of soil on the basis of EC (1:2)

S. No.	Category	EC_e (dSm^{-1})
1.	Normal	<1
2.	Critical for germination	1–2
3.	Critical salt levels for growth of sensitive crops	2–4
4.	Injurious to most crops	>4

On the basis of the soil test interpretations, fertiliser recommendations for each crop may be made.

Table 5.3: Rating of soil on the basis of nutrient availability (1:2)

S. No.	Nutrients	Low	Medium	High
1.	Organic carbon	<0.5%	.5–.75%	>0.75%
2.	Available nitrogen (N)	<280 kg/ha	280–560 kg/ha	>560 kg/ha
3.	Available phosphorus (P)	<10 kg/ha	10–25 kg/ha	>25 kg/ha
4.	Available potassium (K)	<110 kg/ha	110–280 kg/ha	>280 kg/ha

Practical Exercise

Activity

Demonstrate the procedure of soil sampling.

Material required: Soil auger, test tube, spade, cultivated field, paper bag, polythene bag and tag.

Procedure

- Divide the field into different homogenous units based on colour, slope and texture of the soil.
- Remove all surface leaf litter, weeds, etc., at the sampling spot.
- Dig a 'V'-shaped cut at a depth of up to 15 cm, and then, draw a uniform slice of 15 cm. Collect the soil sample up to a depth of 15 cm without digging the soil with the help of soil auger.
- From each sampling unit, collect at least 10 samples.
- Remove foreign material present in the soil, such as stones, pebbles, fine roots, etc., and mix the samples.
- Divide the collected samples into four equal parts.

- The two opposite quarters are removed and the remaining samples from the two other parts are again mixed. The process is repeated until the desired sample size is obtained.
- Dry the moist sample in shade.
- Collect the prepared sample in a sampling cloth or a polythene bag.
- Label the bag with the following information, i.e., name and address of the farmer, date of collection, previous and present crop record, crop to be grown in the next season, etc.

Check Your Progress

A. Fill in the Blanks

1. Alkaline soils are poor in _____ and drainage.
2. For deep-rooted horticultural crops, soil samples must be collected from _____ cm deep zone.
3. Green manuring or addition of organic matter reduces soil _____.
4. Desired size of the sample for soil testing is _____.
5. The pH of saline-alkaline soil is _____.

B. Multiple Choice Questions

1. Soil acidity can be corrected by adding _____.
   (a) zinc (b) phosphorus
   (c) potash (d) lime
2. The major cause of soil salinity is _____.
   (a) arid and dry condition (b) temperate condition
   (c) waterlogging (d) wet and humid condition
3. Available potassium is low in soil if it is _____.
   (a) <50 kg/ha (b) <100 kg/ha
   (c) <110 kg/ha (d) <150 kg/ha
4. White incrustation of salt is commonly seen in _____ soil.
   (a) acidic (b) alkaline
   (c) saline (d) red
5. Soil is injurious to most crops, if EC (milli mohs/cm) is _____.
   (a) >2.0 (b) >3.0
   (c) >4.0 (d) >5.0

C. Subjective Questions

1. Describe the problems of soil sampling.
2. Describe saline and alkaline soils.
3. Explain the reclamation method of saline and alkaline soils.

D. Match the Columns

A	B
1. Gypsum	(a) *Dhaincha*
2. Soil auger	(b) Poor drainage
3. Green manuring	(c) Corrected by lime
4. Soil salinity	(d) Soil sampling
5. Soil acidity	(e) Calcium sulphate

SESSION 3: FIELD PREPARATION AND SPECIAL PRACTICES

Before starting to grow flower plants in a garden, there are some important activities that must be performed for the sustainability of land and other resources. These activities involve primary land preparation and various cultural operations, which must be done prior to the sowing or transplanting of flower plants. The main purpose of field preparation is to provide the necessary soil conditions and escape to the plant from biotic and abiotic stress. This will be helpful in the successful establishment of ornamental plants in a garden.

Selection of site

Climate, soil and location are the prime natural components in choosing a site on which the success or failure of flower crops depend. Careful site selection results in the success of flower cultivation. Different climatic components, such as temperature, rain, atmospheric humidity, altitude, hailstorm, and wind velocity and its direction must also be studied. However, high and low temperatures, as well as, hails are encountered mostly in subtropical plains. Low temperatures and winds mostly occur in hilly areas.

Various factors like soil texture, structure, chemical composition, moisture and temperature of the soil must be taken into account while selecting a site. The location of the site determines its connectivity, exposure to the Sun, nearness to the road, availability of irrigation water, topography, etc.

For a flower grower, basic information regarding soil and climatic conditions, and its influence on growth and flowering of a crop is necessary. Different flower crops differ widely in their soil and climatic requirements. Distance of the garden from market will determine the flowers that can be grown and which marketing facilities are available nearby. Soil for open flower cultivation needs to be fertile and rich in organic matter content, near a water source and well-drained. The soil pH range must be neutral or near neutral. The availability of certain nutrients is strongly influenced by pH as micronutrients, such as manganese, iron, copper and zinc, become less available in highly alkaline soils. Land with a gentle slope is more suitable for successful and profitable flower cultivation. Easy availability of labourers and transportation of crops for economic gains is also essential.

