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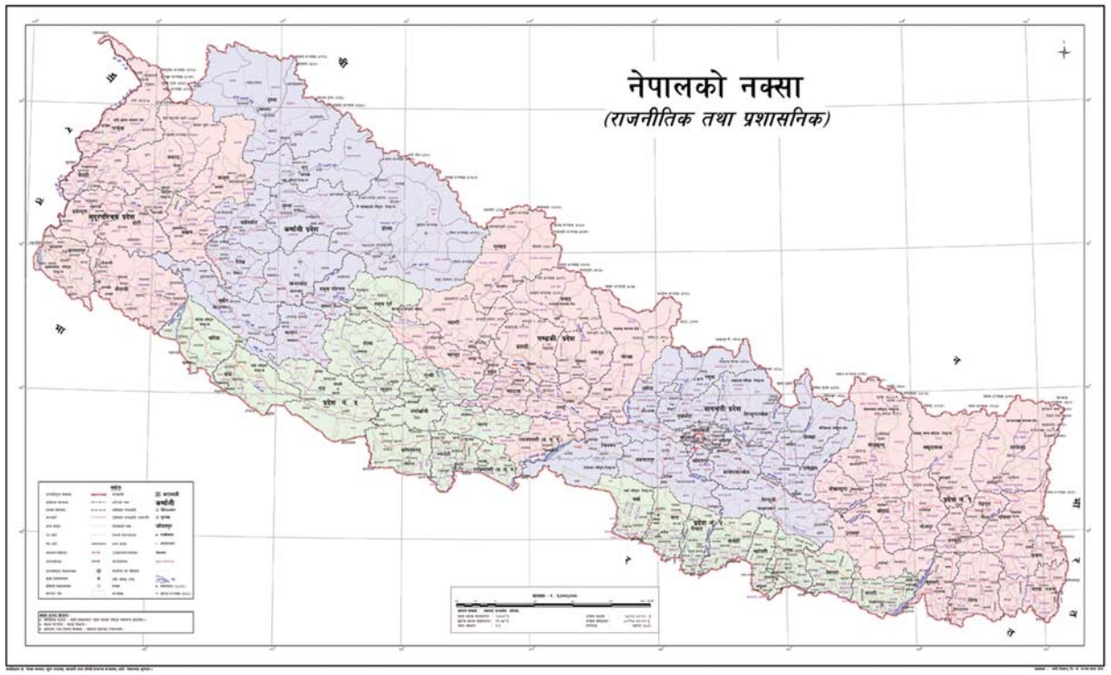

Floriculture and Nursery Management

Government of Nepal
Ministry of Education, Science and Technology
Curriculum Development Centre
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Technical and Vocational Stream
Learning Resource Material

Floriculture and Nursery Management
(Grade 10)

Secondary Level
PLANT SCIENCE

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

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Preface

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

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Khemraj Dahal, Arjun Prakash Poudel, Balachandra Chaulagain, UmeshaTimalsina, DineshTimalsina, Sujan Karki, Samir Shrma is highly acknowledged. The book is written by Mahesh Paudel and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book in this form.

This book is a supplimentary learning resource material for students and teachrs. In addition they have to make use of other relevnt materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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Ministry of Education, Science and Technology

Curriculum Development Centre

Table of Content

UNIT-1

Introduction

A. Objectives:

The main objective of this course is to develop student's ability to:

- Define the meaning and concept of floriculture.
- Explain the importance, scope and status of floriculture.
- Classify the different ornamental plants.

B. Content elaboration:

1.1 Meaning, importance, scope and challenges of floriculture in Nepal

1.1.1 Meaning:

Floriculture can be defined as "a specialized branch of horticulture which deals not only with the cultivation of flowers, foliage, climbers, trees, shrubs, cacti, succulents, etc., but also with their marketing and production of value-added products from them".

Floriculture can also be defined as "a discipline of horticulture concerned with the cultivation of flowering and ornamental plants for gardens and floristry, comprising the floral industry. It includes bedding plants, flowering plants, foliage plants or house plants, cut greens and cut flowers".

Floriculture is aesthetic branch of horticulture science which deals with cultivations and marketing of ornamental plants which includes annual, biennial and potted plants. This is also includes markets and export of cut flowers, live plants and their economic product like scents, oils and medicines etc.

Flowers are associated with mankind from the dawn of cultivation. It is said that man is born with flowers, lives with flowers & finally dies with flowers. Flowers are used for various purposes in our day to day life like worshipping, religious & social functions, wedding interior decoration & self-adornment. Saying it with flowers is very common & different flowers are used to convey the human feelings.

1.1.2 Importance:

Besides beauty and aesthetic values of flower, they are important for their economic

value as sale of flowers (loose as well as cut blooms), extraction of essential oil and making of economic products like gulkand.

Flowers provide less food than other major plants parts (seeds,fruits,roots,stems and leaves)but they provide several important foods and leaves)but they provide several important foods and spices. Flower vegetables include broccoli, cauliflower and artichoke. Marigold flowers are fed to chicken to give then egg yolks a golden yellowed.

The flowers have various important which is maintained below:

Social value:

In our society a human grow flower for their aesthetic purpose which is recognized as a rich person or a person with high social status.

Economic value:

By selling, seedling, sapling& seed the grower can earn in the income. Now a day's importance of cut flower is increasing which fetch high price due to which economic condition of grower is increased.The flower are also used for extraction of oil & perfumes which is also economically important. eg: the price of rose oil is 3800$.

Medicinal value:

Flowers are also use for the extraction of drugs which can be directly used as medicine such as:

a) Rose water: Rose water is used for cleaning the skin, removal of pimples.
b) China rose: China rose is use in stomach ache etc

Convey human feelings:

Flower are used to convey human feelings like

- rose for love;
- white carnation for human love;
- French marigold for jealousy or sorrow;
- African marigold for vulgar mind;
- lily for purity;
- Sweet pea for departure etc.

1.1.3 Scope of floriculture in Nepal

Nepal is a landlocked country having a diversified agro climatic condition which has lots variation in altitude, topography, temperature, humidity within the small space of geography. The following points focus the scope of floriculture in Nepal:

i. In Nepal annual demand of rose 9 lakhs sticks;gladious 7.5 lakhs stick; chrysanthemum 3 lakhs stick which focuses the scope of floriculture is expanding day by day.
ii. Only 30% of cut flower & live plant are supplied nationally & rest 70% are import from other countries especially from India'
iii. Wide range of climatic zone make possible for growing different types of flower plant.
iv. Quality seed production, export of quality seed can fetch foreign dollars.
v. Perfumes & sent can be made by different flower whose demand is growing rapidly.
vi. Technical & research institute can be constructed to generate the research for the development of their field
vii. Only small area is utilized in the flori-business & there are availability of cheap manpower which shows the potentiality of floriculture in Nepal.

Cut-flowers: Nrs 9.4 million; Flowers & plants:Nrs 18.25 million;Landscape:Nrs 20million market estimated for Kathmandu.

1.2 Current status of floriculture in Nepal

Nepal is predominantly an agriculture-based economy where floriculture sector holds a great export potential. Traditional floriculture in Nepal is gradually turning to a modern lucrative business since early Nineties. Entrepreneur's enthusiasm and investment in this sector grew spontaneously with the encouragement received from the domestic as well as foreign markets.

Floriculture in Nepal began some seven decades ago but formal floriculture business began only in the early nineties of the last century. The formation of Floriculture Association of Nepal (FAN) in 1992 resulted in more organized business, data recording, introduction and multi-location trial of new crops, setting up wholesale outlet of cut flowers and formation of floriculture cooperative. Recently, FAN was successful in getting the government to approve Floriculture Policy. The private

sector is looking forward for the positive changes this policy shall bring to propel significant growth in the industry. In this juncture it is important to look back at what different government agencies have done towards development of floriculture in Nepal.

Floriculture in Nepal at a glance:

The status of floriculture in Nepal is very encouraging. The industry is steadily growing over the years and in 2012 the share of different products of floriculture was as shown below (Table 1). The total annual turnover reached new height of Rs. 105.32 corers.

Table 1: Floriculture Industry Data: overall 2011-12

S/No	Description	Amount (Rs in crores)
1	Seasonal Flowers and Seeds	16.56
2	Ornamental Plants	32.0
3	Cut flowers and foliage	16.0
4	Landscaping and gardening	12.0
5	Loose Flowers	4.5
6	Input Supplies (Silpouline, Materials and Equipments)	7.5
7	Others (carpet grass, bulbs, rhizomes, tuber, tissue culture plantlets etc	5.80
8	EXPORT	10.96
9	TOTAL	105.32
10	IMPORT	4.0

Source: FAN, 2013

The growth of floriculture sector in last two decades has been good. It began with annual turnover of Rs. 1.8 crores in 1994 to Rs. 105.32 crores in 2012 (Table 2). However, the growth of different product and services of floriculture is not similar. There are some products that are growing at a much faster rate than others. The faster growing products may result into many new opportunities. The products that have made tremendous growth are Seasonal flowers and seeds, ornamental plants, cut

flowers and foliages, landscaping and gardening. The products such as loose flowers have also grown over years but not at the scale as others. The new in-put product such as Silpouline, materials and equipment is growing very steadily. The export is also increasing steadily whereas the import has been slowed down. The support of the government should be in those areas that is already bearing positive results. The role of research and extension agencies of the government can work closely with private sector a so as to improve product and make it more competitive.

Table 2: Growth of different products of floriculture (Rs in crores)

S/No	Description	1993/94 (crores)	2005/06 (crores)	2008/09 (crores)	2011/12 (crores)
1	Seasonal Flowers and Seeds	0.30	2.5	6.0	16.56
2	Ornamental Plants	0.26	10.0	16.0	32.0
3	Cut flowers and foliage	0.22	2.0	3.5	16.0
4	Landscaping and gardening		2.5	10.0	12.0
5	Loose Flowers	0.32	2.0	3.0	4.5
6	Input Supplies (Silpouline, Materials and Equipments)		2.0	3.0	7.5
7	Others (carpet grass, bulbs, rhizomes, tuber, tissue culture plantlets etc		2.0	5.0	5.80
8	EXPORT			6.0	10.96
9	TOTAL	1.8 (1.1 in ktm valley)	23.0	56.0	105.32
10	IMPORT			3.5	4.0

Source: FAN, 2013

1.3 Classification of ornamental plants (Season, growth habit life span)

The branch of biology that deals with identifying and naming organisms is taxonomy. Plants are classified based on the similarities of their characteristics. Plant taxonomists compare flowering patterns, stem and leaf structures, life cycles, genetic similarities, and many other characteristics in deciding which plants are the most closely related. The study of the form or shape of organisms or parts of an organism is morphology. Ornamental plants are classified on different basis. They are:

1. **Classification of ornamental plants on the basis of flowering season:**

   a. **Summer Season:**
   Those plants that flowers during summer (Jestha, Ashad, Shrawan) Eg: Gulmohar, Nilmohar, Petuia, Phlox etc.

   b. **Winter Season:**
   Those plants that flowers in winter (Mangsir, Poush, Magh) Eg: Poinsettia, Euphorbia, Bougain Villea, Crysantheum, Gerbera etc

   c. **Rainy Season:**
   Those plant which flowers in rainy (Ashad, Shrawan, Bhadra) Eg: Sano Asare (*Laerostomia indica*), Thulo Asare (*Laerostomia flos-regime*), Gomphrena (Makhmali) etc.

2. **Classification of ornamental plants on the basis growth habit:**

3. **Classification of ornamental plants on the basis life span:**

a) **Annuals:**

Annual plant is one which completed its life cycle from germination to seed formation within one season and then dies usually as a result of complete exhaustion of its food reserve in the process of reproduction.

E.g. Nasturtium, Ice plant, Holly hock, Sweet pea, Annual Chrysanthemum, Carnation, Cornflower, Sweet Alyssum, Dahlia, Marigold, Verbena, Phlox, Pinks, Calendula, etc.

b) **Perennials:**

Any plant that lives more than two years is known as perennial.

E.g. Rose, Jasmine, Crossandra, Anthurium, Orchids, Chrysanthemum, Berlaria, Hibiscus, Gerbera, Carnation, Bulbous Crops etc.,

C. **Learning process and support materials**

The learning process includes the participation of student in group work, presentation and skill development, written methods etc.

D. Assessment

Very short (Answer question)

1. Define floriculture.
2. Give any two examples of perennial ornamental plants

2. Short (Answer question)

1. Write any two Scope of floriculture in Nepal.
2. Write the medicine importance of floriculture.

3. Long (Answer question)

1. Classify the ornamental plants on the basis of life span with suitable examples.
2. Write down the current status of floriculture in Nepal.
3. Briefly discuss about the scope of floriculture in Nepal.

Glossary

Cacti: Cacti are a group of plants with peculiar shape and size and mostly adapted for desert life

Climbers: Climbers are the plant which climbs up trees and other tall object.

Foliage: The leaves of a plant or tree.

Gulkand: Sweet preserve of rose petals.

Shrubs: A shrub is a small to medium sized woody plants.

Succulents: Succulents are the perfect plant for getful gardeners.

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UNIT-2

Garden

A. Objectives:

This course will enable the student to:

- Define the meaning and concept of garden.
- Describe the importance and scope of garden.
- Explain the type of garden.
- Demonstrated the landscape gardening and lawn management.

B. Content elaboration:

2.1 Meaning, Scope and importance

2.1.1 Meaning

A garden is a planned space, usually outdoors, set aside for the display, cultivation and enjoyment of plants and other forms of nature. The garden can incorporate both natural and man-made materials. The most common form today is known as a residential garden, but the term garden has traditionally been a more general one. Zoos, which display wild animals in simulated natural habitats, were formerly called zoological gardens. Western gardens are almost universally based on plants, with garden often signifying a shortened form of botanical garden.

2.1.2 Scope and importance

Gardening which was only an art and science in the earlier days has now emerged as a huge industry. With the importance and need of gardening in improving and conserving the environment being strongly felt now, the concept of landscaping and gardening is growing rapidly. Ornamental gardening and landscaping has expanded as a multi-faceted industry encompassing activities such as propagating and rearing ornamental plants, landscaping, production of growing media, pots and other accessories, *etc.,* generating huge employment opportunities and simultaneously promoting activities that would improve the environment.

2.2 Garden types

2.2.1 Formal garden:

Formal garden is the application of garden method and material geometrically balanced and based on the bilateral symmetry. This is a garden laid out with complete regularity on formal lines and in accord with the methods of classic design. Hard landscaping is usually used to define the main lines of the design, although planting may also be symmetrically arranged in rows or geometric beds.

Formal garden design echoes the classical architecture of Greece and Italy. Although some of the earliest Islamic gardens were based on strong geometric lines, and may be considered the earliest of formal gardens, classical and Renaissance influences have had a much stronger impact on formal garden design over the centuries. Among the most famous formal gardens are Versailles and Fontainebleau, both of which were designed by Andre Le Notre. Although these gardens are massive in scale, the structure and balance of formal garden design can also work well on a much smaller scale.

Key elements of a formal garden design include:

Symmetry

Symmetry about an axis or central line. This could be a pathway or lawn, or even a central planting bed. Generally, the axis focuses on a dominant feature, such as a sculpture, statue, or ornament. If space allows, cross-axes can be created; some larger gardens have multiple axial routes that create views along and across the garden. When designing a formal garden, the space is usually divided into halves or quarters. Larger gardens can be partitioned further, but divisions should be as sizeable as possible to maximize the visual impact of long vistas, or the repetition of topiary or trees. Parterres, water pools, and expanses of lawn are also common features in formal design.

Prominent Focal Point

Sculpture is commonly used as a focal point in formal garden design. In traditional gardens, statues of gods and mythological creatures were frequently used. In modern designs, a wider range of subjects and abstract works are used as focal points more frequently.

Topiary

Clipped hedging, typically box or yew for evergreen structure, is often used to define space within a formal design. Topiary provides structure, and dwarf box hedges may be used to form patterns in parterres.

Ornament

Large, ornate urns, often on plinths or balustrades, provide focal points or punctuation in traditional formal designs. Modern formal gardens may use the same technique, but with simpler designs.

Natural Stone

Paving provides an architectural element for pathways and terraces. Sawn and honed natural stone slabs can create regular patterns, or may be used to edge lawns and gravel paths.

2.2.2 Informal garden

The application of garden method and materials for the improvement of any area, on which it is possible and desirable to develop new face. This is a casually designed space with few straight lines, often depending on curving, organic lines. It may draw inspiration from natural habitats. This style of garden is sometimes referred to as naturalistic.

2.3 Concept of landscape gardening

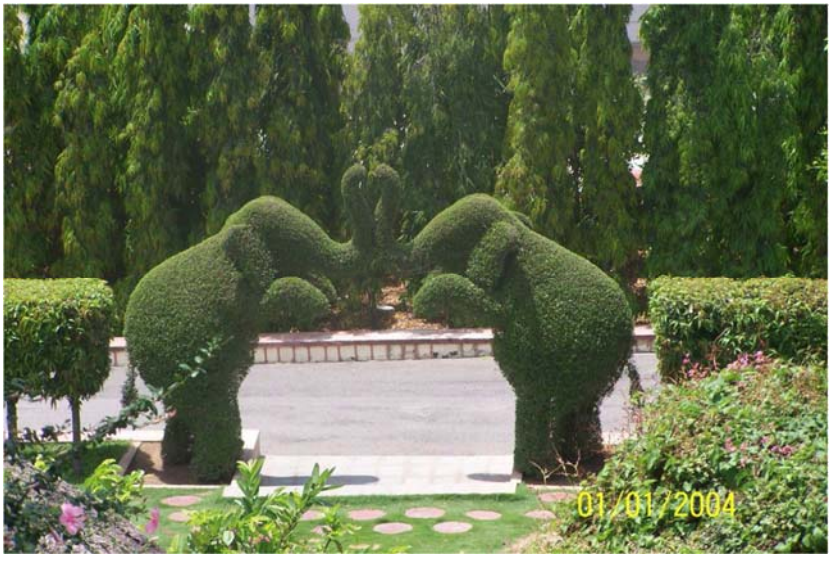
Landscaping is an aesthetic branch of Horticulture, which deals with planting of ornamental plants in such a way that it creates a picturesque effect. Landscape gardening can also be defined as the beautification of a tract of land having a house or other object of interest on it. It is done with a view to create a natural scene by the planting of lawns, trees, shrubs flowering annuals, climbers, creepers, etc. Further, landscape gardening is both an art and science of the establishment of a ground in such a way that it gives an effect of a natural landscape. It can also be defined as "improving of total living environment for the people".

2.4 Principle of landscape design

There are certain basic gardening principles that a gardener should follow to achieve a garden that is pleasing to the senses and provides a pleasant outdoor living space. These principles are:

Balance

The balance in landscape design is visual equilibrium of different garden elements. Balance can be created in a garden either formal or informal by grouping the components, structures and plants equally on both sides of the imaginary central axis. It is a striking feature in a formal garden. The exact duplication of what is on right on the left imposes a balance. The balance should be colour wise, texture wise and shape wise. Trees as an avenue on one side will not make a balance. Care should be bestowed to create balance in colour and texture.



Proportion

Proportion refers to the share of the different parts or components to the whole. It is the relation of the component with other in magnitude. In a landscape garden, the space and area provided for a lawn, paths, borders, trees, buildings etc. should be in right proportion and not equal in proportion. Proportion helps in space organization. The disproportionate occupation of any one component may distract the eye and attention.

Proportion, suggested by plants in a garden indirectly pacifies the psyche as one's mind is conditioned to enjoy one component of a garden in proportion to the other without a discordant note. Such a conditioned mind will not succumb to streak thoughts which are disproportionate.