Optimum conditions for growing flower crops

Ornamental flower crops such as celosia, *amaranth*, *kochia*, gaillardia, gomphrena, zinnia, torch lily, cosmos, etc., grow at or above 40 ^{0}C. But most commercial ornamental crops, such as rose, carnation, gerbera, gypsophila, statice, marigold, chrysanthemum, heliconia, bird of paradise, amaryllis, hippeastrum, etc., grow comfortably at 15–30 ^{0}C, Usually, for flower crop cultivation, sandy loam soil, containing adequate humus with a pH range of 5.5–7.5 is preferred as most of the crops remain comfortable in such soils. Such soil is easily workable, more beneficial for soil microbial activities, has adequate porosity, water retention capacity and provision for easy access to drainage.

Tools and equipment used in field preparation

Harrow, cultivator, plank, spade, *khurpi*, etc., are required for field preparation. The equipment may be

used either manually or with the help of a tractor or may be animal-driven.

Preparation of field

For the cultivation of flowers, the field must be first made free of weeds, roots and stubs of previous season crops. Before the second ploughing of the field, light irrigation must be carried out in order to provide optimum moisture for the germination of weed seeds. The third ploughing may be done at the optimum stage of moisture by hand with a traditional hoe in a small area or by a tractor or animal-drawn cultivator, plough, etc. The depth of ploughing must be kept at 20–25 cm as superficial ploughing will not favour plant development, whereas, ploughing too deep will bury nutrients beyond the reach of the roots of the crop plant. Care must be taken that ploughing is done few weeks before the sowing of seeds to allow enough time for the weeds and crop residues to decompose. After every ploughing, planking is carried out, and then, finally, the levelling of the field is done. Levelling is, usually, done in two phases.

- The first levelling is done to lower the higher parts of the field, from where the soil is spread out over the lower areas.
- The second and more precise levelling is carried out after ploughing for sowing.

The main objective of land preparation is to create a favourable environment for growing flowering ornamentals. Land preparation will help in:

- irrigating the field and keeping it well-drained.
- improving the soil structure (better aeration, permeability and loosening of the root zone) to make easy germination of seeds and penetration of roots.
- maximum and best utilisation of nutrients supplied through fertilisers.
- minimising the growth of weeds.

Harrowing

It is an operation, which is carried out for breaking up and smoothening the hard surface in order to provide

tilth of the soil structure, which is suitable for the sowing of seeds. A harrow can be used to remove weeds from the field and cover the seeds after sowing.

Purpose of harrowing

- To make the soil of the seedbed friable in nature
- To remove grasses and weed seeds from the field by pulling
- To cut and mix weeds and crop residues into the soil
- To make the field surface levelled by breaking the clods
- To break the capillaries to retain the moisture present in the soil

Special practices in flower cultivation

Weeding

It refers to the removal of all unwanted plants from the field other than those planted or sown. Periodic removal of weeds is beneficial for the growth and development of a crop as it prevents the competition of weed with the main crop for sunlight, water, air and nutrients.

Weeding is necessary as weeds harbour many insect-pests and diseases. Primary weeding is done to clear huge amounts of plants other than the main crop. In our country, weeding is, generally, carried out manually. Mechanical weeding may conveniently be carried out in crops that have been sown or planted as per specification and in rows. Chemical weeding can be carried out anywhere in any crop. However, it may have side-effects on the environment. Therefore, mechanical weeding is always preferred. Mulching at the initial stage also minimises weed population.

Mulching

Mulching is a protective layer of material spread on the top of the soil. It consists of organic wastes like straw, hay, dry grass or leaves, sawdust, crop residues, etc., or synthetic material like plastic sheets. Mulching is a cultural method that preserves soil moisture, checks

soil erosion and protects from weeds. It also helps in maintaining the soil temperature.

Staking

Staking is a practice to support plants to grow straight and save them from bending or lodging. Therefore, this operation is done at a time when the plants are not too tall. It saves the plants from getting blown over due to wind, rain and weight of its flowers or fruits when in bloom or fruiting. Bamboo stakes are the most common thing used for the purpose. However, branches of shrubs and trees, such as neem, *subabool*, *phalsa*, eucalyptus, etc., can also be used for staking.

Advantages

- More plants can be grown as staking helps save space.
- It keeps the stem of a plant off the ground.
- It is easier to harvest as staking facilitates working among plants.

Earthing-up

Digging and pulling the soil in between rows and heaping it around the stem of plants is called 'earthing-up'. In case of bulbous ornamentals, this encourages the development of additional underground food storage structures, such as bulbs, corms, rhizomes or tubers as in case of tuberose, gladiolus, canna, begonia and dahlia.

De-shooting

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

Disbudding

Disbudding is the removal of floral buds when a large flower is desired on a plant like in chrysanthemum and dahlia. Hence, the energy saved by disbudding is

diverted towards the development of the retained bud so that the flowers become large and vigorous. Generally, it is followed in large-flowered varieties. The ideal time for disbudding is when the buds surrounding the central one have developed 5-cm long pedicels. Disbudding starts in October or as soon as the flower buds appear. In carnations, disbudding is practised to obtain long stalks with larger blooms.