U**nity**

Though diverse structures, plants and features are used to create a landscape, there should be a unity among each component and all the components with main building. Instead of the individual beauty of a component, the overall beauty should be focused to achieve unity in diversity. Further, a designer should work towards integrating the aesthetic principles of balance, rhythm, proportion and harmony to give unity to the composition. If one's mind is conditioned to freely unite or mingle with other persons, he will be accustomed to interact without reaction. Such interaction without reaction is the quality imposed by the 'unity' concept of a garden.

Perspective

Any object situated at a distance will look small compared to the one of the same size kept close to the vision. Eg. Rail road converges at distance. This visual phenomenon of shrinkage in size and converging of lines is termed perspective. The garden objects can be positioned either at the foreground or background to create pleasing visual illusions.

Artist's perspective is two dimensional, sculpture's perspective is three dimensional while the landscape architects perspective is of four dimensional, the fourth dimension being the time because, as the time passes, the size of plants differ, colour differ and ultimate visual quality will differ.

Prospect

Prospect is the view of a scenery, natural or man-made, through an opening such as window or a gap in the foliage of trees. It is the 'camera view' of any scenery. Such prospects can be created in landscape gardening by adopting suitable proportion and unity.

Restraint

Overuse of any component including grouping of plants in a particular location masks the scenic beauty. If all the features whether natural or artificial are kept within bounds or used with restraint, best results can be achieved.

Rhythm

Rhythm is measured as cyclic repetition of an object, effect and event. In a garden, rhythm can be infused through cleverly repeated colours and shape, topiaries and hedges etc. In Mughal gardens, the fountains and cascades have been repetitively provided to create rhythm. Sometimes rhythm is created through action of lights under water. Boredom clutches the mind predisposing it to become devil's workshop. Rhythm in thouht waves elevates the mind from the tentacles of boredom.

Harmony

Harmony is the pleasing effect obtained due to appropriate arrangement and collation of the various garden features. It is the overall effect of various features styles, colours and structures in the total landscape. Every part of the landscape should synchronize into the other and all the components into the whole. No individual component should project itself beyond its expected limit. The beauty of the landscape depends upon the degree of harmony of various elements. It is the evident relationship of all parts of a thing observed visually, audibly and psychically. When the components of landscape architecture posses harmony, the picturesque effect is produced and can aesthetically please the visitor. Further the garden should harmonize with the building and both should harmonize with the natural landscape beyond the boundaries of landscape area. The synchronization of one within the other is the key factor to achieve harmony.

Scale

Scale is a relative dimension. The height and spread of trees and shrubs and the spread of the water garden are determined by adopting a scale. To make it clear, it may be noted that a small reflecting pool underneath a large tree will be dominated by the tree and render the pool ineffective, owing to the difference in their dimensions. To get the right picture of a tree beside a pool we should adopt a ratio between the size of the tree and pool as is obtained in nature. Appropriate adoption of scales and proportionate measurements are the success of imitative naturalistic garden art.

Space

The aim of every garden design should be such that the garden should appear large than its actual size. One way of achieving this is to keep vast open spaces, preferably under lawn and restrict the plantings in the periphery, normally avoiding any planting in the centre. But if any planting has to be done in the centre, the choice should be a tree which branches at a higher level on the trunk (or the lower branches are removed),

and not a bushy shrub. Such planting will not obstruct the view or make the garden appear smaller than its size.

2.5 Preparation and maintenance of lawn

Lawn

A lawn can be defined as the green carpet for a landscape. It is a basic feature for any type of garden. In a home garden, lawn improves the appearance of the house, enhances its beauty, increases conveniences and usefulness thus adding monetary value to the real estate. The lawn provides a perfect setting for a flower bed, a border, a shrubbery or a specimen tree or a shrub. Besides the material value, a lawn has its spiritual value, too. A lawn is the source of charm and pride and reduces tension of the mind after a day's hard work in the materialistic world.

Preparation of Lawn:

The site selected should have simple sunshine. There should not be big trees near the lawn site as they cast shadows, and during leaf fall, the leaves falling on the lawn make difficult the task of keeping the lawn clean. The soil depth should be about 25-30 cm.

The soil for establishing a lawn should have a ph 5.5to6.0 should be fertile and containing organic matter and having a good drainage.

Generally, the material, i.e. grasses used for lawn arte shallow rooted, and hence, care has to be taken that there is no stagnation of water in rooting zone. On a big town, proper drainage can be achieved by using drainage pipes.

The soil should be dug to a depth of 45 cm. and kept aside. The soil at the bottom may be pressed do that, after filling, there is no sagging of the soil. The clods in the dug up soil should be broken. Presence of clods would present difficulty in achieving proper level. The soil may be refilled in the dug up portion and well rotten. F.Y.M. at the rate of 500 kg per 100 sq. m. Should be spread evenly and then this should be worked up in soil to a depth of 15-30 cm. The digging work should be taken up. In summer so that the insects. Weed seeds would be killed due to heat. The refilled soil needs to be consolidated.

The entire area should be flooded with water. This would also help the wood seeds to

germinate. The woods should be removed. On all sides, 10-12 cm high bunds may be prepared to check run-off. This will also help in leveling the land, as at some places, water pools would be formed which could be filled with soil. From the centre, the land should have gentle slope on all sides. The flooding should be repeated 2 to 3 times.

The most commonly used grass for preparing lawn is doob grass (Cynodon dactylon). It is also called as "HARIALI'. This thrives under hot sunny site. This grass is suitable for large areas and poly ground on account of its tolerance to wear and tear and has good recuperation habit. Another grass is Korean grass (Zoysia japonica). This is recently introduced in India and has become popular due to its velvety growth and cold tolerance. It makes cushion like turf suitable for smaller areas and home lawns. The water requirement of this grass is more. This grass should be clipped at a height of 1.5 to2.5 cm. This is slow growing grass.

Method of Planting of Lawn

The lawn can be prepared by any one of the following methods.

1. **By Sowing Seeds:**

   The doob grass seed is very fine and is also light. The prepared soil should be raked to a depth of d2.5 to 3 cm. The area may be divided in equal plots of approx. 250-300 sq.m. This would ensure even sowing. The seed should be mixed width fine soil and broadcast at the rate of 400-500 gm. Per 200 s-m. The seed should be mixed din the soil and the soil may be rolled with a lightly roller. The seed should be covered with fine sifted soil. The area should be watered with a weather can having fine rose. The seeds would germinate in 3 to 4 weeks. The grass, when it attains a height of 4-5 cm. should be cut with garden shears.

2. **Dibbling:**

   Rooted or uprooted doob grass cuttings can be obtained from close cut lawn or from any other sources. These cuttings are dibbled when the soil is slightly moist. The dibbling may be done 8-9 cm apart, frequent watering should be done till the grass starts sprouting. The grass gets ready for first cutting in 5-6 weeks. This method takes about 4-5 months to establish a good lawn.

3. Turfing:

This method, though costly, is the quickest method. A piece of earth, about 5 cm thick, and having thick grass growing on it is called 'TURF'. Small square processes are dug ort and re-laid closely to cach other (like bricks in a wall) in the land prepared for lawn. The points should be filled in with sandy soil. The tuff is made firm by pressing it with wooden hammer. The area should be watered copiously. This is the quickest method of establishing the lawn.

Maintenance of Lawns:

One of the main items of importance is wooding. The most common wood in lawn is Nagarmoth (Cyperus fortundus). Regular weeding will help in checking this wood.

Regular rolling, moving and sweeping should be done; Rolling may be done after each wooding. Moving is another important item of operation, a good machine which will cut at correct height is necessary. The frequency of moving will depend on growth of the grass. Generally, the grass should not be allowed to grow beyond 5-6 cm.

Light irrigation at frequent intervals is preferred to flooding. By use of sprinkler, there is saving of water as well as labour.

Manuring:

One kg of F.Y.M. or compost per Esq. is enough. Bone meal 100 gm per sq. may also be added. Manuring may be done twice an year. Randhawa and Mukhopadhyay (1986) recommended following mixture.

Mixture of 20 kg Compost + 1 kg Ammonium sulphate + 2 kg superphosphate be added to 100 liters of water. This mixture should be allowed to ferment for a few days. The concentrated mixtures should be strained through gunny cloth and applied to lawn twice a year (May-June and Oct.-Nov.) instead of compost, raw cow clung can also be used. Sometimes, the lawn shows yellow patches, this can be connected by spraying 1% urea solution.

C. Learning process and support materials:

The learning process includes the Visual methods, Presentation methods, Creative thinking, Practical method and Exhibition methods etc.

D. Assesment

Very short (Answer question)

1. What is garden?
2. What are the types of garden?

Short (Answer question)

1. Define formal garden.
2. Define non-formal garden.
3. List out the principles of landscape design.
4. Write down the importance of garden.

Long question (Answer question)

1. How will you prepare lawn in your school?
2. Explain about the principle of landscape design.

Glossary :

Base line: A line used as a base for further work, particularly in making a layout.

Evergreen: Evergreen trees do not have definite resting season and they do not shed their leaves during any particular season.

Formal Gardening: It is the application of garden method and materials geometrically balanced based on the bilateral symmetry.

Garden: A plot or land devoted to the growing of flower, shrubs, flowering and shade trees, creepers, herbs, other ornamental plants.

Lawn: Lawn is an open area with green grass of the garden. E.g. Cynodon dactylon

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UNIT-3

Ornamental Plants

A. Objectives:

Upon the completion of thiscourse, the students will be able to:

- Describe about the cultivation practices of different cut flowers in various aspects.
- Explain about the indoor gardening

B. Content elaboration:

3.1 Cultivation with respect to uses, variety, soil and climate requirement, planting, maturing, training and pruning, disease and insect control of

a. Gladiolus

Gladiolus is one of the important Bulbous plants which is valued the gardens for its beautiful flower spikes. Flowers with brilliant colours, attractive shapes, varying sizes, excellent keeping quality. The gladiolus is ideal both for garden and floral decoration. The florqts open in sequence over a longer duration and hence has a good keeping quality of cut spike. It is ideal as a cut flower, very good for beds, herbaceous border, for making bouquets and does well in pots. Among the different bulbous plants, the gladiolus top the list in its beauty, glamour keeping quality, various colours and shades, shapes, hence it is called as "Queen of Bulb".

Botanical Name: Gladiolus tristis

Family : Iridaceae

Varieties of Gladiolus

Gladiolus varieties are grouped under two groups:

a) Big flowered varieties — preferred for cut flowers and

a) Small flowered varieties

a) Big Flowered Varieties:

1) George mazne 2) Patrica
3) Ratna butterfly 4) Snow princess
5) Apple blossom 6) Black jack

7) Cherry blossom 8) Friendship
9) Happy end 10) Melody
11) Royal tublee 12) Agni - Rekha
13) Suchitra 14) Mayur
15) Nazrana 16) Apsara
17) Sapna 18) Arti
19) Poonam 20) Shobha

b) Small Flowered Varieties:

1) Butterfly 2) Canberra

3) Royal jubilee 4) Red canna

Soil and Climate:

Weil drained fertile loamy soil is preferred for Gladiolus cultivation. Water logged, heavy sticky soil will result in decaying of corms as well as delay in growth of plants.

Site selected for gladiolus planting should have a sunny situation protected from stormy winds, by wind breaks or hedge. It produces bigger size flowers in areas with moderate humidity.

Propagation:

Gladiolus is propagated by corms of at least 4-5 cm diameter. It should be healthy and disease free. Conical shaped corms preferred over flat one as it gives better flowers.

Planting:

Gladiolus corms which are healthy, disease free with diameter of 4 to 5 cm are selected and planted at the spacing of 20 x 20 cm or 20 x 30 cm on ridges and furrows during September. Shallow planting of conns i.e. at the depth of 5 to 10 cm is essential. Deep planting will result into poor production of cormels and also cause decaying of corms i.e.

Size	Spacing	Planting time	Shallow planting
4.5 cm diameterof corms	20 x 30 cm	September	5-10 cm depth

Seed Rate:

A corm weighing 20-30 gm is usually preferred for plantation thus 1 kg = 50 corms - 1,60,000 corms per ha or 3200 kg per ha.

Nutritional Requirements:

FYM is mixed thoroughly in the soil while preparing in the field for planting corms OR 20 tonnes of FYM 100 kg N + 50 kg P2Oj * 50 kg K20 applied for one ha.

FYM - P205 + K20 is added at the time of preparation of field while nitrogen is given in 2 splits doses i.e. first dose at 4-6 leaf stage and second at earthing up stage i.e. 6-8 weeks after planting.

Irrigation:

A gladiolus crop must not be allowed to suffer from water stress especially when spiles are emerging. Regular irrigation at the intervals of 7 to 10 days depending upon weather is necessary. Over watering should be avoided.

Cultural Practices:

Earthing up is essential after 6-8 weeks of planting corms, or before the emergence of spike. But if planted as ridges such operation will not be necessary.

These plants need staking for its satisfactory growth, if not staked may fall or break by high wind velocity when plant will attend the height of 25 cm staking is done.

Curing of Spike (Harvesting):

Early flowering varieties starts flowering within 80 - 90 days, while late varieties starts flowering within 100-145 days after planting. That means September planted corms will start flowering during November - December (January).

The flower spike should be cut as close to the base as possible with sharp knife or scissor leaving 4 to 6 leaves on plant after the first floret on the spike has opened. Later on the other flower buds i.e. florets on the same spike will open in sequence slowly starting from below and continuing upward when placed in water.

For internal market, they are cut when 1-2 lower most florets on the spike have opened and for external market when the colour has fully developed in mature unopened buds.

Immediately after cutting, the spike should be immersed (upto 15 cm from base) in a

bucket containing water. Vase life of cut flowers can be extended if cut flowers are kept in 300 to 600 ppm solution of 8 - HQC (Hydroxy Quinolin Citrate) + 4 % Sucrose

Packaging of Flowers:

Cut flowers should be packed in a card board boxes made for this purpose. Generally card board boxes measuring 110 cm x 250 cm x 10 cm are used.

Harvesting and Storage of Corms:

After harvesting of flowers or spike the plants with leaves are allowed to remain in the soil and irrigation is withheld (stopped). After drying of leaves (i.e. 3-4 weeks) the corms and com lets are-takenout. The corms such dig out are allowed to dry in a open and airy situation for a week. Then after cutting its leaves they are treated with 0.2 % Bavistin for 30 minutes and stored in cold storage or Airy room.

Pests and Diseases:

Thrips and Aphids - Spray 0.2 % Malathion

Fusarium wilt - Spray 0.2 % Bavistin

Yield:

2-3 lakh spikes per ha, 20,000 kg corms per ha.

B. Rose

Genus : Rose

Family : Rosaceae

Rose is called as the 'Queen of Flowers' as well as 'King of Flowers' this indicates that both kingliness (Magesty, Status and Power) and queenliness (Beauty, Grace and Cultural refinement) are its inherent qualities. No other flower surpasses it for its beauty, colour and fragrance. This is the reason why it is considered as a universally favourite flower. Without roses gardens are not considered as complete. Gardens exclusive for roses have been made in various parts of die world for showing die respect to this flower. Great diversity in the plant growth, colour of flowers, flower shape, fragrance, slow opening of flowers and good Keeping quality made roses to so popular that it is grown commercially to meet the demand of cut blooms. It is top ranking cut flower in the flower trade on the basis of acreage, production and consumption. In India roses are grown for cut flowers, making essential oil, rose water and Gulkand.

Classification of Rose

Roses are broadly classified under two groups:

i) Old Garden roses or Wild roses
ii) Modem Garden Roses
iii) Old Garden Roses:

i) Old garden roses includes the crosses between:

a) European Roses x wild roses- and
b) Asian or China roses x wild roses

European roses are having tendency to produce the bloom only once in a year i.e. during summer while Asian or China roses are having habit to produce the flowers throughout the year or at least twice in a year. Due to the development modem roses old garden roses have become out dated.

ii) Modern Garden Roses:

Modern garden roses are developed as a result between the crosses of European Roses x Asian Roses (China roses) and have occupied the place in Commercial gardening. Modem garden roses includes: a) Hybrid Tea (H.T.) b) Floribunda c) Miniature (d)Polyantha (e) Ramblers (f) Creepers (g)Shrub

a) Hybrid Tea:

It is resulted from die crosses between Hybrid Perpetuals x Tea roses of China;

A variety of plant which bears double well shaped flower on erect stem in single. Due to its attractive colours, numerous varieties and fragrance, producing blooms on long canes, elongated buds, slow opening of buds different shapes and size of flowers, good keeping quality widi single, double, multi colour and stripped vars. Hybrid Tea has occupied the important and prestigeans position in the rose garden.

The first modem rose i.e. Hybrid Tea La-France was developed by Guillot in 1867, in France by crossing Hy Perpetuals x China Tea Rose e.g. John F. Keneddy, Gladiator, Superstar, Papa Meilland, First prize.

The first yellow pernet rose was developed by another French rose Breeder Pemet - Drucher by crossing Hy. Perpetual with Rosa lutea "(Rosa foetida) commonly known as Pernet rose'. The first Hy.Tea yellow rose was named as 'Seleil door*.

b) Floribunda:

It has been produced as a result of crosses between Hy. Tea x Polyantha.

Floribunda produce the flowers in cluster Df better shape and bigger size but the flowers are smaller than H-tea. in Floribunda also different colours, shapes and sizes of flowers are available. These roses witfi their large clusters of flowers given a splash of colours for long season.

The first Floribunda ' Rod h a tie' was developed by crossing Hy. Tea x Dwarf Polyantha by a Danish Breeder Poulson in 1912. e.g. Baojaran, Iceberg, Red gold, Queen Elizabeth, Sea pearl.

c) Minature:

These are also called as 'Baby roses'. They are neat and compact but dwarf plants reaching to a height less than 12 inches and producing small or miniature flowers. They have long blooming period and least affected by cold weather and diseases. These are most ideally suited for edging, pots, rockeries and window gardens e.g. Red flush, pixie, Baby masquarade, Baby goldstar, Cri-cri.

d) Polyantha:

They are dwarf type with small flowers in Jarge clusters, free flowering and perpetual bearing habit. The first polyantfia rose was produced as a result of cross between Rosa multi flora x a variety named Dwarf Pink China e.g. Echo, Flamboyent, Snow princess.

e) Ramblers:

Ramblers required support to climb up and are suitable for covering-fences, walls and trellis. They are vigorous growing with small flowers in .clusters. The flowers are produced only in one flush during the year but it lasts for several weeks e.g. American pillar. Excelsa, Dorothy.

f) Climbers:

They are stiffer stem and generally have bigger size flowers. They produce the

multi-petaled flowers in single on a stem like Hy. Tea or in cluster as iloribunda. The climbers are most suitable for arches, pergola, pillars e.g. Golden showers, Royal, gold, Delhi white pears.

g) Shrub:

These are perpetual flowering roses taller than bush type but shorter than climbers and provide continuous flowering. Suitable for hedge and shrubbery e.g. Fountain, Cock tail, Butterfly wings.

Soil and Climate:

Rose require fertile loamy soil. Soil should be deep having good moisture, holding, capacity with proper drainage. Roses are susceptible to water logging.

Plenty of Sun shine is required to produce top quality roses and it does not stand well in deep and continuous shade. Roses suffer heavily due to frost hence frost pruned area should be avoided. If grown in shade the occurrence of disease and pests will be more.

Varieties :

1. Hy. Tea : Gladiator, Papa meilland, Landora, First prize, Superstar
2. Floribunda : Banjaran, Iceberg, Angelface, Queen Elizabeth, Sea pearl

Propagation:

Importance of Root Stock:

Most of the modern roses are propagated by shield budding, hence raising of root stock is an important step. Most of the root stocks are propagated by cutting while modem roses by shield budding. Modem roses do not respond readily to cutting or these which will respond will produce a very poor root system and thus the development and growth of the plant will be affected, which ultimately affect on the quality, size of flowers.