Pinching

It refers to the removal of growing tips of the terminal portion of plants in order to promote bushy growth for more number of flowers as in case of chrysanthemum. It is the removal of 3–5 cm growing tips when the plants are 8 to 10-cm tall, i.e., when they are about one-month old. The second pinching is done about three weeks after the first pinching.

Training

It is the shaping of plants, conforming to a particular form commensurate to the plant's requirement at an early stage. This gives the plant a desired height, shape and strong framework with desired number of branches and eliminates weak crotch development.

Pruning

Pruning is the process to remove unproductive and diseased or dead branches and roots to improve plant health or quality of flowers, fruits and foliage.

Objectives of pruning

- To reduce the apical dominance of the plant so that the lateral branches are encouraged for quality blooms
- To build a balance between shoot and root growth
- To give a definite direction and shape to the plant
- To utilise the available space effectively
- To impart dwarfing in the plant and promote its healthy growth
- To improve the productivity and quality of the produce

- To impart definite objective, such as development of dense top growth in a shady tree, or to keep a neat and impenetrable hedge
- To provide necessary light and air to the inner portion of the plant
- To remove all dead, diseased and interlacing twigs and branches

Time of pruning

- The plant bearing flowers on the last season's growth is, generally, pruned immediately after flowering.
- The plant, which produces flowers on the current season's growth, must be pruned sufficiently in advance ahead of the flowering season.

Methods of pruning

The methods of pruning vary with the plant specimen as ornamental trees hardly need any pruning. Hence, only shrubs are subjected to pruning in the following ways.

Clipping or shearing of hedge

Regular pruning is carried out in hedge plants in order to maintain their shape-cum-beauty, symmetry and health and encourage branching from the base so that they become impenetrable to cats and dogs. Square-cut, round-top, wavy-top, columns, etc., are given through training and pruning. During early age, shrubs are headed back frequently to induce branching from the ground level till the required height is attained. Thereafter, these are sheared frequently during the rainy season.

Topiary

The art of clipping and shearing climbers, shrubs, small trees and herbaceous perennials into artistic shapes is known as 'topiary'. Plants with small dark green foliage amenable to frequent clippings and shearing are selected for topiary making. It takes years to train a plant to reach a desired shape and size. Simple shapes like globe, sphere, dome, table and cube

to difficult objects like birds, animals or humans can be made only with patience. The shapes of difficult objects are obtained by training plants with the help of wire frames.

The Hanging Gardens at the Kamala Nehru Park in Mumbai is famous for its topiary work. Shrubs, such as *Clerodendrum inerme (*Indian privet*)*, *Duranta plumieri* (*duranta*), bougainvillea, *Murraya paniculata* (*kamini*), *Thuja* (*morpankhi*), *Cupressus sempervirens* (Italian cypress), *Putranjiva roxburghii* (*putranjiva*), *Vernonia elaeagnifolia (*curtain creeper, vernonia creeper, parda vel) and *Polyalthia longifolia* (*ashoka*) are, usually, used for making topiary.

Practical Exercise

Activity

Demonstrate weeding, earthing-up and staking in a gladiolus field.

Material required: Gladiolus crop, *khurpi*, spade, bamboo stakes and jute twine (*sutli*)

Procedure

- Remove all weed plants from gladiolus crop.
- Earth-up the plants with surrounding soil (10–15 cm above the ground level) from all sides with the help of a spade.
- Dig straight bamboo stakes about 5 cm away from the plants so that the developing corm and cormlets are not injured.
- Loosely hold the plants with the spikes straight with stakes and tie them with the help of a *sutli.*
- Care must be taken that the *sutli* is not tied tightly.

Check Your Progress

A. Fill in the Blanks

1. Breaking-up and smoothening out the surface of the soil is done by _____.
2. Weeding refers to the removal of _____ plants growing in a field.
3. Mulching is a _____ layer of a material that is spread on the top of the soil.

4. The removal of side shoots of a plant is known as _____.
5. Disbudding is the removal of _____.
6. The art of shaping a plant at an early stage is called _____.

B. Multiple Choice Questions

1. Inorganic mulch is _____.
   (a) straw (b) dry grass
   (c) sawdust (d) plastic sheet
2. Earthling-up is a common practice in _____.
   (a) rose (b) marigold
   (c) gladiolus (d) carnation
3. Pinching in a plant promotes _____.
   (a) plant height (b) flower size
   (c) bushy growth (d) root growth
4. Giving definite direction and shape to a plant is known as _____.
   (a) pruning (b) pinching
   (c) disbudding (d) de-shooting

C. Subjective questions

1. Describe the procedure of field preparation.
2. Write in brief on the following:
   (a) Weeding (b) Mulching (c) Staking
   (d) Earthing-up (e) De-shooting (f) Disbudding
   (g) Pinching (h) Training (i) Pruning

D. Match the Columns

A	B
1. Topiary	(a) Removal of flower bud
2. Training	(b) *Thuja*
3. Disbudding	(c) Removal of the growing tips
4. Pinching	(d) Shaping of the plant

Gardener Class-11 Unit-5 Session-1

A. Fill in the Blanks

1. Soil is composed of _____ per cent minerals.
2. The size of the particles between 0.2 and 0.02 mm is known as _____.
3. The unit of bulk density is _____.
4. pH determines _____ or _____ reaction of the soil.
5. Soil fertility _____ with an increase in CEC.