Hence, due to the development of the poor root system in modern roses, they are commercially propagated by using a different rootstock which are wild in nature and produce very vigorous root system and compatible to the modem rose plant. These wild roses are resistant to pest and diseases and-hardy one.

Generally three root stocks are commonly used for the propagation of roses:

i) Rosa multiflora
ii) Rosa indica var. Odorata
iii) Rosa Edward or Rosa bourboriana var. Edward.

Rosa multiflora and Rosa indica var. odorata produced, plants satisfactory better in size and with more number of flowers than die plants budded on Edward rose. Due to susceptibility to powdery mildew use of Edward rose is restricted.

For Maharashtra and North India, Rosa indica var. Odorata is recommended while for South India, Rosa multiflora is-recommended.

Propagation Methods :

i) By cutting
ii) By shielding budding

i) By cutting : Rootstock of modem roses, miniature, shrub, climbers and ramblers are usually propagated by cutting (stem).

ii) By budding : Hy, Teas and Floribunda are multiplied by Shield budding by using a rootstock namely Rosa indica or Rosa multiflora and most favourable seasons for budding is winter season i.e. October to Januanry. It may extend up to March.

Planting:

The place selected for planting roses are ploughed and harrowed properly during summer season and is kept exposed to Sun light. Then the pits- of 45 cm width and 60 cm depth are prepared at the required distance. In the beginning of rainy season FYM is mixed in the soil as well as pits are filled with mixture of FYM + Sand + Bone meal. During rainy season bud grafts are planted in the pig keeping bud joint 2 to 3 inches above ground level. After planting watering should be done regularly if there is a dry spell or as and when required.

Spacing:

Hy. Tea :		120 x120 cm
Floribunda	:	60 x 90 cm
Miniatures	:	30 x 60 cm
Climbers	:	90 x 120 cm

Manures per Plant:

10 T Aa FYM + N -100 kg + P205 - 50 kg + K20 - 50 kg/ha.

Nitrogen in 4 split doses : First after pruning, 2nd, 3rd and 4ih at monthly interval

P and K in 2 split doses : First after pruning and 2nd in 3d month.

Irrigation:

Water requirement of roses depends upon trie soil type and seasons. Therefore, irrigation be adjusted in such a way that soil will remain moist but not wet.

Pruning:

Pruning is a regulat operation followed in roses for (i) development of frame work of plant and (ii) for maximum number of flowers.

i) Pruning for Development of Frame Work of Plant:
   It is done for giving shape to a plant and this involves removal of suckers unwanted branches, diseased and criss cross branches,
ii) Pruning for Maximum Number of Flowers :
   In such type, pruning is mainly performed for obtaining maximum number of flowers on particular plant.

In roses flowers are borne terminally only on the current season growth which arises from the past season growth hence maximum number of new shoots are encouraged by pruning the mature and old branches.

Time and Type of Pruning :

In our agro-climate a sea produce flowers twice in a year (i) June to Sept (ii) Nov. - Dec. to March. Hence pruning time should be matched with the lime of flowering. Adult plants are pruned in may-June and in 2nd week of Oct. respectively for 2 bahars. Pruning in May-June is desirable only after the weather becomes cloudy indicating the onset of monsoon.

First pruning in rose is usually followed 3-4 months after planting and rose starts flowering 6-7 weeks after pruning.

Pruning .is done once in the month of October, while in South India and Maharashtra in June and October.

For obtaining quality bloom of commercial and exhibition quality pruning is usually done during October.

Depending upon the severity of pruning, pruning is classified as :

a) Light pruning
b) Medium or moderate pruning
c) Heavy or Hard pruning

Light pruning is done during June. Moderate and Medium pruning are done in October and again hard in October. For commercial crops medium pruning is done while for exhibition purpose hard pruning is followed.

Hard Teas are pruned to 5 to 6 buds and moderate pruning is necessary for commercial crops. For exhibition purpose severe or hard pruning is done to 3-4 buds.

In case of Floribunda, dwarf polyanlha and miniature pruning consists of removal of all weak and diseased growth and terminal tips of branches.

Harvesting of Flowers

For local market flowers are harvested when one or two petals are open up partially or fully and for distant market flowers are harvested in tight bud stage having 2-3 sepals fully separated from flower bud. Leaves 2-3 leaflets basal leaves intact with mother stem. Soon after harvest place \he stem in a water bucket almost full length leaving only flowers above the water surface. Flower stems are dethomed at their base and graded according to their length. Roses are graded as follows on stem length basis: i)60 cm ii)45-60 cm iii)30 to 45 cm

After grading flowers are bunched m dozens of each grade, wrapped in the newspaper, keeping the flowers end slightly showing and packed in card board boxes.

Yield :

In the second year, per plant 30-40 flowers are obtained, while from 3fd year onwards, about 50-65 flowers are obtained. The economic life of the plants is 8-10 years.

c) Carnation

Carnation (Dianthus) belongs to the family Caryophyllaceae. Carnations are flowers which are widely recognized by most people. It means “flower of love” or “flower of

the gods. There are approximately 300 species in the genus. They are native to the Eastern Hemisphere and are found naturally in the Mediterranean region, although modern varieties are grown both in greenhouses and in fields around the world. With such widespread commercial production available, there is no limited season of availability. Because of their long lasting qualities and fragrance, carnations are often featured in arrangements at holidays celebrated with flowers, at special occasions such as weddings and parties, and in sympathy arrangements.

There are several types of Carnations such as chabaud/margueriate, border and picotee, malmsison and perpetual flowering. But in Nepali market two types of carnation are popular, those are standard and spray. The demand of the carnation flower is 1,000-1,500 sticks per day. It can be cultivated around 8,000-9,000 plants in a ropani. It is estimated that there is production of 6.5 lakhs stick per annum. Kumari Fresh flower and Flora Nepal Pvt. Ltd. are the renowned producers of carnation (FAN, 2010).

Types of carnation

According to the morphology of the plants along with the flower there are various types of carnation. Actually these types have been developed either by natural breeding or continuous selection or by the effort if present day florists or breeders.

Based on the flower morphology carnation are grouped into three categories:

1. Single: flowers with 5 petals or rarely 4-6
2. Semi-double: flower with 30-60 petals
3. Double(bull head): flower having 100-350 petals

b. Based on genetic composition

1. Chaboud or Marguerite

This type was developed from the crossing between D.chinensis X D.caryophyllus. This may be single or double flowers with large flowers. The petals are fringed. This is not suitable for he flower production. Some of the cultivars under this groups are Gaint Chaboud, Compact dwarf, Chaboud, Enfant de nice, Margarita etc.

2. Border and PIcottee

These are the earliest type of carnation and have symmetrical flowers. Flower colour varies from a single coloured to irregular colour markings or blended colours to make more attractive. Petals are broad and smooth edged.

3. Malmassion

Plants are stiff with massive growth habit. Leaves are broad and large. Flowers are fully double. Colour is generally pink with well filled centers. Flowers have a rich fragrance.

4. Perpetual flowering

These types of carnation are the hybrids involving many Dianthus species. This type of carnation generally flowered all year round. Flowers are suitable for cut flower as they can withstand long distance transportation.

The present day's florist carnations are grouped in two major classes.

a) Standard: standard carnation produces large blooms with a larger flower stalk. These are suitable foe cut flower.
b) Spray: spray carnation are miniature type produces many flowers of small size and are better adapted to warm climate than standard types.

Environmental Requirement

Soil:

A well-drained fertile soil is prime for the successful cultivation of carnation. Since the roots of carnation are highly susceptible to poor drainage. For best performance a rich sandy loam or loamy sand soil is recommended. The ideal pH is between 6.0 to 7.0. Below and above this range has been found adverse effect on flower quality.

Light:

Sufficient sunlight is required for best production. However direct sunlight may cause sunburn, which lowers the flower quality. Genetically carnation is a long day plant, but the present breeding efforts have developed lesser sensitive photoperiod cultivars of carnation.

Temperature:

Temperature regimes vary on the seasons. In summer season the best temperature regime is 13-20oc while in winter a little lower temperature 11oc is recommended. Protection from hot dry wind is must during summer. Hot and dry wind hinders the growth and development of plant. Higher day and night temperature during flowering resulted in abnormal flowering opening and calyx splitting.

Propagation:

1 Sexual propagation

Seed propagation is either followed for breeding purpose or for annual plantings. Seed are sown in the well prepared seed bed just after harvesting of matured seeds. Germination is completed in about 5-10 days and seedlings are ready for planting in about 20 days. Seeds germinate well in temperature 20-21 oC . Different chemicals have been reported to hasten germination percentage in carnation.

2 Asexual propagation

Soft terminal shoot cutting is practiced for vegetative propagation in commercial carnation cultivation. In commercial nursery, a certified nucleus block of vigorous plants free from disease maintained. In every one to two years, these nucleus blocks are replaced.

Shoot tip of about 10-15 cm from healthy and vigorous plants are taken. Plants from longer cutting are precocious than plants grown from shorter shoot tip. A longitudinal

slits at the base below the node gives better rooting. Also cutting should be taken with leaves of ensured rooting of the cutting.

Cutting could be stored in dark for six months. It gives equally or better rooting of the cuttings. Rooting is done in sand, perlite or damp sphagnum moss. The pH of the media should be almost neutral. The best time for propagation is from early November to end of March. Cooler months are better than warmer months. Some of the chemicals could be used to hasten the rooting of cuttings.

Cultural requirement

1 Spacing

Depending on the variety and purpose of cultivation, crop geometry differs. For the production of the cut flower, higher density plantings is preferred for the both standard and spray type carnation. The recommended spacing for the cut flower production are 15x15cm to 20x20 cm. again the distance differs on the styles of pinching followed.

2 Manuring and fertilization

Depending upon the soil type and cultivars selected the nutrient requirement of the crops varied. However carnation could be considered as a heavy remover of the nutrient from the soil. Both macro and micronutrient have significant role on the production and quality of the flower. In general 20-40 gm N, 10gm P, 10 gm K per m2 gave best quality flowers with higher flower yield.

3 Irrigation

When rooted cuttings are transplanted for its cultivation, immediate irrigation is required. But it should be either from sprinkler or mist. During the plant establishment phase the moisture of the soil should kept optimum. Water stagnation has detrimental effect on growth and development of the plant.

4 Pinching

Pinching is an unavoidable operation on cut flower production of carnation. Pinching is done to regulate time of flowering as well as get more flower yield. In pinching the tip of the stem is removed when the plants has 6-7 pairs of leaves and above the sixth node from the base.

Generally pinching is done to get more number of lateral shoots, which are capable of producing cut standard flowers.

5 Disbudding

Lateral buds are removed either from lateral shoot or from apical shoot. This operation helps to give larger size flower bud in the shoot.

6 Harvesting

Generally harvesting of cut flower is done when the flower bud attaining a size of 15mm with tight flower bud stage (brush shaped stage) or it can be harvested when the petals are visible. immature bud does not open properly and exhibit shorter vase life as well.

Common disorder, pest and disease

Disorders:

a) Calyx splitting

During opening of bud the calyx become splitted. The petals are support less after this phenomenon. Various factors have been found associated as genetic factors, nutritional factors environmental factors and spacing.

b) Curly tip

The growing tips curled during the growth of the plant. This is due to the failure of young shoot in differentiation in growth cycle. Poor light and nitrogen deficiency have been considered responsible for the disorder.

Pests:

The common pest are red spider mite, aphids thrips.

Disease:

a) Fusarium wilt

It is soil borne disease caused by fusarium oxysporium f.dianthi. This disease is favoured by warm temperature. The symptoms is abnormal growth and stunting of the younger shoot, leaves become yellow and stem become soft.immediate collapse of plant occurs after this disease attack.

b) Phalophora wilt

It is also soil borne disease caused by phialophora cinereseens. The dull appearances of the foliage, loss of turgidity of cells, uniform light discolouration of the basal wood followed by collapse of the plant are the diagnostic symptoms.

c) Gerbera

Gerbera is commonly known as Transvaal Daisy, Barberton Daisy or African Daisy Produces very attractive flowers. It is an important commercial flower grown throughout the world in a wide range of climatic conditions. This is ideal for beds, borders, pots and rock gardens. The flowers are of various colours and suit very well in different floral arrangements. The cut blooms when placed in water last for a long time.

Botanical Name : Gerbera jamesanii
Family : Compositae.

Origin, History and Morphology:

The genus Gerbara was named in honour of a German Natturalist, Traugoot Gerber who travelled in Russia in 1743.

Gerbera jamosonii, native to Natal and Transvaal and G. viridifolia form cape, were crossed after both these species were introduced in Cambridge Botanic Gardens by Jameson, and the hybrid was named as G. cantabrigensis.

Gerbera belongs to the family compositac. Plants are stem less and tender perennial herbs. Leaves radical, petioled, lanceolate, decply-lobed, sometimes leathery, narrower at the basc and wider at top and are arranged in resette ate the base.

Cultivars and Varieties:

Gerbera cultivars of commercial importance throughout the world are Cream clementinc : Maron Clementine (orange) : Flamingo (pale rose) L Delphi (white : Vesta (red) ; Uranus (yellow) ; Fredeking (Terraqueen (pink); Dusty (red) ; Valentine (pink) etc.

Amber, Romilda, Anke, Appelbloesem, Marleem, sympathic, Salmrosa and Pascal are some other promising varicties.

Gerberas can be propagated be both sexual and asexual methods. Seeds propagation, however is not always satisfactory.

Vegetative Propagation:

Division:

This method involves in dividing large climps into smaller units and is practiced in June when the plants may be set out in the field.

Cutting:

The buds in the axils of the leaves are detached and rooted in rooting medium. They are ready for transplanting in 2 or 3 months. Approximately 40-50 plants can be produced in 2-3 months form a single mother plant. Young stem cuttings produce roots and shoots much easily and quickly under intermittent mist.

Micro-propagation:

Although the propagation of gerberas has been either by seed or by division of clumps, these methods are not very suitable for commercial production of large number of plants.

Soil and Climate:

A well-drained, rich, light, neutral or slightly alkaline soil is most suitable for gerbera production. The growth of plants is adversely affected in ill-drained soil.

In tropical and sub-tropical climate, gerberas are grown in the open, but in temperature climate they are protected from frost and cultivated in greenhouse.

Cultivation:

Planting:

Grew gerberas on raised beds in rows 30 cm apart. The spacing in rows ranged from 20 to 40 cm giving from 9.4 to 4.7 plants/m2.

Manuring and Fertilization:

Gerbera requires plenty of organic matter in the soil for proper growth and flowering. An application of 7.5 kg rotted stable manure /m2 to gerbera, growing in fairly light sandy soil gave somewhat better result than several proprietary organic manure. Specially prepared peat was a satisfactory substitute for manures, provided the PH was maintained at 6.0 – 7.5 b liming, particularly in the second year.

They also need ample nutrients, especially phosphorus and potassium for profuse flowering.

Irrigation:

Gerbera needs thorough irrigation instead of light sprinkling at frequent intervals. However, waterlogging should be avoided as it is harmful to plants.

Harvesting:

Flowers are generally cut when the cuter two rows of disc florets are perpendicular to the stalk.

d) Tuberose

Common Names	Nishigandha, Rajanigandha, Sword Lilly
Botanical name	Polianthes tuberosa
Family	Amaryllidaceae

Importance and Uses:

It is one of the important cut flowers used for vase decoration and bouquets. The flowers stalk is 75 to 100 cm long bearing 10-20 flowers (florets) of white colour. The spikes or tuberose are used as a cut flowers due to its delightful appearance, sweet fragrance and good keeping quality. The individual florets are used for making Veni and Garlands. Besides the floral decoration it is suitable for pots, beds and for extraction of oil.

Soil and Climate:

Medium sandy loam with good drainage is best for production of flowers and bulbs. For luxurious growth of the crop moderate humidity with mild temperature is essential. Very high temperature or frost may damage the crops.

Varieties:

1. Single Flowered- 5 petals per flower.

Flowers single petalled

Calcutta single, Coimbatore single, Bangalore single

2. Semi Double 10 petals per flower
3. Doulje More than 10 petals / flower Pearl
4. Variegated The leaves are variegated i.e. yellow on the margin
5. Variegated single : Rajat (White margin)
6. Variegated double- Dhawal (Golden margin)

Single flowered varieties are more fragrant than double flowered and usually preferred

for Gajara and Garlands. While' doubles are preferably used for Vase decoration.

Propagation:

The tuberose is propagated by bulb having a diameter of 1.5 to 2.0 cm and weight above 30 gms. In single, 1,2.3 or a clump of bulbs are planted per hill. For one year crop, only 3 bulbs should be planted to get better, yields and quality of flowers. For a crop more than one year duration. Only one or two bulb per hill should be planted. In doubles only two should be planted for one year crop.

Selection of Planting Materials:

Tuberose is propagated by bulb A spindle shaped bulb having average diameter of 1.5 to 2.0 cm and weighing 30 gms and above are selected from previous year's crop. Those bulbs should be healthy and free of pests and diseases.

It has been observed that bulb weight is important factor in tuberose which influences on flowering. When a bulb having weight more than 30 gms are used than flowering started within 40 days after planting while 15 gms required 50 days for flowering. Bulbs with 10 gms weight do not produce flowers even in 200-250 days. Before planting bulb should be treated with 0.1 % Bavistin for 30 minutes.

Planting:

For commercial crop, planting of bulb is usually done in March-April. For getting the regular supply of flowers, planting of bulbs can also be done during May — June and September — October. Planting is done at the spacing of 30 x 20 cm or 20 x 15 cm by using a bulb of 1:5 to 2.0 cm diameter with average weight of 30-60 gms at a depth of 5-7 cm.

Sees Rate:

5000 - 6000 kg bulb /ha; 1,60,000 bulbs /ha. 2,50,000 bulbs

Nutrition Requirements:

20 tonnes FYM + 100 kg N + 50 kg P2Os + 50 kg K20.

Full dose of FYM + Potash + Phosphorus along with V* dose of nitrogen is given at the time of planting or as a basal dose, while remaining dose of nitrogen is given in 3 doses i.e. 30 days after planting, 60 days after second dose, and 90 days after 3rf dose.

Irrigation:

As the planting is done in summer, it requires adequate moisture supply for the luxurious growth of the plant. After rains, proper frequencies of irrigations should be maintairled to keep the soil moist.

Harvesting of Flowers:

Tuberose flowers are harvested for two purposes i) As a cut flowers for/vase decoration and ii) As a loose flowers for Veni and Garlands.

When the flowers are to be harvested for vase decoration, then spikes are to be cut when the lower most 1-2 florets have opened. Immediately after cutting the spike the base of spikes are immediately placed in a bucket full of water-When the loose flowers are to be harvested, then fully developed but unopened florets, are plucked. Each spike produces 16-20 florets out of this terminal 3-4 pairs of florets are very small and of no use. After the harvesting of flowers, flowers are placed in shade in wet cotton cloth or in a gynny bag cloth after the harvest of flowers the spike should be cut off.

Yield:

3-4 months after planting tuberose starts flowering. Summer and rainy seasons are the peak period. Bulb once planted gives the commercial yield upto 3 years.6000 to 8000 kg flowers /ha,15,000 kg/ha, 60 to 80 qtls flowers/ha.

Pests and Diseases:

Thrips and mites : Nuvacron spray 2 ml/litre.
Fungal diseases : Soil drenching with Brassicol 2 gm/lit

Marigold

Botanical Name : *Tagets erects*, (African Marigold)
Tagetspatula (French marigold)
Family : Compositae

Importance and uses:

Marigold is one of the most commonly grown flowers for garden decoration and extensively used as loose flowers for making garlands for religious and social functions.