B. Multiple Choice Questions

1. Humus is _____.
   (a) organic colloid (b) inorganic colloid
   (c) chemical (d) fertiliser
2. Black soil has _____.
   (a) neutral to acidic reaction
   (b) neutral to alkaline reaction
   (c) saline alkaline
   (d) None of the above
3. Red soil results from the weathered material of _____.
   (a) igneous rock (b) sedimentary rock
   (c) limestone (d) metamorphic rock
4. The soil ideal for horticultural crop production is _____.
   (a) black (b) red
   (c) alluvial (d) laterite
5. The factor that determines the ability of soil to change the shape or moulding when wet is known as _____.
   (a) soil consistency (b) soil pH
   (c) soil porosity (d) soil density

C. Subjective Questions

1. What is soil? Describe its physical properties.
2. Describe the types of soil found in India.
3. Write a short note on the following:
   (i) Soil pH
   (ii) Soil salinity
   (iii) Biological properties of soil

D. Match the Columns

A	B
1. Soil texture	(a) Ideal for horticultural crops
2. Clay	(b) Acidic soil
3. Low pH	(c) Finest soil particle
4. Soil	(d) Size of soil particles
5. Alluvial soil	(e) Holds roots and provides nutrition to plants
6. Saline soil	(f) Highly acidic and black in colour
7. Peaty and marshy soil	(g) High salt content

Gardener Class-11 Unit-5 Session-2

A. Fill in the Blanks

1. Alkaline soils are poor in _____ and drainage.
2. For deep-rooted horticultural crops, soil samples must be collected from _____ cm deep zone.
3. Green manuring or addition of organic matter reduces soil _____.
4. Desired size of the sample for soil testing is _____.
5. The pH of saline-alkaline soil is _____.

B. Multiple Choice Questions

1. Soil acidity can be corrected by adding _____.
   (a) zinc (b) phosphorus
   (c) potash (d) lime
2. The major cause of soil salinity is _____.
   (a) arid and dry condition (b) temperate condition
   (c) waterlogging (d) wet and humid condition
3. Available potassium is low in soil if it is _____.
   (a) <50 kg/ha (b) <100 kg/ha
   (c) <110 kg/ha (d) <150 kg/ha
4. White incrustation of salt is commonly seen in _____ soil.
   (a) acidic (b) alkaline
   (c) saline (d) red
5. Soil is injurious to most crops, if EC (milli mohs/cm) is _____.
   (a) >2.0 (b) >3.0
   (c) >4.0 (d) >5.0

C. Subjective Questions

1. Describe the problems of soil sampling.
2. Describe saline and alkaline soils.
3. Explain the reclamation method of saline and alkaline soils.

D. Match the Columns

A	B
1. Gypsum	(a) *Dhaincha*
2. Soil auger	(b) Poor drainage
3. Green manuring	(c) Corrected by lime
4. Soil salinity	(d) Soil sampling
5. Soil acidity	(e) Calcium sulphate

Gardener Class-11 Unit-5 Session-3

A. Fill in the Blanks

1. Breaking-up and smoothening out the surface of the soil is done by _____.
2. Weeding refers to the removal of _____ plants growing in a field.
3. Mulching is a _____ layer of a material that is spread on the top of the soil.
4. The removal of side shoots of a plant is known as _____.
5. Disbudding is the removal of _____.
6. The art of shaping a plant at an early stage is called _____.

B. Multiple Choice Questions

1. Inorganic mulch is _____.
   (a) straw (b) dry grass
   (c) sawdust (d) plastic sheet
2. Earthling-up is a common practice in _____.
   (a) rose (b) marigold
   (c) gladiolus (d) carnation
3. Pinching in a plant promotes _____.
   (a) plant height (b) flower size
   (c) bushy growth (d) root growth
4. Giving definite direction and shape to a plant is known as _____.
   (a) pruning (b) pinching
   (c) disbudding (d) de-shooting

C. Subjective questions

1. Describe the procedure of field preparation.
2. Write in brief on the following:
   (a) Weeding (b) Mulching (c) Staking
   (d) Earthing-up (e) De-shooting (f) Disbudding
   (g) Pinching (h) Training (i) Pruning

D. Match the Columns

A	B
1. Topiary	(a) Removal of flower bud
2. Training	(b) *Thuja*
3. Disbudding	(c) Removal of the growing tips
4. Pinching	(d) Shaping of the plant

Glossary

Alkaline soils: *These are clayey soils with high pH (>8.5), poor soil structure and a low infiltration capacity.*

Actinomycetes: *A class of bacteria that is beneficial to plants. The bacteria also form a symbiotic relationship with various plants. These also help fix nitrogen in the soil.*

Adventitious roots: *A root that arises from any point other than the radicle.*

Androecium: *The male reproductive part in a flower that consists of long-stalked filament and the top of the filament is a cluster of micro sporangia called 'anther'.*

Annuals: *Plants that complete their life cycle in one growing season or year.*

Bagasse: *Plant residue (of sugarcane or grapes) left after the product (juice) has been extracted.*

Band placement: *In this method, fertilisers are applied in bands close to the root spread.*

Biennials: *These are plants, which complete their seed-to-seed life cycle in two seasons or years.*

Bud: *A compact knob-like growth on a plant, which develops into a leaf, flower or shoot.*