It has gained popularity amongst the gardeners on account of its easy culture and wide adaptability. Its habit of free flowering, short duration to produce marketable flowers, wide spectrum of attractive colours, shape, size and good keeping quality has attracted the attention of flower growers.

Marigolds are ideal for cut flowers, especially for making garlands. They can be planted in the beds for mass display or grown in pots. The French Marigolds are suitable for hanging basket and edging. The demand for Marigold flowers during Dashara and Diwali is very high.

Soil and Climate:

It requires well drained loamy soil. It can be grown well in hot and dry as well as humid climate. It cannot stand severe cold.

Types of Varieties of Marigold:

Varieties of Marigold are grouped in two groups:

A) African Marigold: Tall growing plant / big size flowers

B) French marigold: Dwarf plant with small flowers

Varieties:

A) African Marigold : Cracker jack. Climax, Yellow supreme, Hawai, New Alaska, Aapricot, Glitters, Happiness, Primrose, Fiesta

B) French marigold : Rusty red, Star of India, Red Bokardo, Flash, Petit spray, Harmony, Gypsy, Lemon drops

Propagation: By seed

Seed Rate: 1 to 1 V2 kg per ha

Raising of Seedlings and Transplanting:

For raising seedlings, well dried flowers are crushed by hand and seeds are broadcasted on the raised bed during May - June and watered regularly. When seedlings will attend the age of one month or a height of 10-15 cm then those seedlings are transplanted in well manured and fertilized bed at the spacing of 60 x 60 cm or 45 x 45 cm.

Nutritional Requirements:

20 to 25 tones FYM + 25 kg N + 25 kg P + 25 kg K per hectare

Special Culture Practice:

Pinching:

Three weeks after transplanting earthing up is done and then one week after earthing up or 1 month after transplanting the seedlings, pinching is followed for bushy growth of the plant and development of lateral branches. Pinching results into production of more number of flowers.

Irrigation:

Constant moisture supply be maintained from bud formation to harvesting of flowers.

Harvesting of Flowers:

French Marigold starts flowering 1 to 1 Vz months after transplanting while African Marigold I 14 to 2 months after transplanting of seedlings. For Garland stalk less fully opened flowers (loose flowers) are picked, white for vase decoration also fully opened flowers with stalk are plucked.

Loose flowers are packed in a bamboo basket, while flowers with stalk are bunched in bundles and transported to market. From one plant near about 100 to 150 flowers are obtained. Blooming duration is near about 3 months.

Yield:

6000 to 8000 kg flowers per ha, 100 to. 150 qtl flowers per ha.

Pests and Diseases:

Thrips and Caterpillar : 0.1 % Nuvacron spray

Black spot, leaf spot : 0.2 % Dithane M 45

g. Chrysanthemum

Botanical Name : Chrysanthemum spp.

Family : Compositae

Importance and Uses:

Chrysanthemum is among the more popular flowers grown in our country for its diversified beauty of colours, shapes, shades and keeping quality. It is highly suitable for beds, pots and for floral arrangement. Its bloom last over a short period of 1 to 2

months. Hence, they command remunerative price in the market. On account of its good, keeping quality flowers can be transported to a distant market easily.

Chrysanthemum plant is not very attractive but it produces most showy flowers. Flowers of standard varieties are produced on long, sturdy stems and have a good keeping quality. These characters make it highly suitable for flower arrangements. Flower of spray varieties are highly suitable as loose flowers for making Garland, Veni and Gajara.

Now a days large number of varieties are available and natural blooming period of November to December has been extended from September to December by just selecting suitable types and planting on different dates.

On account of its origin and commercial production in Asia it is called as, 'Queen of East' OR 'Glory of East' and sometimes *Winter Queen* as the flowers are available during winter.

Important Groups and Varieties of Chrysanthemum:

The chrysanthemums are classified into two main categories according to size i.e.: i) Large flowered and (ii) Small flowered.

These two are further divided into groups. Some of the important ones being

i) Large Flowered:

1. Incurved: The ray florets are incurved and overlapping. Florets are not twisted and blooms are compact and globular when fully developed e.g. Snow ball (White flowers), Sonar bangla (yellow), Chandrama (Yellow), Ghenghis Khan (Copper, Bronze and Orange), Graoe bowl (Rosy purple).

a) Re Flexed: This is just opposite to incurved. Ray florets reflex outside and overlap one other e.g. Creota (White), Dorothan (White), City beauty (Yellow),Sweet heart (Pink).

b) Spider: Ray florets are large and tubular and usually curved, e.g. Rirpasi Bangla (white), Bidhan's best (Mauve), Mahatma Gandhi (Cream).

ii) Small Flowered:

a) Korean (Single) : The ray florets are flat, strap like and blooms are flat

Numbers of whorls of ray florets are five or less than five and disc is open e.g. Cardinal (red), Chairman (Bright yellow).

b) Korean (double) : Similar to Korean single but whorls of ray florets are more than five and disc is open e.g. Junta Wells (Yellow), Flirt (maroon), Manbhawan (Yellow).

c) **Decorative:** Similar to Koreoan double except that flower is completely double and center of bloom is not visible e.g. Aretic (White), Blue chip (Purple), Jubilee (Yellow), Alankar (Orange).

d) **Anemone:** Ray florets are small or may be twisted or quilled but disc florets are well developed and prominent e.g. Caleb cox (light brown).

e) **Pompon:** These are now getting popular and produce large crop of-small bloom. Pinching once or twice is very helpful. Ray florets are short, broad, regularly arranged to give bloom a compact hemispherical shape and florets are incurved or reflexed e.g. Camoo (White), Dandy (Bronze), Eve (Purpoe), Nanako (Yellow).

New Chrysanthemum Cultivars:

Chrysanthemum Shanti, Sadbhavana, Y2K, and 'Kargil 99' have been developed through open pollinated seedling selections and released for commercialization.

'Shanti' is a very good cut flower variety. "Whereas 'Sadhbhavana*, 'YzK' and 'Kargil 99* are suitable for mini culture. These four varieties have been released in January 2000.

PKV Shubhrn: It is high flower yielding variety of chrysanthemum released by PDKV, Akola for Vidarbha region.

Soil and Climates:

Chrysanthemum is herbaceous perennial plant having soft and succulent stem. It produces fibrous root system hence it requires well drained soil. Water logged or ill drained soil may cause adverse effect on plant growth. pH of soil should be between 6.5 to 7.0.

Chrysanthemum is a short day plant. For its vegetative growth it requires long Jay

with bright sunlight and high temperature ranging from 20 to 27 °C. For bud formation and flowering it requires short day and low temperature ranging from 10 to 27 'C. During growing period if the atmospheric humidity remains 70 to 90 per cent, it helps in vigorous vegetative growth of plant.

Propagation :

Chrysanthemum is propagated by two methods:

i) Root suckers and
ii) Terminal stem cutting.

Propagation by cutting is preferred over suckers because cutting produces the neat and sturdy plant whereas the plant raised through suckers are shaggy and haggard (Wild looking).For commercial crops, it is generally propagated by suckers, while for pot culture it is generally preferred by terminal stem cutting.

i) By Suckers:

After flowering is over, the plants are cut to a height of about 15 to 20 cm from the ground level during January February and ample irrigations and fertilizers are applied for encouragement of root suckers. When these root suckers are 10-15 cm high, they are separated in February. - March and planted in small pots and later on planted in bigger pots.

ii) By Terminal Cuttings:

5 to 7 cm long cuttings are taken from healthy plant from middle to end of June. For enhancing rooting, these cuttings are treated with Copper fungicide to check the fungus and later on treated with plant growth regulators like NAA 25 ppm or Seradex. Then these cuttings are planted in sand in pols or beds and are kept in partial shade. Water is sprayed 4 to 5 times a day. Rooting takes place in 2-3 weeks and then these cuttings are ready for transplanting.

Planting:

The planting of Chrysanthemum is done during April - May and some varieties are planted during August also. April - May plantings start flowers in the month of September- October. While August planted in the month of December.

Preparation of Soil:

Before planting the field should be prepared by. Ploughing and harrowing to which 15 to 20 tons of FYM be added. Rooted suckers or cuttings are planted on the ridges and furrows at the spacing of 30 Jt 30 cm and 30 x 45 cm irrigated immediately.

Nutritional Requirement per Hectare:

It needs 200 kg N, 200 kg K20 and 200 kg P3O5. lA dose of N and full dose of P and K is given at the time of planting while XA dose of N is given 1 to I 'A months after planting.

Irrigation:

As the planting is done during summer, it is essential to have an adequate irrigation facilities. Water stress during bud formation, flower opening till harvesting will cause adverse effect on the quality of flowers. Excess irrigation result in decaying of root systems.

Flower Harvesting:

Usually Chrysanthemum takes 5 to 6 months from planting to flowering and thus flowers are available from October to December. Fully opened flowers are harvested without their stalk (Loose flowers) preferably in the morning. Harvested flowers are packed in bamboo basket and then send to market.

Yield:

10 to 12 tonnes flowers / hectare, 40 to 120 quintals flowers / ha.

Pest and Diseases:

1) Aphids: Black aphids suck the juice from the leaves and young stems.
   Control: Spray Rogor, 30 EC or Metasystox 25 EC @ 250 ml in 250 litres of water
2) Powdery Mildew: This disease is caused by fungus. White powdery mass appears on leaves and stems.
   Control: Spraying with 0.5 % Karathen (40 EC) is very useful.

Orchids

Family : Orchidaceae.

Orchids are most fascinating and beautiful of all flowers. They exhibit a wide range of diversity in form, size, colour and texture of flowers beyond the imagination of

human mind. This manifold and perplexing range of floral structures arouse our highest admiration.

Cultivation of orchids has become a very profitable occupation. Development of new hybrids and commercial production of cut flowers in orchids have expanded tremendously.

Importance and Uses:

Orchids with their bewildering range of flowers and beautiful colour combinations provide a source of profound aesthetic pleasure to both owners and visitors. The striking resemblances of their flowers to various forms of animal life behold the attention of everyone who looks at them.

A Brassia spike suggests a small collection of large and colourful spiders. The flowers of Phalaenopsis sp. Producing white or pink blossoms look like moths while those of Oncidium palilo and O. Kramerianum resemble gorgeous tropical butterflies.

Orchids are excellent item in gardens, grown in garden, beds, pots, baskets, best for indoor. Flowers have more vase life. Very excellent cut flowers. On plot it remains good for 1-3 months. Orchids are used as food in Indonesia. It has got medicinal value.

Climate:

It is grown in tropical, sub-tropical and temperature. It requires 40-75% R. H. it requires less light intensity. Temperature 15-21OC. It prefers high humidity.

Orchids are grown in orchid houses, Lath house, Fabre glass house, controlled glass house.

Propagation:

Orchids can be propagated by both seeds and vegetative means. The creation of hybrids and raising the seedlings in flasks are being practiced by commercial growers throughout the world. Plants raised from seeds, however take long time to bloom. The technique of meristem culture is used for rapid and large scale multiplication and in fact it has revolutionized the orchid propagation. Multiplication by traditional methods of vegetative propagation such as by division, cutting, air layering etc. are followed, particularly by amateurs.

Cultivation:

An orchid house is a protecting structure that provides suitable environment for the successful cultivation of different kinds of orchids. Many types of structures have been used over the years and the simplest ones are those used in warm regions.

Containers:

Clay pots, wooden or galvanized wire baskets, tree fern blocks, logs of wood, etc. are the different types of containers used for growing orchid. Clay pots provided with several cuts and holes to facilitate adequate aeration and proper drainage are very popular in different places.

Potting and Media:

Under natural conditions, terrestrial orchids are found growing in forest soils composed of rich humus, accumulated from the falling leaves over a period of time. For a potting medium simulating this natural humus, a mixture of equal parts of leaf mould, garden and soil and coarse river sand will be suitable. In fact any well drained petting mixtures of equal parts of leaf mould, garden and soil and coarse river sand will be suitable. In fact any well drained potting mixtures containing 50% or more organic matter can be used.

Manuring and Fertilization:

Like other plants, the growth and flowering in orchids are markedly improved by proper supply of nutrients in liquid forms. The major mineral elements required in large amount are nitrogen, phosphorus, potassium, calcium, sulphur and magnesium. Iron, boron, copper, manganese, molybdenum, Zinc, and other micronutrients are also necessary but in extremely small quantity. Under natural conditions, orchids get their necessary inorganic nutrients from the soil or decayed organic matter on the bark upon which they are growing and also form the atmosphere washed down by rain. The organic matters are supplied by the decaying vegetable and animal debris. When under cultivation, all these nutrients should be supplied to the orchids regularly for their growth and flowering.

Harvesting:

This is a very important operation and the growers should have through knowledge about the flowering behavior of the orchids used for cut flower production. Proper

time, stage and method of harvest determine the quality of the produce. In general, orchid flowers do not mature until 3-4 days after they open. Flowers cut prior to their maturity may wilt before reaching the wholesaler. Harvesting should preferably be done in the evening.

Post Harvest Handling:

Grading:

There are no standard grades for orchid flowers and their prices and fixed according to the size.

Storage:

Since most orchid flowers are long lived on the plants they should not be harvested until needed. If these are to be cut they should be stored ate 507OC.

Packaging:

Packaging is another important aspect in the flower trade. If it is not done properly, the flowers may with or suffer mechanical injury during transit. An ideal package should be airtight, water proof, strong enough to withstand handling and small in volume.

Pests and Diseases of Orchid:

Diseases of Orchid:

Fungal Diseases of Orchid

Leaf Spot:

This disease is very common and can be found on almost all cultivated species or orchids. It is caused by species of Glocosporium, Colletotrichum, Carcospora and Phyllostictina.

Spraying of Bordeaux mixture ‘6-6-50 or 4-4-50) will effectively control the disease.

Pythium Black Rot:

This disease affects mostly seedlings in community pots and is caused by Pythium ultimum. Affected plants turn black and leaves start falling.

Infected plants should be removed and the remaining healthy ones sprayed with fungicide like Monoozeb @ 2.5 g/lit.

Root Rot:

The fungus Fusarium is responsible for this disease which causes the destruction of the root tissue.

The disease kills the seedlings and retards the growth of mature plants. Affected plants should be treated with Zineb or tersan.

Orchid Wilt:

This disease is caused by Selerotium rolfsti which affects mostly Cymbidium and Paphiopedilum plants. The leaf base initially becomes yellow later turning brown. Affected leaves should be removed and plants repotted in fresh medium after treatment with protective fungicide like Pentachloronitrobenzene. Treatment with Zineb or Natripheno is effective.

Pests of Orchid:

Mites:

There are minute insects which suck juices form the cells of leaves, leaving them specked with white.

These can be controlled with a 20% emulsion of DMC diluted at the rate of 1 pint per 100 gal.

Thrips:

Thrips are very small insects' which feed on foliage or remain hidden in the flower buds.

Thrips that feed on orchid leaves have successfully been controlled by the use of systemic pesticide.

Scales:

Both armoured and soft scales attack orchids. They attach themselves to leaves and suck the juice form the cells.

To control the scale insects', the use of the root extract of Derris, a plant which is common in Malaysia, is recommended. Because of their scales, these insects get protection from the insecticides.

Plant Bugs:

Bugs injure orchids by sucking sap and causing pale spots on the leaves.

Good control could be obtained with the application of gesarol A (5 % DDT) @ 1 kg

in 100 liters water with rhodiatox at 1:5000

Aphids:

Aphids suck the sap form plants and excrete honeydew on the now spikes and foliage. They also transmit certain virus diseases or orchids. Certain organic phosphates, parathion and Malathion give good control of aphids.

Meally Bugs:

The mealy bugs are easily identified by its soft and filamentous body with a covering of white powdery wax.

Spraying with 0.02% Parathion will control these bug species found on orchids.

3.2 Indoor Gardening

Indoor gardening refers to beautifying the areas inside the house with plants. Unlike outdoor gardening, the house plants are grown generally in containers made of earthen pots, ceramic pots or any container of cheap cost. In some places, the plants are grown on 'totum pole' which is a support covered with sphangnum moss. Big sized bottles with, narrow mouth are also sometimes used to grow the house plants and this technique is popularly known as 'Terrarium'.

Selection and maintenance:

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

1. Open Zone:

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

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

Such places near the eastern side of the building may be considered for growing certain house plants which can easily come up under shade. Most of the foliage plants like Crotons, Graptophylium, Eraisthemum, Dracasnca, Asparagus are preferred as potted plants in the area.

3. Varsndah of a House:

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

4. Living Room, Drawing Room etc:

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

The house plants may be arranged in symmetrical or asymmetrical style, but care must be taken to avoid overcrowding. The important plants which are preferred as indoor plants are given below:

a) Foliage Plants :

Dieffenbachias, Philodendron, Aglaoenoma, Monstora, Anthurium, Colocasia, Caladium, Aloccasia, Maranta, Aralia, Panax, Helicorrium, Begonia, Asparagus and all kinds of ferns.

b) Flowering Plants:

Ixora, Graptophylium, Hibiscus, Eranthemum, Nerium, Zerbrina etc.

Care of Indoor Plants:

1. **Repotting:** The house plants soon fill the pots with its roots and often need a large pot for satisfactorily continuing its growth. It is then shifted to a pot a little larger on size with its root and soil intact. This process is known as 'Repotting* Plants should never be repotted when the soil is in a dry state.In this condition they should be watered some time before potting is commenced, sq that the surplus water will have to drain away. Soil used for potting should be sufficiently moist to hold together when pressed in the hand, but not wet.
2. Watering: Pot plants require to be watered much more carefully than those growing in the ground. Applying too little or too much of water is undesirable. When the leaves droop it is a sign that the plant is either in need of water or suffering from soil stagnation at the root Always use soft water for watering the potted plants.
3. Syringing: It refers to the operation of spraying the plant surfaces through a fine

syringenose. It is essential to the health of plants, growing under cover where the natural rain does not reach them. Syringing creates a.moist atmosphere, cleans the leaves and thus assist in promoting their functions.

4. A plants growing in a varandah should be frequently turned round in their position so as to equalize the effect of the light odierwise their growth will be top sided.
5. Too much light is just as detrimental as too little and the majority of indoor plants should not be placed in full Sun. Sun scorch or leaf bum will soon make them very unattractive. Requirement for light vary with the individual plants. Most flowering plants require considerable light to bloom, while most foliage plants need diffused light. The only exception to this rule is plants that have variegated leaves. When a variegated plant is placed in a dark corner, the few green cells present in the leaves cannot manufacture enough food to maintain a healthy growing condition. Flowering plants since require more sunlight for profuse flowering can be better located near the windows.
6. The humidity of air in the house or room is very low. Many house plants require a higher humidity than is normally present it is often difficult to provide the necessary humidity in the room. The humidity around the plants can be increased by the following ways:
    i) Use trays of pebbles in which water is poured to just below the tops of the pebbles. Place the pots on the pebbles, being certain that the bottoms are not sitting m the water.
    ii) Another method is the single plant may be top dressed with sphangnum moss and the moss kept nicely damp.

Pot culture and hanging basket

Pot Culture

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

Purposes of pot culture are:

1. Preparing plants for sale such as rooted cuttings of grapes
2. Growing plants for decoration like crotons
3. Growing plants for experimental studies like pot -culture studies

Hanging basket

'Hanging basket' refers to the practice of growing plants in certain kinds of plat baskets and other containers of pleasing design and suspending them, after placing them in wire frames, in conservatories, corridors, rooms and under shady trees to have great ornamental value. Hanging baskets are usually made of galvanized wire or wood, as single plant in such baskets, those which are crect growing, intermediate in size with graceful foliage may be selected. Similarly, plants which are intermediate or dwarf in growth habit with dropping graceful foliage with or without bloom are also a fitting material for massing in these baskets. Selected plants should have an ability to grow and bloom in hanging basket.

Introduction of bonsai making

Bonsai:

Bonsai is a fascination art which has thrived in Japan for hundreds of years and has become in integral part of Japanese culture.

The word Bonsai is a combination of two Japanese words Bon (meaning shallow pan) and Sai (meaning plant), which can be translated as " Tray Planting". By growing the trees in shallow containers the growth is checked or dwar4fed but the plant is not starved. The great Japanese expert on Bonsai, Kyozo Morata, is on record to have said, "Like a pet animal, it needs, water, sunshine, and nourishment".

Criterion for Selecting Plants for Bonsai:

Among the various factors that determine the suitability of a plant as a Bonsai the foremost is its hardiness. It should stand the rigours of growing in a shallow container, withstand the operations of pruning of roots, branches and tough training but still manifest itself as a lively replica of normal plants. All Bonsai specimens should have a trunk which looks natural. The growth of such plants should be in harmony with the container where it stands and the branches should also reflect a rhythm consistent with the artistic value. The trees whose trunks are strong and thick at the ground level gibe a good appearance. The plants which show seasonal variations in growth pattern and flowering are greatly favored. For example, some trees which change their leaf color in one season or others bearing fruits in another season, all add color to the collection.

Bombax malabaricum, Callistemon lanceolatus, Ficus religiosa, F. benghalensis, Jacaranda mimodsifolia, kigellia pinnata, Milletia ovalifolia, Punica granatum.

Several conifers can also be grow several conifers can also be grown as bonsai under tropical conditions. These are Juniperus chinensis, J. prostrate.

There are certain shrubs listed below which are also trained as Bonsai: Adenium obesum, Fortunellla japonica, Jatropha podarica and Murraya exotica.

Learning process and support materials:

Learning process includes the Visual methods, Demonstration method, Practical method, Observation method, Exhibition methods.

Assessment:

Very Short (Answer question)

1. Write down the scientific name and family of Rose.
2. List out the importance cut flower in Nepal.
3. Name any two importance varities of carnation.
4. List any two major diseases of gladiolus.

Short (Answer question)

1. Define pot culture.
2. Write down the criteria for selection of indoor gardening plant.
3. Write any four varities of orchid.
4. Define bonsai.

Long (Answer question)

1. Write the cultivation practices of Tuberose with respect to Land preparation, method of propagation, manure & fertilizer.
2. What is bonsai? Write down its types.

Glossary:

Acre: A unit of land measure equal to 43560 square feet, 4840 square yards, 4047 square meters or 0.4 hectare.

Cutting: A detached portion of a plant parts placed in suitable medium like sand, soil or saw dust in order that it may produces roots and shoots to form a new plant.

Heading back: Removal of a portion of stem leaving a portion for promoting new growth.

Hectare: Area measured in the metric system, equal to 10,000 square meters or 2471 acres.

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UNIT-4

Introduction to nursery

A. Objectives:

This course will enable students to:

- Define the meaning, concept and types of nursery.
- Explain the importance, scope of nursery in Nepal.

B. Content elaboration:

4.1 Meaning and Concept

A nursery is a place where young plants are raised under intensive management for later transplanting into the field. Many horticultural crops can be grown in situ but, experience has shown that raising seedlings in the nursery has a number of advantages. These may include

Advantage:

a) Intensive care :

Seedlings receive better care and protection (from animals, weeds and pests) in the nursery. The average garden soil is not an ideal medium for raising seedlings especially from the point of view of soil tilth. At an early stage of development most vegetable crops require special attention that is not possible in the main field.

b) Reduction of costs:

Fewer seeds are used for raising seedlings in the nursery than for sowing directly in the field,because in the latter seedlings have to be thinned to one, which is wasteful. When expensive hybrid seeds are used, transplants therefore become more economically attractive. Pesticides and labour are also reduced under nursery conditions as compared to planting directly in the field.

c) Opportunity for selection:

Raising seedlings in a nursery affords the grower an opportunity to select well grown, vigorous, uniform and disease free seedlings.

Extend a short growing season for late maturing crops:

Seedlings can be raised in a nursery under a protected environment before conditions outside become suitable for growth and transplanted into the field when conditions

allow, thus reducing the amount of time spent in the field.

Disadvantages

1) Increased cost of production of a particular crop.

2) Specialized labour requirements in the nursery, especially skilled budders and grafters.

3) Skilled personnel required for transplanting operations.

4.2 Types of nurseries:

Types of nurseries depend on the size, scope and investments put in place. Therefore, there are

3 types of nursery under 2 groups:

i. Temporary / shifting nurseries:

a) Peasant nursery:

These include spots / places where peasant farmers raise tree crop seedlings like cocoa, kola, coconut, citrus, coffee, mango or vegetables. They are normally located within the compound or along river banks, streams, swamps or family bathroom sheds or any other place with regular source of water. The site is normally under brushed leaving the trees standing for shade provision. The soil is loosened with hoes, seeds sown and covered with palm fronds. Little care is given to the nursery materials. Such a nursery can be shifted at any time.

b) Intermediate nursery:

An improved type of peasant nursery. They are established very close to field in order to avoid the cost and attendant problems on long distant transportation of seedlings. Here, there are no permanent installations and it can be used for one or more seasons. It can also serve as a resting station for transported seedlings.

ii. Permanent / Standard / Central nurseries:

Permanent nurseries are larger and more intensively managed. Although, proximity to field is important, but centralization with respect to the total area the nursery is expected to serve, nearness to source of labour and supervision minimize transportation cost in the long run and thus bring greater economic benefits.

Factors of nursery establishment

Selecting a site for permanent nursery is a difficult task. This is because the degree of success achieved in the production of nursery plant materials is largely dependent on careful study and objective judgment on the site. Thus, the following factors must be considered:

1) Water supply:

Water is of prime importance in any successful nursery management. The must be sited near an adequate supply of water. Therefore, in selecting a site, the amount and quality of water available during the period of low water table and extreme drought should be ascertained if possible. This is because the highest water demands by seedlings is during these periods and particularly important in the drier agroecological regions.

2) Soil and topographical features of the proposed site:

A good soil is a prerequisite to the success and economy in the production of nursery plants. The soil should be deep, with fine to coarse sandy loam texture, underlain by somewhat stiffer but still permeable subsoil. Good drainage is very essential to carry off excess water from the tropical rainstorm. Such soils found on freely-draining flat ground or on a gentle slope sufficient to permit satisfactory drainage are considered the best sites.

3) Source of labour:

An adequate supply of labour and proper supervision especially when transplanting, weeding and lifting is essential. Whether in temporary or permanent nurseries, labour must be swift and on schedule to ensure success. The problem of recruiting more labour could be very serious where manpower is scarce or alternative employment exists.

4) Protection against winds:

In a savanna ecosystem, protection against wind is very important. Very often, the violent parching winds in the dry season do cause high rate mortality in nursery stock especially in the exposed part of the nursery. Under such conditions, nursery should be sited preferably in the naturally sheltered areas. When this not possible and the proposed site is exposed to dry winds like harmattan, artificial screens made of mats

or coarse cloth are provided round the nursery or screen houses are constructed.

5) Air pollution:

This is very important especially in the industrial areas and where there is heavy traffic. Sulphur dioxide, cement dust and dust from dusty roads do settle on leaves and this detrimental to the growing seedlings in the nursery. Therefore, the final choice of a nursery site is usually a compromise that favours those factors that ultimately permit future development and higher efficiency in the nursery.

Selection and preparation of nursery sites

Selection of nursery sites:

The size of land to be selected for nursery depends on:

1) Morphological characteristics of the plant species.
2) Size of the stock to be planted
3) The annual production target
4) Method of raising the seedlings
5) The degree of permanence of the site.

For intermediate nursery, the area actually occupied by the seedlings plus the access roads and storage sheds constitute the nursery area. In a permanent nursery, additional room has to be provided for crop rotation in order to maintain the organic matter and nutrient status of the soil. Where mechanical equipment is to used, equipment maintenance and storage centers have to be provided for in the nursery.

Importance and scope of nursery in Nepal

Some species are not annual good seed bearer, but need to be planted annually. To meet the need of seedlings of such species, nursery is important. Slow growing species need a nursery to be planting out to avoid competition. Roadside and urban plantation always needs a nursery for their plantation. The best method of introduction of exotics is only by nursery. Planting of nursery-grown plants is the surest method of artificially regenerating poor and barren sites. Casualty replacement is only possible by the plants grown in the nursery.

C. Learning process and support materials:

The learning process includes the participation of student in group work, presentation and skill development, practical methods, written methods etc.

D. Assesment:

Very short (Answer question)

1. What do you mean by nursery?
2. List out the nursery types.

Short (Answer question)

1. Write any two importance of nursery.
2. What do you mean by permanent nursery?

Long (Answer question)

Explain about the scope of nursery in Nepal.

Glossary

Nursery. An area where the planting materials are raised for planting in garden or fields.

Plant density: Number of plants per unit area in a crop field or orchard.

Planting board: Wooden equipment with three notches which ensures the planting in the correct position.

Seed bed:A prepared area in which seeds are sown.

Thining out: Type of top pruning where the entire twigs, cane or shoot is removed.

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UNIT- 5

Nursery Containers

A. Objectives:

After completion of this unit student will be able to:

- - Discuss about the nursery container.
- - Explain about the different cultural media.

B. Content elaboration:

5.1 Characteristics of media

Propagation media is a basic need in which the rooting of cuttings or germination of seeds takes place and also for growing stock plants. Growing media being a store house of water, air and mineral supply ensuring easy germination of seed, rooting of cuttings and their further growth. Proper crop selection of medium is important. The following ideal characteristics are taken into consideration for selection of media.

- It should be sufficiently firm and dense to hold seeds and cuttings are placed for germination and rooting respectively.
- Preferably it should not shrink when dry and increase its volume when wet.
- It should possess sufficiently high moisture retention capacity.
- It should be porous to drain out excess of water and permit aeration.
- It should be free from weed seeds and harmful organism.
- It should be cheap, slightly acidic or neutral.

5.2 properties and use

5.2.1 Soil

Light and sandy soils are well suited as rooting or germinating media while loamy silty or clayey soils are unsuitable on account of poor aeration and stickiness. These soils in combination with sand, some organic matter, moss, shredded bark and peat are useful as media.

5.2.2 Sand

Sand consists of small rock grains of 0.05 to 2.0 mm in diameter. Quart sand is most

useful as it is suitable for sterilization of fumigation. It has no mineral nutrients.

5.2.3 Compost

Compost is prepared by putting alternate layers of dried leaves with soil and small quantity of sulphate of ammonia is added to accelerate decomposition rate and to increase mineral content. These layers are watered to maintain decomposition action. For decomposition a period of 12 - 18 months are required.

5.2.4 Vermiculite

This is a micaceous mineral which expends markedly when treated chemically. It is a hydrated magnesium diauminium iron silicate. It is light in weight (25 - 45 kg/cu ft.) with good mineral supply and able to absorb fuanity of water i.e. 13.5 to 18 liters / cu ft. Generally particles of 2 - 3 mm are more useful.

5.2.5 Sphagnum moss

Commercial sphagnum moss is the dehydrated remains of acid bag plants which is acidic, sterile, light in weight and has high water holding capacity being able to absorb water upto 10 - 20 times of its weight. It contains small amount of minerals. It has ability to inhibit damping of seedlings.

5.3 Mixture of container growing

Well prepared garden soil is great for growing things in the ground but when it comes to growing things in containers, soil as you know it needs to be changed. Soils for containers need to be well aerated and well drained while still being able to retain enough moisture for plant growth. When choosing what to use to fill containers, never use garden soil by itself no matter how good it looks or how well things grow in it out in the garden. When put into a container both drainage and aeration are severely impeded, and the results are that plants grow poorly or not at all. Soils for containers are always modified in some way to ensure proper drainage and aeration. Container soils are often referred to as soilless or artificial media, because they contain no soil at all. They are often composed of various things such as peat, vermiculite, bark, coir fiber (ground coconut hulls) in a variety of recipes depending on the manufacture and the type of plant material being grown. They can be found under a variety of trade names and in sizes ranging from a few quarts to bales that are many cubic feet in size. Sometimes the choice of media will be directed by what type of plants you are

growing. Succulents, herbs, and perennials tend to prefer soils that are well drained and not retaining a lot of moisture over a long period of time. For them you might choose media that are courser in texture containing more bark, perlite or sand. For tropical and foliage plants, you might choose a media with more peat and less course material as these plants tend to prefer moisture growing conditions. When these mixes are used, they should be moistened slightly before planting. Fill a tub with the media, add water and lightly fluff the media to dampen it.

Garden soil can be used as a container media but it needs to be modified or amended. An acceptable soil based mix can be made by using one part garden soil, one part peat moss and one part perlite or coarse builder's sand. Don't use fine beach sand or play sand. A good mix consists of one part each of potting soil, one part vermiculite, sphagnum peat moss and compost. Garden soil should be avoided as it is likely to be infested with soil pests, bacterial or fungal disease, and drains poorly in containers. When using compost, make sure temperatures during the composting process were high enough to kill pest organisms or you can add a slow release fertilizer by following label recommendations to each pot. This provides additional nutrients slowly over a longer period when there is active growth and fruit production.

Additional nutrition will be required more often with containers as nutrients can quickly leach out with the frequent watering needed but avoid high nitrogen fertilizers as it is the fruit you want, not giant plants. One problem with container growing is that you have to watch the watering more closely. These plants will dry out far more quickly than if they are planted in the ground. Water holding gels or crystals has been developed to help reduce the watering requirements of container plants. These gels can be added to the soil mix or can already be included in the mix. The gels help to retain moisture in the soil until it is needed by the plant and have the advantage or stabilizing soil moisture levels, something that is a common problem with container gardening. Mulching the soil on the top of the container with moss or straw will also help retain soil moisture and prevent soil splashing up onto the leaves and fruit to cause damage.

5.4 Treatments of media and mixes

- Avoid compaction of growing media. Containers should be lightly filled and the

excess brushed off the top. Do not stack growing containers or pre-fill them too far in advance.

- Add water to peat-based mixes before filling plug trays to help create more aeration.
- Test the media pH, electrical conductivity and wettability before use.
- Do not make changes to your current growing media without experimenting first to see if changes may affect your cultural practices.
- If mixing your own media, thoroughly mix components, but do not over-mix, especially if a media contains vermiculite or controlled release fertilizer.
- Do not store media that contains fertilizer especially if the media is moist.
- Avoid contamination of components for finished media by keeping amendments in closed bags or by covering piles.
- Avoid contamination of bagged commercial media by keeping any broken bags covered.
- It is advisable to wear a dusk mask when handling dry peat moss or vermiculite to avoid inhaling these materials.
- Use surfactants occasionally to assure rapid wetting of the media.

C. Learning process and support materials:

The learning process includes the participation of student in Group work, Presentation, Demonstration methods, Skill development, Practical methods etc.

D.Assesment:

Very short (Answer question)

1. What is media mixture?
2. Give any two suitable formulations of media preparation methods.
3. What is compost?

Short (Answer question)

1. Write down the properties of vermiculite.

Long (Answer question)

1. What are the characteristics of good media mixture?

2. How will you treat the media before using in container?

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UNIT-6

Nursery Containers

A. Objectives:

After completion of this course, the students will be able to:

Discuss about the nursery container used in ornamental horticulture.

B. Content elaboration:

Many types of containers prepared from wood, earth, plastic, metal, cement concrete are available for propagation and growth of nursery plants. All water generally shallow and small containers are used for germinating seeds and rooting of cuttings, while bigger containers having sufficient depth are used for growing the plants.

6.1 Clay pot

These are made from red clay round in shape and as porous, loose moisture readily and heavy. These are soaked in water before use. Mostly suited for growing nursery plants.

6.2 Plastic pot

This are available in different shapes and sizes and are light in weight, requires less space for storage. Useful for growing plants.

6.3 Polythene bags

Polyethylene bags are available in various sizes and cheap light in weight and easy to handle. The holes are made for proper aeration and drainage. A single seed or cutting is placed for germination or rooting of cuttings.

C. Learning process and support materials:

The learning process includes the participation of student in Group work, Presentation, Demonstration methods, Skill development, Practical methods etc.

D. Assessment:

Very short (Answer question)

1. List the nursery container.
2. Which pot is made up of mud?
3. Give any two advantage of plastic pot.

Short (Answer question)

1. Why plastic pot is preferred than clay pot?
2. Write down the features of polythene bags.

Reference:

1. Arora, J.S. 1990. Introductory Ornamental Horticulture, Kalyani Publisher, New Delhi
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UNIT-7

Nursery structure

A. Objectives:

This course is designed to develop knowledge and skills to:

Demonstrated the different nursery structure.

B. Content elaboration:

Green house are the permanent protected structure being used for horticultural crop production in several countries of the world. Green house are used for providing maximum control over varied environmental conditions surrounding the plant. The green houses structures modify the environmental condition and allow the crop production in the region where outdoor production is not possible. Different types of propagating structure such as green house, hot bed, plastic tunnel, cold frame, lath house, net house and mist chamber are commercially used for creating favorable condition facilitating germination of seed, rooting of cutting and also for hardening of young seedlings before transplanting them to the main field. Among them green house and hot beds are structure with controlled temperature and ample light are mainly used for seed germination and rooting of cutting. The lath house, cold frame, net house are structure for hardening the young seedling.

7.1 Hot bed

Hot bed is a small fixed structure having three component mainly Frame, Cover and Heating units. It is also used for growing small, tender seedling and rooting of cutting. The cover is made up of glass or transparent polythene sheet. The soil of the bed is drought and replaced with 30-50 cm thick layer of raw cow dung preferably hot manure and covered with 15-20cm thick rooting medium. Decomposition of raw dung; generate heat and temperature. The rooting medium is raised in larger size. Modern nursery improves heating arrangement like steaming or hot water piping, electric cable etc. are used for heating the bed.

7.2 Plastic tunnel

Plastic tunnel are simple and low cost structure for offseason production of vegetable crops and flower in open field. These are flexible, transparent covering that are

installed over single or multiple rows of crops during winter season. To enhance plant growth as the micro climate around the plants gets warmth. The soil temperature is also raised and the plants are also protected from hails, cold wind injury, frost etc. These structures provide temporary shelters and they are generally removed at the end of the cultivation.

7.3 Green House

A green house is a structure covered with glass for protection against adverse climatic condition. Plants are grown or cuttings are rooted in a green house. A green house is used when the atmospheric condition doesn't permit for raising them in outdoor condition. These structure ranges in size from small to very large buildings. Commercial green houses are often hi-tech production facilities for vegetables or flowers. Green house are generally equipped with heating, cooling, lighting installation that are automatically controlled by a computer.

C. Learning process and support materials:

The learning process includes the participation of student in Group work, Presentation, Demonstration methods, Skill development, Practical methods, Exhibition methods, observation methods, Creative thinking etc.

D. Assesment:

Very short (Answer question)

1. List the importance nursery structure.
2. Write down any two advantage of plastic house.

Short (Answer question)

1. What do you mean by hot bed?
2. What are the difference between plastic tunnel and green house?

Long (Answer question)

1. What do you understand by green house? Write down its advantage and disadvantage.

Glossary:

Green House: A green house is a structure covered with glass for protection against adverse climatic condition.

Hot bed: Hot bed is a small fixed structure having three component mainly Frame, Cover and Heating units.

Reference:

1. Arora, J.S. 1990. Introductory Ornamental Horticulture, Kalyani Publisher, New Delhi
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UNIT- 8

Propagation Form Seed

A. Objectives:

After completion of this unit student will be able to:

- Explain the merits and demerits of sexual propagation.
- Discuss about the seed viability and germination.
- Describe about the seed dormancy and its causes.
- Explain about the seed bed preparation.