Buffering capacity: *The capacity of the soil to absorb more acid and base without a significant change in its pH.*

Bulb: *A specialised underground swollen structure having a flat basal stem and is surrounded by fleshy scales, e.g., onion.*

Bulbous ornamentals: *Plants propagated through modified underground stems.*

Callus: *A growing mass of unorganised plant parenchyma cells. In living plants, callus (plural calluses or calli) cells are those that cover a plant wound.*

Cambium layer: *A delicate layer between the phloem and xylem, which produces new phloem on the outside and new xylem on the inside in stems, roots, etc.*

Climbing plant (climber): *Plants, which climb up trees and other tall objects, are climbers. Many of them are vines, whose stems twine around trees and branches.*

Clipper or grass shear: *A tool used to maintain a lawn. It is used for trimming and side-dressing of a lawn*

Coco peat: *A growing medium prepared from dried powder of coconut plant fibre.*

Calyx: *The sepals of a flower that typically forms a whorl that encloses the petals and forms a protective layer around the flower bud.*

Colloids: *A mixture, in which insoluble particles of one substance is dispersed and suspended throughout another substance.*

Contact placement: *In this method, both seeds and fertilisers are applied simultaneously at the time of sowing.*

Crowbar: *It is a steel bar, whose one end is pointed and another is spoon or chisel shaped.*

Cut flowers: *These are the flowers that are harvested with stalk, especially, for arrangement in vases, and hence, are lasting.*

Cut greens: *These are the foliage of ornamental plants that are used as fillers along with cut flowers in flower arrangements and elsewhere for increasing aesthetic value.*

Cutting: *Detached vegetative part of a plant, which on separation and planting regenerates the missing parts and develops itself into a new plant. It is an inexpensive method of propagation.*

Deciduous plants: *Trees and shrubs that seasonally shed leaves, usually, during autumn.*

Defoliation: *The removal of foliage or leaves.*

De-shooting: *The removal or cutting of shoots.*

Disbudding: *It refers to the removal of secondary or tertiary floral buds when a large flower on a plant is desired.*

Diseases: *A plant disease is defined as an abnormal growth or dysfunction in a plant. Diseases are a result of some disturbance in the normal life process of the plant. Diseases may be because of living or non-living causes.*

Earthing-up: *It is a technique in horticulture, wherein soil is piled up around the base of a plant.*

Embryo: *An important segment of a seed, which contains tissues related to the development of leaves, stem (plumule) and root (radicle), as well as, food material storage tissues.*

Etiolation: *Plants grown in partial or complete absence of light. It is characterised by long and weak stems, smaller leaves due to longer internodes and a pale yellow colour.*

Evergreen plants: *Plants that hold their foliage all the year round.*

Explant: *The transfer of living cells, tissues or organs to a nutrient medium for growth.*

Extinct: *Something that does not exist any more.*

F1 Hybrid: *An F1 Hybrid (also known as filial 1 hybrid) is the first filial generation of the offspring of distinctly different parental types.*

Fertigation: *A method in which fertiliser is added to the irrigation water using drip system.*

Fertilisation: *The joining of male and female gametes, resulting in the formation of zygote.*

Fine nozzle: *A nozzle is a narrow pipe used to control the flow of a liquid as it leaves another pipe. The liquid can be sprayed into a gas stream with the help of a nozzle, which disperses the liquid into a fine spray of drops.*

Foliage plant: *Any plant grown for its attractive leaves.*

Floriculture: *It is a branch of horticulture that deals with the cultivation, processing and marketing of ornamental plants vis-a-vis landscaping of small or large areas, and maintenance of gardens so that the surroundings may appear aesthetically pleasant.*

Fumigant: *Any volatile chemical compound used to suffocate or poison pests in plants.*

Gametes: *A mature haploid male or female germ cell, which unites with the opposite sex in sexual reproduction to form a zygote.*

Genetic diversity: *It is the total number of genetic characteristics in the genetic make-up of a species.*

Girdling: *It is the complete removal of the strip of a bark.*

Growing media: *The material in which plants grow. Growing media is designed to support plant growth and can either be a solid or liquid.*

Head back: *When the terminal portion of a branch or shoot is removed and encourages lateral growth from the remaining shoot.*

Heat shock: *It is a conserved reaction of cells and organisms to elevated temperatures (heat shock or heat stress).*

Harrowing: *It is the process of breaking-up and smoothening out the surface of the soil through an implement called harrow.*

Herbaceous: *Plants that have no woody stem above the ground.*

Herbicide: *A chemical substance that is toxic to plants and is used to destroy unwanted vegetation, especially weeds.*

Humus: *The organic component of soil formed by the decomposition of leaves and other plant material by soil microorganisms.*

In vitro: *Performing a given procedure in a controlled environment.*

Incision: *A surgical cut made in the bark of a stem.*

Indoor gardening: *Growing house plants inside a house.*

Juvenile phase: *The period from the germination of a seed to the production of flowers, i.e., reproductive maturity.*

Knapsack sprayer: *It is a sprayer carried on the back for spraying insecticides, fungicides, herbicides, fertilisers and other chemicals.*

Landscaping: *The beautification of a piece of land in order to make it more attractive.*

Lawn: *It is a green carpet for landscape.*

Loamy soil: *Soil made of sand, silt and clay particles.*

Localised placement: *When fertilisers are applied close to seeds or plants at a specific place.*

Loose flowers: *These are the flowers that are plucked from plants without stalks just below the calyx.*

Micro propagation: *Multiplication of plants in aseptic condition and artificial growth medium from very small plant parts (tissues) like meristem tip, callus embryos, anther, etc.*

Morphology: *The branch of biology that deals with the forms and structures of living organisms.*

Mouldboard plough: *A power-driven plough used for ploughing the field. It is made up of carbon steel or steel alloy whose base is of right-angle triangle.*

Mother block: *An area that is devoted to plants known to be free from diseases and are true-to-type. It is used as a source of stock for propagation.*

Mother plant: *A plant grown for the purpose of taking cuttings or offsets in order to grow more quantity of the same plant.*

Mulching: *The act of applying 5 to 10–cm thick layer of covering material on the ground surface around growing plants.*

NAA: *Abbreviated from of Naphthalene acetic acid, which is an organic compound.*

Nursery: *An area meant for multiplying and supplying plants and planting material, and by-an-large giving guidance in the growing of ornamentals and maintenance of gardens.*

Offspring: *Young ones of living organisms, brood or progeny in a general way.*

Ornamental plants: *Plants grown for decorative purposes in gardens and landscape design projects, such as house plants, cut flowers and specimen display.*

Ovary: *In botany, it is an enlarged basal portion of the pistil—the female organ of a flower. The ovary contains ovules, which develop into seeds upon fertilisation.*

Ovule: *The structure that contains female reproductive germ cells.*

Parthenocarpy: *Development of fruits without fertilisation.*

Pedogenic: *It refers to processes that occur in soil and leads to the formation of soil.*

Pedology: *It is the study of soils; pedogenesis refers to the processes involved in the formation of soils.*

Pellet placement: *The process of applying fertilisers in pellet form.*

Petiole: *The stalk that joins leaves to the stem.*

Perennials: *Plants that survive for more than two years and do not die even after producing seeds.*

Pests: *An insect or animal that attacks crops, food, livestock, etc.*

pH: *Expressing the acidity or alkalinity of a solution on a logarithmic scale, on which 7 is neutral. Lower values are more acidic and higher values more alkaline in nature.*

pH-meter: *A digital meter (pocket size) to measure acidity in moist soils. The most favourable levels are 6 and 7 for crop cultivation.*

Phloem tissues: *Tissues that conduct food prepared in the leaves to the other parts of a plant.*

Photosynthesis: *The process by which plants, containing chlorophyll, convert light into chemical energy, which can later be released to fuel plant activities.*

Pinching: *It is the removal of growing tips of the terminal portion of plants to promote bushy growth for more lateral formation.*

Ploughing: *It is the initial operation that involves breaking of hard soil surface.*

Plumule bud: *A part of a plant embryo situated above the cotyledons that consists of epicotyl and immature leaves.*

Pollination: *The process in which pollen is transferred to the female reproductive organ of a plant.*

Potting: *It refers to planting in pots containing the potting mixture.*

Pro-trays or plug-trays: *These are shallow plugs, in which the germination medium provides better aeration to the seeds sown. It is used for sowing costly hybrid seeds.*

Pruning: *The planned removal of branches, twigs, limbs, shoots or roots.*

Radicle: *The part of a plant embryo that consists of a small branch of a root called rootlet.*

Rainy season annuals: *These are grown in the rainy season and can produce flowers under high humidity and rain as compared to other annuals.*

Rake: *It is a tool used for breaking up the soil surface into a fine tilth, ready for sowing and collecting weeds.*

Re-potting: *This refers to transferring a plant after de-potting into a larger pot, containing fresh potting mixture.*

Rhizome: *A specialised stem structure, in which the main axis of the plant grows horizontally or just below the ground surface.*

Rooting: *A part a plant that develops, typically, from the radicle and grows downward into the soil, anchoring the plant and absorbing nutrients and moisture.*

Rootstock: *It is the stump of a related species, which already has an established and healthy root system, and is utilised for grafting or budding of scion.*

Scion: *A young shoot, twig or bud of a desirable plant utilised for plant propagation.*

Seed coat: *The protective outer coat of a seed, which encloses the embryo and stored food material.*

Serpentine: *It refers to the movement like that of a serpent or snake.*

Shovel: *A tool used for lifting young seedlings from nursery beds.*

Shrubs: *A woody plant smaller than a tree that has several main stems arising at or near the ground.*

Silty: *Fine sand, clay or other material carried by running water and deposited as sediment.*

Slant: *Slope or lean in a particular direction.*

Soil: *It may be defined as a dynamic natural body developed as a result of processes that take place during and after the weathering of rocks, in which plants and other forms of life can grow.*

Soil density: *It is the weight per unit volume of soil and can be expressed in particle and bulk density.*

Soil genesis: *The transformation of rocks into agricultural land is called soil formation or soil genesis.*

Soil morphology: *It deals with the form and arrangement of soil features.*

Soil solarisation: *The method of controlling soil-borne pathogens and pests by using high temperatures and capturing solar energy. This method involves heating the soil by covering it with a clear plastic sheet for 4 to 6 weeks during the summer season when the soil will receive direct sunlight the most, resulting in the killing of soil-borne pests, such as weeds, pathogens, nematodes and insects.*