B. Content elaboration:

8.1 Merits and Demerits

Sexual reproduction refers to multiplication of plants by seeds. Seeds are formed after successful pollination and fertilization by the union of male and female gametes. Meiosis division takes place in the course of fusion and the chromosome numbers are reduced to half, which after fertilization becomes normal. The plants raised through seed are called seedling plants. Propagation of plants by seeds offers many advantages however several have disadvantages too.

Merits:

Sexual method of propagation has several advantages, like

- Propagation by seeds is simple and easy.
- Seed propagation is only mean of diversity particularly in the selection of chance seedlings.
- Seedling plants are long lived, productive and have greater tolerance to adverse soil and climatic conditions and diseases.
- Seed propagation makes feasible to propagate plants like papaya and coconut in which asexual means of propagation is not common.
- Hybrids can only be developed by sexual means.
- Sexual propagation offers opportunities of polyembryony (citrus, mango or jamun) and apomixis (Malus sikkimensis, Malus hupehensis, Malus sargentii), which produces true- to - type plants.
- Seed is the source for production of rootstocks for asexual propagation

- Seeds, if stored properly can be kept for longer duration /period for future use

Demerits:

Sexual method of propagation has some disadvantages, like

- Seedling plants are not true to type to the mother plants due to heterozygous nature of fruit plants.
- Seedling plants have long juvenile phase (6-10 years) and hence flowering and fruiting commences very late in them.
- Sexually raised plants are generally tall and spreading type and thus are cumbersome for carrying out various management practices like pruning, spraying, harvesting etc.
- Seeds of many fruits are to be sown immediately after extraction from the fruits as they lose their viability very soon e.g. cashew nut, *jamun*, jackfruit, citrus, mango and papaya.
- The beneficial influences of rootstocks on scion variety cannot be exploited in sexual propagation.
- Seedling plants usually produce fruits inferior quality.

8.2 Collection of tree seeds

Following things should be considered while collecting seed:

- Collect seed directly from trees is of high quality because collectors have the ability to select mature and healthy seed, and the seed has not been exposed to soil moisture or soil microorganisms. Additionally, by selecting seed from many parts of the crown, which may be pollinated by different father trees, the collector can encourage a broad genetic base of the seed collected.
- During field activities, seed that has been collected should be placed in a temporary storage area for initial processing. Seed processing is done in sacks or any container (bamboo buckets, etc.) used to store seed in the field should be labeled with accurate information concerning the seed's identity. This is important especially when collecting seed on an individual tree or family basis.
- If seed extraction and processing cannot be conducted immediately, place sacks or containers of seed in a dry and cool room with good air circulation. Place the sacks or containers on a shelf or rack to facilitate air movement.

- Sacks may also be hung from the ceiling.
- Do not place the sacks directly on the floor, otherwise the sacks and seed will absorb moisture and be more easily contaminated by insects and rodents. Seed placed directly on the floor deteriorates more quickly.

8.3 Seeds Viability and germination

8.3.1 Seed viability

Viability is a measure of the proportion of seeds in a lot that are capable of germinating. Viability is measured using germination and tetrazolium tests. Viability of seed during storage depends on the storage environment as pertains to seed moisture content temperature and relative humidity.

8.3.2 Seed Germination

Germination is the emergence and development of a seedling from the seed embryo, which is able to produce a normal plant under favorable condition. All the viable seeds which have overcome dormancy either naturally or artificially will readily germinate under suitable environmental conditions necessary for seed germination i.e. water ,oxygen, temperature and in some case light.

Types of germination:

There are two types of seed germination, they are-

1. Epigeal germination (cotyledon above the ground)
2. Hypogeal germination (cotyledons below the ground)

1. Epigeal germination:

- In epigeal germination, the cotyledons are raised above the ground where they continue to provide nutritive support to the growing points.
- During root establishment the hypocotyl begins to elongate in an arch which breaks through the soil, pulling the cotyledon and enclosed plumule (epicotyl) through the ground and projecting them into the air.
- Afterward the cotyledons open, plumule growth continues and the exhausted cotyledons wither and fall to the ground.
- It is found in bean, soyabean, black gram, green gram, groundnut, pigeon pea, sunflower, pine seeds, etc.

2. Hypogeal germination:

- In hypogeal germination, the cotyledon remains beneath the soil, while the plumule pushes upward and emerges above the ground.
- The plumule elongates in hypogeal germination whereas in epigeal germination, the hypogeal is the rapidly elongating structure.
- Regardless of their above ground or below ground locations, the cotyledons continue to provide nutritive support to the growing points throughout germination.
- Most cereals or monocots except onion are hypogeal type of germination. Some winter pulses have also hypogeal germination e.g. pea, gram, Lentil, etc.

Factors affecting germination

The major environmental factors affecting seed germination are:

1. Moisture:

- Seed most imbibe moisture to a certain degree for the germination process to be initiated.
- Moisture is needed to initiate the enzymatic breakdown of food reserves. The critical degree of imbibition differs among species.
- Horticultural plants that germinate best under conditions of high moisture include beet, celery and lettuce. When raising seedlings in flats, a glass plate may be used to cover the flat to prevent moisture loss through evaporation.
- Similarly, the flat may be placed in a plastic bag to accomplish the same purpose.
- Although moisture is critical to germination, excessive moisture encourages rotting and other diseases.

2. Tempereature:

- Temperature regulates seed germination. In seeds that require cold temperature treatment to break dormancy, abscisic acid or other inhibitors are broken down under low temperature (as obtained in winter).
- When a warm spring temperatures arises, levels of endogenous gibberellins increase, resulting in germination.
- The rates of biochemical reactions are controlled by temperature. When soils are too cold, growth processes slow down or cease altogether.

- Generally, a warm seed bed is desirable for seed germination, but warm season crops (such as bean and squash) do better at warmer temperatures (15 to 25^0C or 59 to 77^0C) and cool season crops (such as cole crops) do well at cooler temperature (less than 10^0C or 50^0F).

Light:

- A number of horticultural species including some herbaceous garden flowers, some vegetables (e.g. lettuce and celery), and grasses require light to germinate.
- The species are therefore planted shallowly in the soil. Light inhibits germination in some species (such as onion), which must be planted deeper in the soil or covered with a dark cloth or other material in the nursery. Geraniums require darkness to germinate.

Air:

- In most species, germination is an aerobic process. The low oxygen concentration of soil air is inhibitory to most species. The seedbed must be well drained for good aeration.

Disease free:

Soil less media are sterile, but field soil may contain pathogens that can overwhelm a developing embryo or young seedling.

- One of the most common diseases of seedlings is damping-off, a fungal attack caused especially by Pythium ultimum and Rhizoctonia solani.
- These fungi are active at warm temperatures (20 to 30^0C or 68 to 86^0F)and thus are less of a problem when germination occurs under cooler conditions.

Seed dormancy and its causes

8.4.1 Seed dormancy

Dormancy is a condition where seeds will not germinate even when the environmental conditions such as water, temperature and air are favorable for germination. Seed dormancy is a condition of plant seeds that prevents germination until optimal environmental conditions exist. Living, non-dormant seeds germinate when soil temperatures and moisture conditions are suited for cellular processes and division; dormant seeds do not.

Types of dormancy

a. Exogenous dormancy

Exogenous dormancy is caused by conditions outside the embryo and is often broken down into three subgroups:

i) Physical dormancy

This occur when seeds areimpermeable to water or the exchange of gases. Legumes are typical examples of physically dormant seeds; they have low moisture content and are prevented from imbibing water by the seed coat. Chipping or cracking of the seed coat or any other coverings allows water intake. Impermeability is often caused by an outer cell layer which is composed of macrosclereid cells or the outer layer is composed of a mucilaginous cell layer. The third cause of seed coat impermeability is a hardened endocarp. Seed coats that are impermeable to water and gases form during the last stages of seed development.

ii) Mechanical dormancy

Mechanical dormancy occurs when seed coats or other coverings are too hard to allow the embryo to expand during germination. In the past this mechanism of dormancy was described to a number of species that have been found to have endogenous factors for their dormancy instead. These endogenous facts include physiologically dormancy caused by low embryo growth potential

iii) Chemical dormancy

Chemical dormancy includes growth regulators etc. that are present in the coverings around the embryo. They may be leached out of the tissues by washing or soaking the seed, or deactivated by other means. Other chemicals that prevent germination are washed out of the seeds by rainwater or snow melt.

b. Endogenous dormancy

Endogenous dormancy is caused by conditions within the embryo itself, and it is also often broken down into three subgroups: physiological dormancy, morphological dormancy and combined dormancy, each of these groups may also have subgroups.

i) Physiological dormancy

Physiological dormancy prevents embryo growth and seed germination until chemical changes occur. These chemicals include inhibitors that often retard embryo growth to the point where it is not strong enough to break through the seed coat or other tissues. Physiological dormancy is indicated when an increase in germination rate occurs after an application of gibberellic acid (GA3) or after Dry after-ripening or dry storage. It is also indicated when dormant seed embryos are excised and produce healthy seedlings: or when up to 3 months of cold (0-10°C) or warm (=15°C) stratification increases germination: or when dry after-ripening shortens the cold stratification period required. In some seeds physiological dormancy is indicated when scarification increases germination.

Seeds with physiological dormancy most often do not germinate even after the seed coat or other structures that interfere with embryo growth are removed. Conditions that affect physiological dormancy of seeds include:

a. Drying;

Some plants including a number of grasses and those from seasonally arid regions need a period of drying before they will germinate; the seeds are released but need to have lower moisture content before germination can begin. If the seeds remain moist after dispersal, germination can be delayed for many months or even years. Many herbaceous plants from temperate climate zones have physiological dormancy that disappears with drying of the seeds. Other species will germinate after dispersal only under very narrow temperature ranges, but as the seeds dry they are able to germinate over a wider temperature range.

b. Photo dormancy

Photo dormancy or light sensitivity affects germination of some seeds. These photoblastic seeds need a period of darkness or light to germinate. In species with thin seed coats, light may be able to penetrate into the dormant embryo. The presence of light or the absence of light may trigger the germination process, inhibiting germination in some seeds buried too deeply or in others not buried in the soil.

c. Thermo dormancy

Thermo dormancy is seed sensitivity to heat or cold. Some seeds including

germinate only at high temperatures (30C or 86F) many plants that have seed that germinate in early to mid-summer have thermo dormancy and germinate only when the soil temperature is warm. Other seeds need cool soils to germinate, while others like celery are inhibited when soil temperatures are too warm. Often thermo dormancy requirements disappear as the seed ages or dries.

8.3 Breaking seed dormancy

A dormant seed is one that is unable to germinate in a specified period of time under a combination of environmental factors that are normally suitable for the germination of the non-dormant seed. Dormancy is a mechanism to prevent germination during unsuitable ecological conditions, when the probability of seedling survival is low. To get some seed to germinate you need to break dormancy. The method used will depend on the type of plant and the different mechanisms that control dormancy.

Softening seed coat and other seed coverings: This helps in better absorption of water and gases, which ultimately leads to better germination of the seeds. This can be achieved by scarification.

a. Scarification:

Scarification is the process of breaking, scratching, mechanically altering or softening the seed covering to make it permeable to water and gases. Three types of treatments are commonly used as scarification treatments. These include mechanical, chemical and hot water treatments.

i) Mechanical scarification

It is simple and effective if suitable equipment is available. Chipping hard seed coat by rubbing with sand paper, cutting with a file or cracking with a hammer are simple methods useful for small amount of relatively large seeds. Scarification should not proceed to the point at which the seeds are injured and inner parts of seed are exposed.

ii) Acid scarification

Dry seeds are placed in containers and covered with concentrated Sulphuric acid (H_2SO_4) or HCl in the ratio of one part of seed to two parts of acid. The amount of seed treated at any time should be restricted to not more than 10kg to avoid uncontrollable heating. The containers should be of glass, earthenware or wood, non-

metal or plastic. The mixture should be stirred cautiously at intervals during the treatment to produce uniform results.

iii) Hot water scarification

Drop the seeds into 4-5 times their volume of hot water with temperature ranging from 77 to 100oC. The heat source is immediately removed, and the seeds soaked in the gradually cooking water for 12 to 24 hours. Following this the un swollen seeds may be separated from the swollen seeds by suitable screens. The seed should be sown immediately after hot water treatment.

iv) Warm moist scarification

The seeds are placed in moist warm medium for many months to soften the seed coat and other seed coverings through microbial activity. This treatment is highly beneficial in seeds having double seed dormancy. The hard seeds are planted in summer or early fall when the soil temperature is still higher, that usually facilitates germination. For instance the stone fruit including cherry, plum ,apricot and peaches) show increased germination if planted early enough in the summer or fall to provide one to two months of warm temperature prior to the onset of chilling.

b. Stratification

Stratification is a method of handling dormant seed in which the imbibed seeds are subjected to a period of chilling to after ripen the embryo in alternate layers of sand or soil for a specific period. It is also known as moist chilling. However, temperate species displaying epicotyl dormancy (like fringed tree) or under developed embryo (like hollies) a warm stratification of several months followed by a moist chilling stratification is required. Several tropical and subtropical species (like palms) require a period of warm stratification prior to germination to allow the embryo to continue development after fruit drop. The seeds can be sown after fruit drop. The seeds can be sown immediately after stratification in the field.

8.3 Preparation of seed bed

A seedbed or seedling bed is the local soil environment in which seeds are planted. Often it comprises not only the soil but also a specially prepared cold frame, hotbed or raised bed used to grow the seedlings in a controlled environment into larger young

plants before transplanting them into a garden or field. A seedling bed is used to increase the number of seeds that germinate. The soil of a seedbed needs to be loose and smoothed, without large lumps. These traits are needed so that seeds can be planted easily, and at a specific depth for best germination.

The preparation of a seedbed may include:

1. The removal of debris. Insect eggs and disease spores are often found in plant debris and so this is removed from the plot. Stones and larger debris will also physically prevent the seedlings from growing.
2. Leveling: The site will have been leveled for even drainage.
3. Breaking up the soil: Compacted soil will be broken up by digging. This allows air and water to enter, and helps the seedling penetrate the soil. Smaller seeds require a finer soil structure. The surface the soil can be broken down into a fine granular structure using a tool such as a rake.
4. Soil improvement: The soil structure may be improved by the introduction of organic matter such as compost or peat.
5. Fertilizing: The nitrate and phosphate levels of the soil can be adjusted with fertilizer. If the soil is deficient in any micro nutrients, these too can be added.
6. The seedlings may be left to grow to adult plants in the seedbed, perhaps after thinning to remove the weaker ones, or they may be moved to a border as young plants.

8.4 Seed bed treatment and sowing

There is various method of seed bed treatment being used in nursery management. Some common techniques used for seed bed treatment are:

Soil solarization

Soil solarization is the technique of seed bed treatment. Suitable Time Period for seed bed treatment is May-June as temperature rises up to 45^{o}C at this time. The general procedures of soil solarization are:

- Wet the soil with water, or saturate it with water
- Spread white polythene of 200 gauges on the whole nursery area for about 5-6 weeks.
- The margin of the polythene should be covered by wet soil (compressed mud)

to check the entry of air.

- After 5-6 weeks remove the polythene sheet
- Prepare the beds for seed sowing.

1. Formalin Solution treatment:

Formalin dust treatment is another method of seedbed preparation. The general procedures of treatments are:

- This treatment should be done 15-20 days before seed sowing.
- Prepare formalin solution (1.5 to 2%) in one container and drench the soil @ 4-5 litre of water per square meter soil surface to saturate it up to a depth of 15-20 cm.
- Cover the drench area with polythene sheet of 200 gauge.
- Put the wet soil on the margin of the covered polythene sheet so as it does not allow the polythene film blown away by the wind and air from the covered area to outside.
- Removes the cover (polythene) after 15 days.
- Prepare the beds for seed sowing.

2. Application of fungicides:

Fungicide application in the soil is the method of seedbed treatment. Generally used fungicides for treatment are Captan, Thiram which kill the soil borne pathogens.

3. Insect Control:

Presence of certain insect pest and their egg or secondary stage insects present in the soil which can infect the seedlings in the later stage. To save the seedlings against them, some insecticides are also used as soil treatment. Recommended insecticide is Chlorpyriphos @ 2 ml/ liter of water. Depth of 15 to 20 cm in the nursery soil and then prepared the beds for seed sowing.

4. Steam treatment:

Hot steam can be used to treat the soil against harmful insect pest. For this, cover the required area with the help of polythene sheet and stop the movement of air in the covered area. Supply the hot steam for at least 4-6 hours continuously. This way all the harmful pathogen and insect pest will be killed.

5. Sowing of seeds in the nursery:

After the seed bed preparation seeds are sown in the nursery bed either by broadcasting or in lines depending upon the nature and season of crop.

Broad casting method:

In broadcasting method seeds are broadcasted on the well prepared nursery beds and later on the seeds are covered with well rotten fine sieved and treated FYM or compost. The major disadvantages of this method are:

- Uneven distribution of seeds in the nursery beds.
- Growth and development of seedlings is poor.
- Sometimes nursery becomes so dense to look like as patches of grasses. In such cases there is more possibility of damping off disease occurrence.

Line Sowing

Line sowing is the best method of seed sowing in nursery. Lines are made 0.5 to 1.0 cm deep parallel to the width at a distance of 5.0 cm from the line and seeds are sown or placed singly at a distance of about 1.0 cm apart. Cover the seeds with fine mixture of sand, soil and well rotten and sieved FYM or leaf compost etc. (1:1:1). After the seed covering a light irrigation must be given.

8.5 Care and maintenance of seedling

1. Watering:

The seedbed or seed box should be watered carefully with a fine stream of water. After the plants are well established, watering should be done thoroughly but not too often. It is advisable to irrigate seedlings in the morning and not in the afternoon as the latter leaves the soil surface moist overnight, a condition favoring damping off.

2. Shading:

Shading should be done to protect the young seedlings from high heat intensity in sunny areas and also from heavy rain. Shade can be provided by polythene nets or even grass. The shade should be removed some days before transplanting to allow the seedlings to acclimatize to field conditions.

3. Thinning:

This is a way of regulating plant density in rows and in holes. During thinning, weak, diseased plants are pulled out to allow healthy seedlings to grow well. It is normally done when seedlings have formed a few true leaves.

4. **Insect pest and disease control:**

   This is a continuous process from seedling emergence to transplanting. It is normally done by physical means but chemicals can also be used if the need arises.

5. **Weeding:**

   This is done by physical means when weeds emerge.

6. **Hardening-off:**

   Transplants must be 'hardened-off' so that they can withstand the transition from a relatively sheltered and protected environment to a sometimes harsh open situation. Generally, hardening is imposed from about 1 to 2 weeks prior to transplanting seedlings, by gradually exposing them to higher (or lower) temperature and the higher light intensity prevailing in the field. It should, however, not involve any treatment that may reduce the rate of photosynthesis, such as nutrient stress. Care should be taken not to over-harden plants, as this may delay maturity and in some instances even reduce crop yields.

7. **Transplanting:**

   This refers to the operation of lifting the seedlings from the seedbeds or containers and transferring them to the field where they will grow and mature. The main aim during transplanting should be to interrupt growth as little as possible, and if the operation is not carried out properly it can severely check growth or in extreme cases cause death of transplants.

   Most vegetable seedlings are ready to be moved 4-8 weeks after sowing. The seedbed should be given a thorough soaking about 6-12 hours before the plants are moved to ensure that they are fully turgid and that the roots retain plenty of soil when the plants are lifted. The main field should also be irrigated at the same time so that the planting holes can be opened up easily and the plants easily 'firmed'. The best time to carry out transplanting is in the late afternoon or early evening, as this allows the plants some time to get partially reestablished before

having to face heat stress during the day. A cool cloudy weather is ideal for transplanting. It is always wise to raise about 30% more seedlings than are actually required so that the weak ones can be discarded and any casualties replaced. The adaptability of vegetables to transplanting varies widely between crops. Transplanting success depends on how rapidly a plant is able to regenerate those parts of the root system that were lost or damaged during transplanting.

8.6 Packaging and marketing of seed

Packaging:

Seed packaging helps to maintain the quality while facilitating handling and identification of the product. Packaging is a very powerful seed marketing tool and several factors have to be taken into account when deciding on appropriate packaging to be used:

- Maintaining quality
- Identification
- Labeling etc.

Marketing:

Seed marketing should aim to satisfy the farmer's demand for reliable supply of a range of improved seed varieties of assured quality at an acceptable price.

For the marketing process to be successful:

- The farmer consumer's needs must be satisfied;
- The seed company's objectives must be realized.

C. Learning process and support materials:

The learning process includes the participation of student in Group work, Presentation, Demonstration methods, Skill development, Practical methods, Exhibition methods, observation methods, Creative thinking etc.

D. Assesment:

Very short (Answer question)

1. Define seed viability.
2. What is seed dormancy?

3. What is seed germination?

Short (Answer question)

1. Write any two causes of seed dormancy
2. What is sexual propagation?
3. Write down themajor Advantages of seed propagation.

Long (Answer question)

1. Write down the proper packaging and marketing techniques of seedling.
2. What is sexual propagation? Write its advantage and disadvantage.
3. Explain about the seed bed treatment methods.

Glossary:

Polyembryony: Some seed contains more than one embryo is known as polyembryony.

Propagation: Means production of new individuals.

Viability: Capacity of seed to germinate is called viability.

Seed: Seed is a material which is used for planting or regeneration purpose.

Seed Germination: Germination is the emergence and development of a seedling from the seed embryo, which is able to produce a normal plant under favorable condition.

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UNIT – 9

Vegetative Propagtion

A. Objectives:

The main objective of this course is to provide students the knowledge to:

- Explain the merits and demerits of vegetative propagation.
- Discuss about the different methods of propagation.

B. Content elaboration:

Vegetative reproduction (vegetative propagation, vegetative multiplication, vegetative cloning) is a form of asexual reproduction in plants. It is a process by which new organisms arise without production of seeds or spores.

9.1 Reasons for using vegetative propagation

Vegetative propagation is the independent of sexual propagation process as there is no involvement of sex organs. It takes place due to mitotic division. Mitotic division continues in shoot tip, root tip and cambium. When some portion of plant is wounded, mitotic division takes place. Under mitotic division, chromosomes divide longitudinally to form two daughter cells. This forms the basis of asexual propagation. The plants raised through asexual process are identical to mother plants. Cutting, division, layering, budding and grafting are main techniques of asexual propagation. The reasons behind using vegetative propagation are:

Asexually propagated plants are true to type to their mother plants.

1. Asexually propagated plants have short juvenile phase and bear flowers and fruits in the early age (3-4 years) than seedling plants.
2. The vegetative propagated plants are smaller in stature and hence management operations like spraying, pruning and harvesting etc. become easy.
3. Plants in which seed setting does not take place (e.g. orchid), asexual propagation serves as a substitute for sexual propagation.
4. Using asexual methods, desirable characters of a mother plant can be perpetuated/ multiplied easily.
5. The benefits of rootstocks and scion are usually exploited through asexual

propagation.

6. Repairing of damaged portion of plant is possible through asexual propagation as in case of bridge grafting.
7. It is possible to convert a non-productive local variety into productive improved variety by using asexual methods.
8. It is possible to grow several varieties on one plant or change variety of existing plant by top working.

9.1.1 Propagation of seedless plants

Many plants have not appropriate seed available in the market or no any propagating methods by seed at that situation vegetative propagation is useful. Due to complexity in seed production of some plants, vegetative propagation is preferred. It can grow faster than the plant propagated with seeds.

9.1.2 Avoidance of long juvenile phase

Through vegetative propagation there is avoidance of long juvenile phase as seed takes long time to germinate as well as retaining its maturity. Sometimes, due to bad climatic condition, the seed don't attain its juvenile phase which delays germination.

9.2 Methods of propagation

9.2.1 Cutting

Cuttings are piece of vegetative material obtained from any of the tree primary organs i.e. stem, leaf, or root. These tissues are nursed under appropriate conditions of temperature, humidity, light, moisture, and nutrients to develop into full-fledged plants. Cuttings are by the far most commonly used asexual propagation method in the horticulture industry. A variety of cuttings may be the plant part, and succulence of the tissues. However, certain materials are more successful or easier to use for establishing certain species than others. Stocks plants from which cuttings are obtained should be grown under optimal conditions for rapid rooting.

9.2.1.1 Advantage and disadvantages of cutting

Advantage of cutting

- Easiest and most convenient method of vegetative propagation.
- As the plant develops and grows on its own root system, the complex stock-

scion relationship that exists in a graft can be avoided.

- The stem pieces can easily be transported to different places in controlled condition and can be propagated easily.
- Plants can be prepared in short time.

Disadvantage of cutting:

- All plants do not readily form roots on cuttings.
- Benefits derived from using some desirable rootstock cannot be exploited.
- The root system of cutting originated plants is weaker than seedling originated.

9.2.1.2 Different techniques of cutting

There are different techniques of cutting being used in vegetative propagation. Some common techniques are:

Root Cuttings

Some plant species hava a atendency to sprout and Produce adventitious shoot from the roots; roots cuttings can propagate these species. Root cutting sould be taken while the root has maximum reserve carbohydrate. For this first take root cuttings about 1 meter away from the tree trunk. These cuttings should be 20-25 cm long and 1-2 cm thick. Place these cuttings horizontally into the soil about 10 cm deep until they shoot. This technique is useful for propagation of guava, breadfruit, apple, blackberry and raspberry.

Stem cutting

The stem cutting is the most common type of cutting. In this case, the segments of shoot or branches with lateral or terminal buds are selected. stem cutting can be further divided into 4 categories:

Hardwood Cuttings

There are two types of hardwood cuttings. Hardwood cuttings are taken from deciduous plants in early winter after the plants have dropped their leaves.

a) Simple Cuttings

This simple cutting is done on a stem, which usually contains 4-6 buds. The top part of the stem is cut off at an angle. If the cutting originated from an evergreen plant, the bottom two leaves should be removed and planted immediately after being cut. The

shoots will then grow from the buds above the soil and the roots will grow from the nodes in the soil. Typical examples for the use of this method are the Gooseberry, Currant, Quince, Fig and Olive.

b) Torn Cuttings

This cutting is performed at the bottom portion of the stem where there is a union with the mother plant. This is a very old technique and it is rarely used nowadays.

i) Semi-Wooded Cuttings

These types of cuttings are usually made from woody evergreen plants, which are taken during the growing season. They are cut off before the wood hardens and turns brown. Cuttings are used from the leafy shoot tip. Closed propagation structures are the best for rooting the cuttings. When the cuttings have developed their root systems, we can then transplant each one into a larger container. We use this propagation technique for the reproduction of coffee, kiwi, litchi, macadamia, mango, granadilla and pomegranate plants.

ii) softwood cutting

Cuttings are made from soft succulent and non-lignified parts of some woody plants from current season growth. The cuttings are always taken with intact leaves and should be handled carefully in order to prevent wilting. Moderately vigor's shoot growing under full sunlight are most suitable for soft wood cutting. They root faster under conditions of high humidity and adequate sunlight. Softwood cuttings propagate many ornamental shrubs and ornamental plants.

Herbaceous cuttings:-

In this method, the soft, tender and succulent terminal portion of stems of herbaceous plants is used. The cuttings should be prepared just before they are placed in rooting media. While planting the leaves from the basal portion should be removed. Herbaceous cuttings root faster in favourable environment, having high relative humidity. Sometimes, they can be treated with root promoting chemicals for better result. The examples of herbaceous cuttings are carnation, chrysthemum, coleus and sweet potato.

Leaf cutting:-

In this method whole leaf or a section of it can be used or propagation. Leaf cutting is generally practiced in those species having thick, fleshy leaves, which can reproduce roots in suitable media and continue to develop into a new individual. Propagation by this method is limited to those species have regenerative tissue in their leaves. *Broyophyta* leaves produce new plantlets in the serration of leaf margins while still attached to the plant and can be easily propagated by this method. Other examples are *Sanseviera, Sainpaullia, oppunita.* e.t.c.

Leaf bud cutting:-

In leaf bud cutting the axillary bud along with leaf blade, petiole, and short piece of stem are cut and for propagation. Under favorable condition each cuttings develops into a new individual plant. Plant species suited for this cutting are camellia, rhododendron, lemon, blackberry etc.

9.2.2 Layering

The development of roots on a stem while the stem is still attached to the parent plant is called layering. A layer is the rooted stem following detachment (removal) from the parent plant. Layering is an easy way to start new plants from old ones. The principle of layering is to encourage development of new roots on a stem while the stem is still attached to the parent plant. The rooted stem is then detached to become a new plant growing on its own root system.

9.2.2.1 Advantage and disadvantages of layering

Advantages:

- The parent plant supplies the new individual with water and food, particularly carbohydrates and proteins, and hormones, particularly the auxins, until it makes its own food and hormones.
- Comparatively bigger plant could be obtained through layering.
- It is possible to avoid mutagenic effects in certain species that happened if propagated by cutting.
- It is possible to generate few individuals of important species with minimum propagation facilities.
- It is possible to propagate difficult to root plants vegetatively.

Disadvantages:

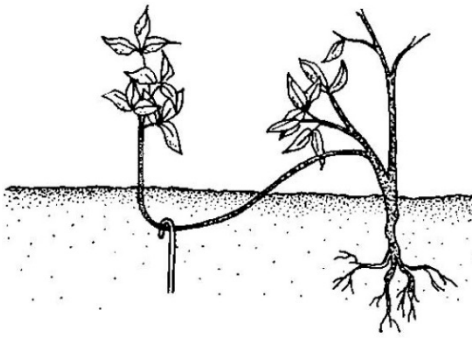
- This method of propagation is limited to plants which form growing points readily.
- It is difficult to produce large number of plants through this method. In other words, this method does not use propagation material economically.
- This method is short but time consuming and little difficult in some cases. This method is laborious, cumbersome and expensive.

9.2.2.2 Different techniques of layering

There are six common types of layering: air, simple, tip, trench, serpentine and mound. Air and simple layering are the most popular types.

Simple layering

Simple layeringcan be accomplished by bending a low growing, flexible stem to the ground. Cover part of it with soil, leaving the remaining 6 to 12 inches above the soil. Bend the tip into a vertical position and stake in place. The sharp bend will often induce rooting, but wounding the lower side of the bent branch may help also.



Simple layering can be done on most plants with low-growing branches. Examples of plants propagated by simple layering include climbing roses, forsythia, rhododendron, honeysuckle, boxwood, azalea, and wax myrtle. Simple layering can be performed in early spring using a dormant branch, or in late summer using a mature branch. Periodically check for adequate moisture and for the formation of roots.It may take one or more seasons before the layer is ready to be removed for transplanting.

Tip layering

Most plants with drooping growth habits can be propagated easily by tip layering. Tip layering is quite similar to simple layering. In tip layering, rooting occurs near the tip of the current season's branch which touches the ground. This occurs naturally in black and purple raspberries, dewberries and trailing blackberries. The layers can be removed either in the fall or early spring and transplanted directly to new locations.

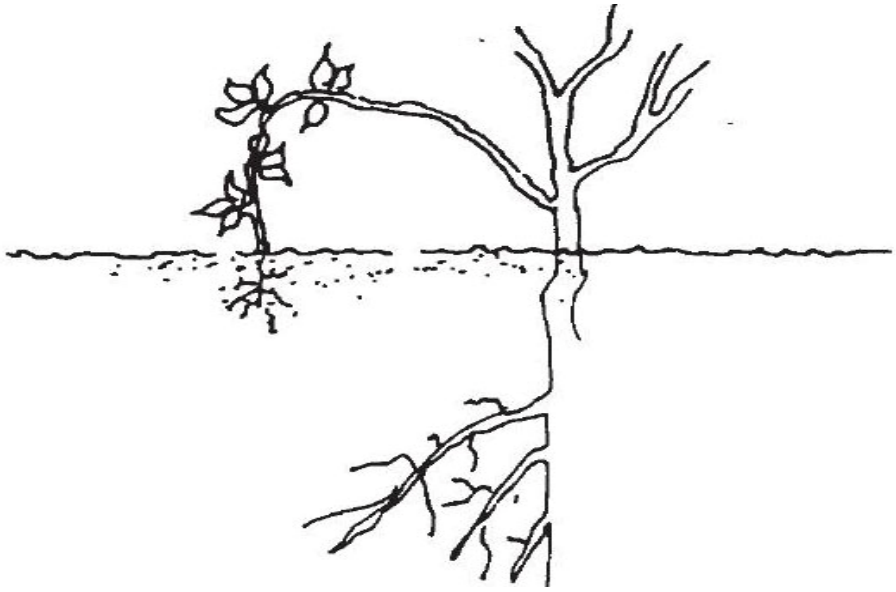


Fig. tip layering

Compound (serpentine) layering

Compound (serpentine)layeringis similar to simple layering, but several layers can result from a single stem. Bend the stem to the rooting medium as for simple layering, but alternately cover and expose sections of the stem. Each section should have at least one bud exposed and one bud covered with soil. Wound the lower side of each stem section to be covered. This method works well for plants producing vine-like growth such as heart-leaf philodendron, pothos, wisteria, clematis, and grapes.

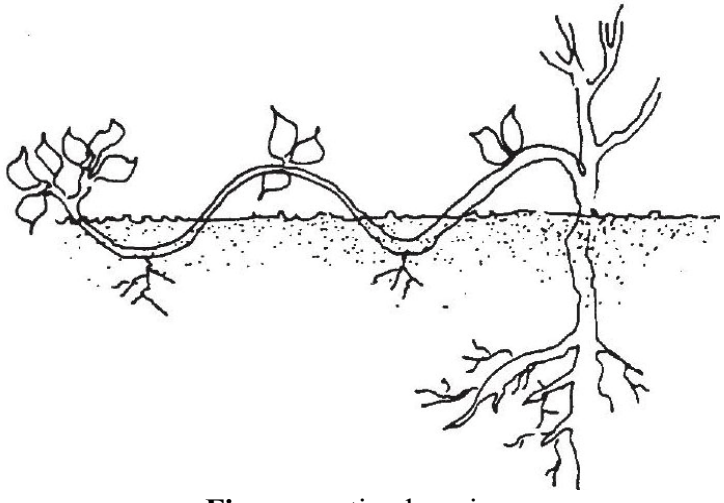


Fig. serpentine layering

Mound (stool) layering

Mound (stool) layeringis useful with heavy stemmed, closely branched shrubs and rootstocks of tree fruits. Cut the plant back to 1 inch above the soil surface in the dormant season. Dormant buds will produce new shoots in the spring. Mound soil over the new shoots as they grow. Roots will develop at the bases of the young shoots. Remove the layers in the dormant season. Mound layering works well on apple rootstocks, spirea, quince, daphne, magnolia, and cotoneaster.

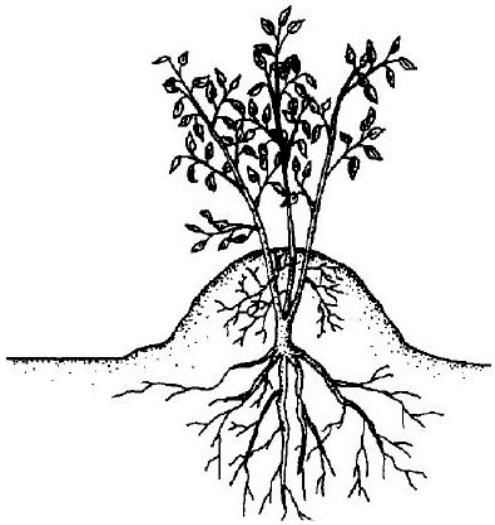


Fig. Mould layering

Air Layering

Air Layeringcan be used to propagate large, overgrown house plants such as rubber plant, croton, or dieffenbachia that have lost most of their lower leaves. Woody ornamentals such as azalea, camellia, magnolia, oleander, and holly can also be propagated by air layering. For optimum rooting, make air layers in the spring on shoots produced during the previous season or in mid to late summer on shoots from the current season's growth. For woody plants, stems of pencil size diameter or larger are best. Choose an area just below a node and remove leaves and twigs on the stem 3 to 4inches above and below this point. This is normally done on a stem about 1 to 1½ ft from the tip.

Air layering differs, depending on whether the plant is a monocot or a dicot. For monocots, make an upward 1 to 1½ inch cut about one-third through the stem. The

cut is held open with a toothpick or wooden match stick. Surround the wound with moist, unmilled sphagnum moss (about a handful) that has been soaked in water and squeezed to remove excess moisture. Wrap the moss with plastic and hold in place with twist ties or electrician's tape. No moss should extend beyond the ends of the plastic. Fasten each end of the plastic securely, to retain moisture and to prevent water from entering. If exposed to direct sun, the plastic should be covered. Aluminum foil can also be used, as it does not require twist ties or tape to hold it in place.

The process for dicots is similar, except a 1-inch ring of bark is removed from the stem. With a sharp knife, make two parallel cuts about an inch apart around the stem and through the bark and cambium layer. Connect the two parallel cuts with one long cut. Remove the ring of bark, leaving the inner woody tissue exposed. Scrape the newly bared ring to remove the cambial tissue to prevent a bridge of callus tissue from forming. Application of a root promoting substance to the exposed wound is sometimes beneficial. Wrap and cover using the same procedure as that described for monocots.

After the rooting medium is filled with roots, sever the stem below the medium and pot the layer. The new plant will usually require some pampering until the root system becomes more developed. Provide shade, adequate moisture, and fertilize lightly until the plant is well established.

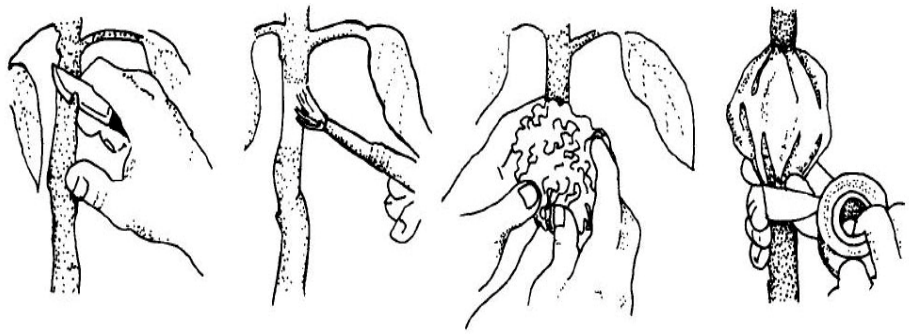
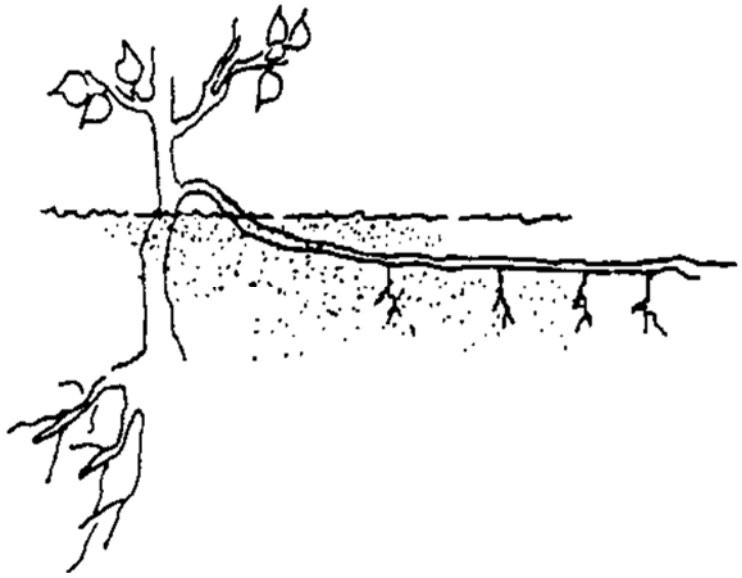


Fig. air layering

Trench layering

In trench layering, a branch is laid horizontally in a small trench to encourage the development of several new shoots from it. As these shoots develop, soil is filled around them and roots eventually develop. The little plants can then be removed from

the original branch after roots have formed. This method is used primarily for fruit trees which are difficult to propagate by other methods.