Soil test: *It is a method for determining the fertility status of the soil, so that recommendations as regards to soil amendments can be made.*

Soil texture: *This refers to the size of soil particles that comprise the soil.*

Staking: *It is the practice to support plants to grow straight and save them from bending or lodging.*

Sterilisation: *The process that eliminates, removes, kills or deactivates all forms of life and other biological agents from a medium.*

Stone: *A hard shell containing nut or seed in the centre of some fruits like mango, cashewnut, etc.*

Succulents: *A plant (especially a xerophyte) having thick fleshy leaves or stems adapted to store water.*

Texture: *The feel, appearance or consistency of a surface or substance.*

Tissues: *These consist of specialised cell or aggregation of cells in an organism.*

Tissue culture: *Growing tissues in controlled conditions. It is a specialised technique of vegetative propagation.*

Top dressing: *This refers to fertilisers, such as nitrogen and micronutrients that are applied in standing crops.*

Top working: *The process employed to repair or change varieties without removing and replacing a tree. The top is cut back to several major limbs (branches).*

Totipotency: *It is the genetic potential of a plant cell to produce the entire plant.*

Training: *This refers to giving shape to a plant, conforming to a particular form commensurate to the plant's requirement at an early stage.*

Tree: *It is woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground.*

True seeds: *Plants whose seeds will yield the same type of plant as the original plant.*

True-to-type: *Being or behaving as expected.*

Tunicated: *Having concentric layers.*

Turf grass: *These are plants forming continuous ground cover that requires mowing.*

Variations: *A change or slight difference in condition.*

Vermicompost: *It is an organic manure (bio-fertiliser) produced as vermicast by earthworms, who feed on biological waste material and plant residues.*

Weeding: *This refers to the removal of all undesirable plants growing in a field other than ones planted or sown.*

Wheelbarrow: *A tool, primarily, used to move heavy things.*

Answer Key

Unit 1: Introduction to Floriculture

A. Fill in the Blanks

1. herbaceous 2. woody 3. annuals
4. biennials 5. six 6. indoor
7. lawn 8. planting 9. fillers

B. Multiple Choice Questions

1. (d) 2. (a) 3. (a) 4. (a)

D. Match the Columns

1. (e) 2. (d) 3. (f) 4. (a) 5. (b) 6. (c)

Unit 2: Nursery Management

Session 1: Nursery and Its Importance

A. Fill in the Blanks

1. material 2. pollution-free 3. seasonal
4. dry 5. 15 cm 6. solarisation

B. Multiple Choice Questions

1. (a) 2. (c) 3. (a) 4. (c) 5. (b)

D. Match the Columns

1. (e) 2. (d) 3. (b) 4. (a) 5. (c)

Session 2: Growing Media

A. Fill in the Blanks

1. organic 2. perlite 3. lacks 4. growing

B. Multiple Choice Questions

1. (b) 2. (a) 3. (c) 4. (a)

D. Match the Columns

1. (b) 2. (a) 3. (a)

Session 3: Sowing of Seeds and Planting Material

A. Fill in the Blanks

1. nursery 2. Clay 3. de-potting
4. July–August 5. immediately 6. higher

B. Multiple Choice Questions

1. (c) 2. (a) 3. (b) 4. (c) 5. (b)

D. Match the Columns

1. (c) 2. (b) 3. (e) 4. (a) 5. (d)

Unit 3: Plant Propagation

Session 1: Plant Propagation by Cutting

A. Fill in the Blanks

1. propagation 2. asexual/vegetative propagation
3. tissue culture 4. sexual
5. seeds 6. variation
7. long 8. asexual
9. hardwood cutting

B. Multiple Choice Questions

1. (c) 2. (b) 3. (a) 4. (a)

D. Match the Columns

1. (c) 2. (d) 3. (a) 4. (b)

Session 2: Plant Propagation by Layering

A. Fill in the Blanks

1. simple 2. attached
3. aerial 4. 2.5 cm

B. Multiple Choice Questions

1. (a) 2. (a) 3. (c) 4. (d)

D. Match the Columns

1. (e) 2. (d) 3. (a) 4. (b) 5. (c)

Session 3: Plant Propagation by Grafting

A. Fill in the Blanks

1. rootstock 2. scion
3. grafting 4. approach
5. tongue

B. Multiple Choice Questions

1. (a) 2. (d) 3. (b) 4. (a)

C. Match the Columns

1. (c) 2. (d) 3. (a) 4. (b)

Session 4: Plant Propagation by Budding

A. Fill in the Blanks

1. budding 2. shield 3. bulb
4. tuber 5. flute

B. Multiple Choice Questions

1. (a) 2. (d) 3. (a) 4. (b) 5. (a)

D. Match the Columns

1. (e) 2. (d) 3. (b) 4. (a) 5. (c)

Unit 4: Garden Tools and Equipment

A. Fill in the Blanks

1. 20
2. 50–90
3. 50
4. cultivator
5. budding-cum-grafting
6. cuttings
7. hedge shear
8. trimming, side-dressing

B. Multiple Choice Questions

1. (a) 2. (d) 3. (d) 4. (b) 5. (c) 6. (b)

D. Match the Columns

1. (h) 2. (g) 3. (f) 4. (e) 5. (d) 6. (c) 7. (b) 8. (a)

Unit 5: Soil Management and Field Preparation

Session 1: Soil and Its Properties

A. Fill in the Blanks

1. 45
2. silt
3. g/cm^3
4. acidic or alkaline
5. increases

B. Multiple Choice Questions

1. (a) 2. (b) 3. (d) 4. (c) 5. (a)

D. Match the Columns

1. (d) 2. (c) 3. (b) 4. (e) 5. (a) 6. (g) 7. (f)

Session 2: Soil Reclamation or Improvement

A. Fill in the Blanks

1. aeration
2. 15–30
3. salinity
4. 500 g
5. 8.5 or more.