Natural Forms of Layering

Sometimes layering occurs naturally, without the assistance of a propagator. Runners and offsets are specialized plant structures that facilitate propagation by layering. A runner produces new shoots where it touches the growing medium. Plants that produce stolons or runners are propagated by severing the new plants from their parent stems. Plantlets at the tips of runners may be rooted while still attached to the parent or detached and placed in a rooting medium. Examples include strawberry and spider plant.

Plants with rosetted stems often reproduce by forming new shoots, called offshoots, at their base or in the leaf axles. Sever the new shoots from the parent plant after they have developed their own root systems. Unrooted offsets of some species may be removed and placed in a rooting medium. Some of these must be cut off, whereas others may simply be lifted from the parent stem. Examples include date palm, bromeliads, and many cacti.

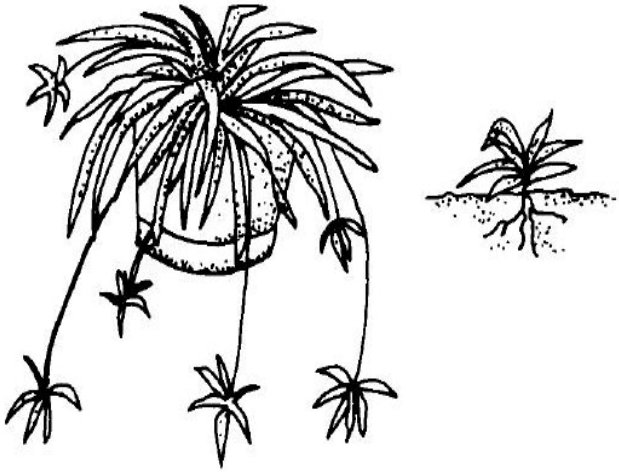


Fig. Nautral layering

9.2.3 Grafting and budding

Grafting is an art of insertion of a scion into the stem of the root stock in such a way that union takes place and the combination continues to grow.

Budding is a type of grafting. Budding can be defined as an art of insertion of a single mature bud into the stem of the root stock in such a way that the union takes place and the combination continues to grow. Stock is a lower portion of the graft union, whereas, scion is the upper portion a place at which both unites is termed as scion or graft union.

9.2.3.1 Advantages and disadvantage of grafting and budding

Advantages

The plants which cannot be propagated by other vegetative means viz. cutting, layers, or division can be multiplied, preserved and perpetuated by grafting and budding.

Grafting and budding can be very well adopted to convert inferior plant of established trees into superior one. Variety of the established plant can be changed by top working.

- Root stocks influence size and vigour of tree and quality of fruits.
- Root stocks impart disease resistance to the scion.
- Some root stocks are tolerant to saline and alkaline conditions and high moisture contents of the soil.

- Bridge grafting or buttress grafting helps to repair the damaged trunk or roots of the plant.
- Special form of plant growth obtained by grafting and budding.
- Novelty can be produced in nature by growing several types of flower or fruits on a single stock.
- Early induction of flowers and fruits.
- Budding and grafting are used for indexing the presence of virus disease. Virus susceptible stocks are used to detect the viruses. These are called indicator plants.

Disadvantages:

- New varieties cannot be developed.
- These are extensive methods of propagation. They require specialized skill.
- The life span of grafted and budded plants is short as compared to seed propagated plants.
- Spread of viral diseases may occur through this method.

9.2.3.2 Different techniques of grafting

There are many methods of grafting which differ only in detail of technique. Sometimes one method is superior for some particular purpose or occasion. At other times, the grafter has a choice of methods.

Wood Grafts

With this type of graft the sapwood is split or cut and the wedged scion is placed in cambial contact with the stock. The scion is held in place by the tension of the stock so that no tying or nailing is necessary.

Cleft Graft

In this method the stock is a branch or trunk about 2 to 7 cm in diameter. If the stock is smaller or larger than this, it produces either too little of too much tension on the scion. The stock is first sawed across at right angles to the direction of growth at a spot that is straight and free from knots and branches. The stub is then split or "cleft" down the center with a heavy knife (or special grafting tool) and mallet. The cleft should be about 7 cm long.

The scions with 3 to 5 buds are cut to a blunt wedge-shape, with one edge of the wedge

slightly thicker than the other. The wedge should be cut in such a way that the lowest bud of the scion will be immediately above the wedge on the thick side. The leaf growth from this bud will speed callus formation at the upper area of contact and result in rapid healing of the wound. Three-bud scions, with the top cut made near the upper bud, are commonly used.

The cleft is opened with a grafting iron or screw-driver, and the two scions are placed so that the cambium layers of scion and stock are in contact or very close proximity throughout the whole length of the scion wedge. This requires very careful cutting and placement of scions with due allowance for the differences in bark between scion and stock. Of importance too, is a uniform thickness of wedge for the two scions in any given stub. If one is thicker than the other, it may reduce the pressure by which the other is held, thereby preventing good contact. The grafting tool (or screw-driver) is then removed and all wound surfaces are thoroughly covered with a grafting compound.

To add additional strength to the newly set scions, some grafters will wrap two passes of PVC tape (electrical tape) around the cut end of the stub before applying the grafting compound.

The cleft graft can be used in top working to replace a branch with one of another cultivar, or to change over the trunk and top of a tree that has been girdled.

Figure. Cleft Graft

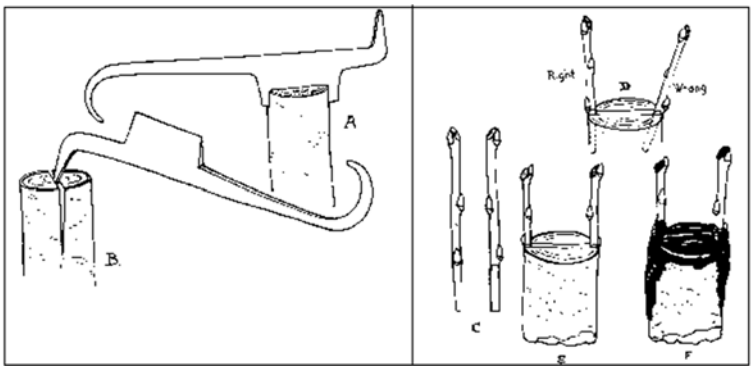


Figure . The Cleft Graft, in which two scions are placed in a cleft.

a) Stub Graft

In stub grafting the main framework of the tree is retained. All suitably placed branches, 1 to 2 cm diameter at the base and with wide-angled crotches, are used for grafting. Other branches are removed completely before or during the grafting operations. The terminals of all branches are cut off at a point immediately above the uppermost stub graft. The greater the number of scions used, the less will be the interruption of fruiting. In each sector of the tree, scions should be placed and wounds covered, working from the top of the tree towards the base.

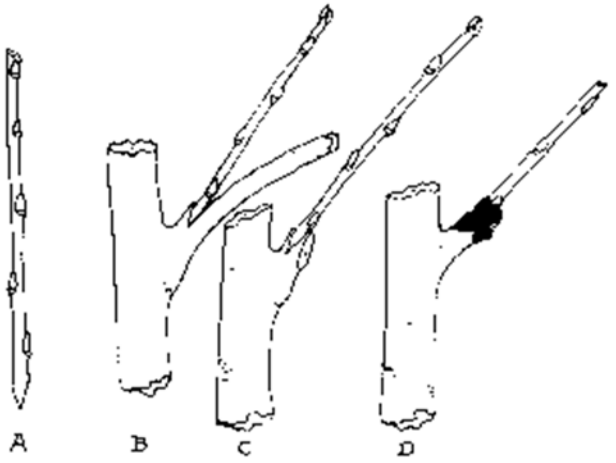


Figure . The stub graft can be used effectively in frame-working. Here is the 6 to 8 bud scion (A) and the 3-step operation (B), (C) and (D).

b) Side Graft

This method is used to insert a number of grafts on a long, otherwise bare limb. It thus quickly provides a large leaf surface to replace what has been pruned off, it prevents sunscald, the fruiting area is brought in closer to the truck, and it provides laterals to fill in gaps on the branch.

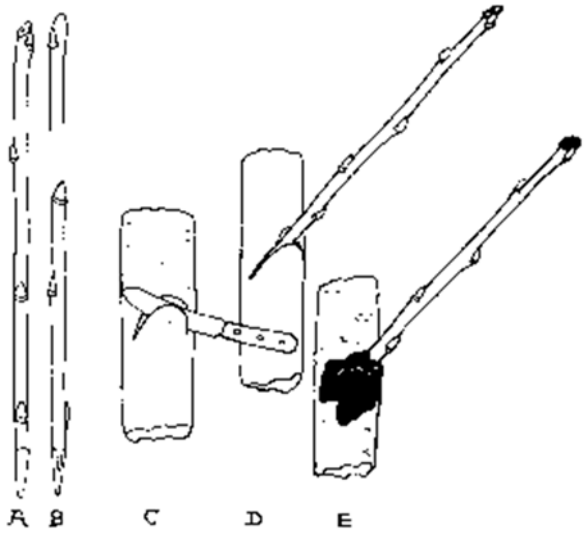


Figure . The side graft is a quick, simple method for placing scions anywhere on the branches of the stock.

In side grafting, the 6 to 8 bud scions are cut to a sharp wedge, about 2 to 3 cm long, with one side of the wedge thicker and longer than the other. A sloping cut is made with a heavy knife on the side of the limb of the stock and not more than one-quarter of the way through it.

By bending the branch slightly or opening the cleft with the knife, the scion in inserted, thick side of the wedge uppermost, and pushed into the proper position for cambial contact with the stock. The scion should be so placed that narrow crotch angles do not develop between scion and stock. A coating of a suitable grafting compound, but no nailing or tying, is required.

c) Bark Grafts

With this type of graft the wood of the stock is not split or cut. Only the bark is lifted, allowing the cambium layers of stock and scion to be brought in contact.

A bark graft can be done successfully only after the cambium has become active in the spring, permitting the bark to lift or "slip" readily. This is usually about mid-May or later in Ontario.

Figure . The inverted "L" graft and the "awl" graft method. In each case the bark of the stock is

d) Veneer Graft

Veneer or inlay grafting is a method for top working large trees where it is difficult or impractical to cleft-graft stubs larger than 3 cm in diameter, and where growth is desired on large bare limbs. Scions somewhat thicker than a lead pencil are the best. The scions may be 5 to 15 cm long, including one or more buds. A 2- to 5-cm bevel to the pith is made at the base of the scion, with or without a shoulder. The stock is cut and prepared for the scion by cutting one slit (if bark is thin) or two parallel slits the width of the scion (if the stock is large and the bark thick). The beveled scion is positioned under the bark and nailed. For additional strength 2 layers of PVC tape is often wrapped around the stub next to scions. The scions are spaced about 5 cm apart around the stock and treated with grafting compound. Spurs will form the second year and bloom the third. Some crop should be harvested the third year and a full crop by the fifth or sixth year. An entire block of trees can be top worked by spreading the job over a 4- to 6-year period.

The scions should be placed within a meter of the main crotch and on scaffold limbs approaching a 45° angle; almost-vertical limbs are unsatisfactory. The scions should be placed somewhat on the sides of the scaffold limbs, and not on top, for best results.

After shoots from these grafts have grown two or three years, the best can be selected for permanent scaffold limbs. The top of the tree can be gradually opened over a period of from four to six years or more. This will admit more light and room to the new limbs, while the old unneeded limbs are gradually pruned away and eventually removed.

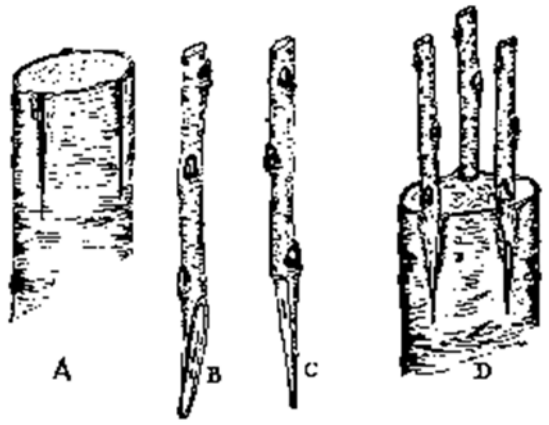


Figure . (A) Slit stock ready for scion; (B, C) scion with straight bevel and shoulder bevel; (D) scions nailed in place.

e) Bud Graft (Budding)

Budding is done in the summer when buds of the current season are well formed and the bark slips well. It may take place in July or early August, depending on the geographic locality and the kind of fruit. Buds may be too immature for successful budding, but seldom are too mature.

Cut shoots (bud sticks) of the current season's growth from trees of known fruit quality. Promptly remove leaves and keep the bud sticks moist. Leaving a short portion of the petiole in place as a "handle", wrap the bud sticks in moist cloth, in plastic bags, or place them with the basal end in water in a container. They can thus be stored in a cool place for several days; but it is better to use them soon after cutting. Use the well-developed, plump and hard buds from the mid-portion of the shoot.

Prepare the seedling nursery stock by stripping off the lateral shoots on the lower 15 cm of the stem in early summer. Wipe the stock clean of soil particles near the point of bud insertion.

At budding time make a T-cut in the bark of the stock through the bark to cambium depth (not into the wood). Twist the knife blade to raise the edges of the bark just enough, without tearing, so that the bud may be easily inserted.

Cut the bud with a thin shield of bark attached and retain the thin strip of wood that is cut with the shield.

After cutting, hold the bud by the petiole and insert it into the T-shapes incision. A properly inserted bud is at least 2 cm below the transverse cut. Avoid undue manipulation or prying of the bark flaps and be sure the bud is not upside down.

Buds are usually placed on the same side of the stock along the row so that they may be readily seen the following season. The side from which prevailing winds come is the preferable one to prevent breakage. After inserting the bud wrap it snugly. Be sure to leave the bud exposed. Rubber budding strips are available for this purpose.

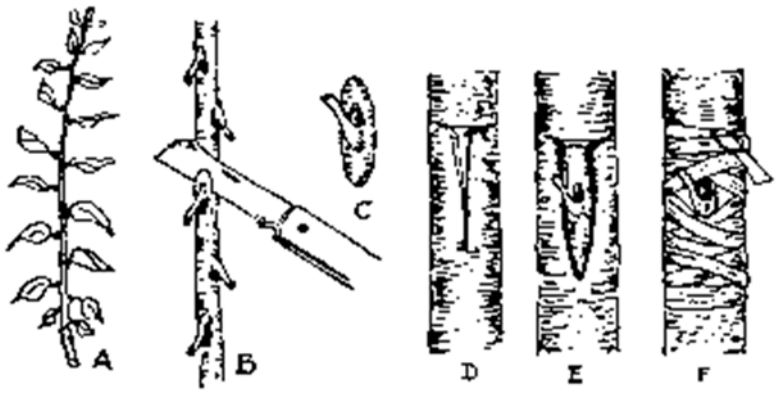


Figure . (A) Terminal growth of current season, the source of buds. (B) Prepared budstick showing method of cutting the bud. (C) The shield bud. (D) The T-cut in the stock. (E) Bud in place. (F) Bud tied snugly against stock.

9.2.3.2.1 Different technique of budding

a) T-budding or Shield budding

In this method a “T” or inverted “T” shaped incision is made on the rootstock stem. A transverse cut of 1 to 1.5 cm length is made first & then either below or above to this vertical cut of 2.5 to 3 cm length is made & connected to the transverse cut. Then the bark is lifted by using the ivory edge of the budding knife. The scion bud is removed in the form of shield with or without a piece of wood. The bark is raised & then the bud is inserted into the “T” cut surface of the rootstocks. Then it is secured in position by proper bandaging. This method of budding is practiced extensively in the propagation of different ornamental plants. Eg. Rose etc.

Figure . T-Budding

b) Patch budding

A rectangular patch of bark of about 3 cm length & 1.5 cm width is removed from the stem of the rootstock. Similar patch of bud is removed from the bud wood with the bud in the centre. Then it is placed in the rootstock & wrapped.

c) Chip-budding

Chip-budding does not use the protective bark flaps as T-budding does, but it also does not use slipping bark. The first step is to make a cut about 2-2.5 cm long with a depth of ¼ to 1/5 the diameter of the stock. With a horizontal cut made on the bottom, the cutting can be removed. The bud can also be cut off if necessary. The bud stick and stock must be the same diameter. The stock and scion must be placed together in such a way that allows the cambia of the bud and stock to match together as much as possible. Desiccation is a high risk when we use this method, therefore, the wound should be wrapped tightly with grafting tape.

d) Flap or forket budding:

A transverse incision is made in the bark of the rootstock & then the bark is peeled

off carefully to a length of 5 cm. The bud shield is removed from the scion is pushed under the flap till the exposed edges of rootstocks meet. Flap is then cut to half & is brought to cover the bud shield partially & is then warped. If entire flap of the rootstock stem is retained instead of cutting the flap into half, the method is then known as modified flap or forket method.

e) Ring budding :

The bud is prepared by taking a ring of bark 3cm in length with the bud in the center. In the rootstock, two circular cuts 1.5 cm apart are made & these are connected with the vertical cut & the ring of bark is removed. The prepared scion bud with the ring of bark is fitted in the exposed portion of the rootstock & tied as usual. This is commonly practiced in cinchona.

f) Flute budding

This is exactly same as ring budding, the difference being that the ringed bark can be removed easily in the firm of flute. Here the stock plant is topped off at 25 cm height and at the top about 2.5 to 3 cm of the bark is removed leaving the wood exposed. The bud in the form of a flute is then fitted in the rootstock. It is essential that the diameter of the rootstock and scion should exactly be same; otherwise the contact between them will not be proper.

C. Learning process and support materials:

The learning process includes the participation of student in Group work, Presentation, Demonstration methods, Skill development, Practical methods, Exhibition methods, observation methods, Creative thinking etc.

D. Assesment:

Very short (Answer question)

1. Define vegetative propagation.
2. Give suitable examples for vegetative propagated plants.
3. Lit out the types of cutting.
4. Write any two disadvantage of grafting.

Short (Answer question)

1. What is air layering?

2. What do you understand by grafting?

3. What are the types of cutting?

Long (Answer question)

1. What do you mean by vegetative propagation? Write down its merit and demerits

2. How will you produce new plant from seedless plant?

3. Explain about budding.

GLOSSARY:

Asexual propagation. It does not involves, the gamate from parent in which vegetative parts such as leaf, stem, or root are used, instead of seed.

Bud. A bud is undeveloped and elongated stems composed of a very short axis of meristem cells from which embryonic leaves, lateral buds, flower parts or all tree arises.

Budding. Type of grafting in which a scion is placed in the stock/ stock plant.

Graftage. It is a process of joining a part of plant with another in such a way that both will unite to work as a unit and unit will continue to grow.

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