B. Multiple Choice Questions

1. (d) 2. (a) 3. (c) 4. (c) 5. (c)

D. Match the Columns

1. (e) 2. (d) 3. (a) 4. (b) 5. (c)

Session 3: Field Preparation and Special Practices

A. Fill in the blanks

1. harrowing
2. unwanted
3. protective
4. de-shooting
5. flower bud
6. training

B. Multiple Choice Questions

1. (d) 2. (c) 3. (c) 4. (a)

D. Match the Columns

1. (b) 2. (d) 3. (a) 4. (c)

List of Credits

Unit 2

Fig. 2.1: DAAH, PSSCIVE, Bhopal

Fig. 2.2: https://bit.ly/2Kp7kV3

Fig. 2.3: V. K. Tripathi, CSAUA&T

Fig. 2.4: https://bit.ly/2Jh17Ke

Fig. 2.5: R. K. Pathak, PSSCIVE Bhopal

Fig. 2.6: https://goo.gl/CzZs9f

Fig. 2.7: https://goo.gl/Z9mh6R

Fig. 2.8: https://bit.ly/2IQSbMw

Fig. 2.9: R. K. Pathak, PSSCIVE Bhopal

Fig. 2.10: R. K. Pathak, PSSCIVE Bhopal

Fig. 2.11: R. K. Pathak, PSSCIVE Bhopal

Fig. 2.12: V. K. Tripathi, CSAUA&T Kanpur

Fig. 2.13 V. K. Tripathi, CSAUA&T Kanpur

Unit 3

Fig. 3.1: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.2: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.3: R.K.Pathak, PSSCIVE Bhopal

Fig. 3.4: V.K. Tripathi, CSAUA&T Kanpur

Fig. 3.5: https://bit.ly/2tJJ2uD

Fig. 3.6: DAAH, PSSCIVE Bhopal

Fig. 3.7: DAAH, PSSCIVE Bhopal

Fig. 3.8: DAAH, PSSCIVE Bhopal

Fig. 3.9: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.10: DAAH, PSSCIVE Bhopal

Fig. 3.11: DAAH, PSSCIVE Bhopal

Fig. 3.12: DAAH, PSSCIVE Bhopal

Fig. 3.13: V. K. Tripathi, CSAUA&T Kanpur

Fig. 3.14: DAAH, PSSCIVE Bhopal

Fig. 3.15: V. K. Tripathi, CSAUA&T Kanpur

Fig. 3.16: DAAH, PSSCIVE Bhopal

Fig. 3.17: DAAH, PSSCIVE Bhopal

Fig. 3.18: V. K. Tripathi, CSAUA&T Kanpur

Fig. 3.19: V. K. Tripathi, CSAUA&T Kanpur

Fig. 3.20: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.21: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.23: R. K. Pathak, PSSCIVE Bhopal

(a) R. K. Pathak, PSSCIVE, Bhopal

(b) https://bit.ly/2KEkxpZ

(c) https://bit.ly/2tOoJNq

(d) https://bit.ly/2MsyjfU

(e) https://bit.ly/2NiSnm7

(f) https://bit.ly/2tMhIN2

Unit 4

Fig. 4.1: R. K. Pathak, PSSCIVE Bhopal

Fig. 4.2: R. K. Pathak, PSSCIVE Bhopal

Fig. 4.4: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.5: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.6: R. K. Pathak, PSSCIVE Bhopal

Fig. 4.7: R. K. Pathak, PSSCIVE Bhopal

Fig. 4.8: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.10: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.12: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.13: R. K. Pathak, PSSCIVE Bhopal

Fig. 3.14: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.15: V. K. Tripathi, CSAUA&T Kanpur

Fig. 4.16: R. K. Pathak, PSSCIVE Bhopal

Fig. 4.19: R. K. Pathak, PSSCIVE Bhopal

Unit 5

Fig. 5.1: R. K. Pathak, PSSCIVE Bhopal

Further readings

Arora, J.S. 2013. *Introductory Ornamental Horticulture*. Kalyani Publishers, New Delhi.

Joshi, A.K. and B.D. Singh. 2013. *Seed Science and Technology*. Kalyani Publishers, New Delhi.

Randhawa, G.S. and A. Mukhopadhyay. 1986. *Floriculture in India.* Allied Publishers, New Delhi.

Singh, Jitendra. 2008. *Introduction to Horticulture*. Kalyani Publishers, New Delhi.

Tripathi, Vivek Kumar. 2017. *Experimental Approaches in Horticulture*. AGRO India Publications, Allahabad.