PRACTICAL MANUAL

Course No. : HORT-111 **Credits : 2(1+1)**
Course Title : Fundamentals of Horticulture
Semester : I (New Course)

INDEX

Seen
8/12/17

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EXERCISE NO. 1
IDENTIFICATION OF GARDEN TOOLS

The garden tools which are used in the garden to carryout different horticultural operations are described below :

A) Tools used for soil operation :

For successful planting and proper growth of the garden plants soil has to be made porous and friable. Its surface is required to be leveled and at the same time it is to be laid out in particular form, such operations are done by the following tools.

1. Dibbler : It is used for making the holes in the soil for sowing bigger seeds, planting the seedlings and cuttings.

2. Digging fork : It is used for digging and turning the soils and manures, also used for digging small plants with their root ball.

3. Garden fork : Small hand fork for weeding and loosening the surface of soil of nursery beds.

4. Garden iron rake : It is useful in preparing fine soil of nursery beds and useful for levelling the surface.

5. Trenching Hoe or Japanise Hoe : Small strong instrument useful for light digging, preparing seed bed and planting.

6. Hand Cultivator : A small instrument useful for mulching the soil and removal of weeds.

7. Shovel : It is used for filling and turning the manures in the pits.

8. Ditch Hoe : It is used for mulching the soil and removal of weeds.

9. Crow Bar : It is used for digging of soil for planting seedling.

10. Spade or Phawada : It is used for preparing, collecting soil and making furrows and beds etc.

11. Pickaxe : It is used for heavy digging.

12. Kudli : It is used for light digging.

B) Tools used for propagation, training, pruning and cutting the branches :

Several operations are carried out while the plants are in growing condition in the garden. Propagation is a process of multiplication of any particular plant. Tender

plants are reared in the nursery. Growing plants have to be trained, pruned, transplant and thinned out.

1. **Bill hook :** It is used for chopping the small and medium sized branches, preparing and dividing the bulbs for planting.

2. **Hedge shear or Garden Shear :** It is used for clipping and training hedges and for purning of bushes.

3. **Grass shears :** It is used for trimming grass edge of the lawns.

4. **Tree Pruner :** It is used for pruning small and medium sized branches located at more height from ground.

5. **Budding knife :** It is used for budding fruits, and ornamental plants.

6. **Grafting knife :** It is used for grafting operations of fruits and ornamental plants.

7. **Lawn mower :** It is used for mowing the grass. There are 3 types of machines i.e. hand, bullock and power driven are used.

8. **Pruning saw :** It is used for pruning thick, woody branches of trees and shrubs.

9. **Secateur :** It is used for pruning, preparing cuttings for planting and pruning shoots and small branches of trees and shrubs. It is also used for training the bushes.

10. **Water can :**
It is used for watering the plants and seeds beds. A rose should be fitted to it while watering the seed bed.

11. **Transplanting trowel or Garden trowel :** It is used for lifting and planting small seedlings from the nursery beds alongwith soil ball.

12. **Chisel :** It is used for rejuvenation and renovation methods of horticultural crops.

13. **Sickle :** It is used for weeding.

14. **Froester's shear :** It is used for cutting the bigger branches of trees.

15. **Khurpi :** It is used for weeding and also to make the soil loose.

16. **Garden scrapper :** It is used to cut lawn grasses uniformly.

C) Tools used for plant protection :

1. Air compressed sprayer : It is used for spraying insecticides and pesticides for control of pests and diseases.

2. Ganesh sprayer : It is used for spraying the insecticides and pesticides on small scale area in nursery.

3. Duster : It is used for dusting the powder form of insecticides and pesticides e.g. Sulphur.

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EXERCISE NO. 2
IDENTIFICATION OF HORTICULTURAL CROPS (I)

Horticulture deals with Fruit Science, Vegetable Science, Medicinal and Aromatic Crops, Floriculture and Landscape gardening, Spices and Condiments. The list of horticultural crops is given for identification.

I)Fruit crops

S.N.	Botanical Name	Common Name	Family
1.	*Ficus carica*	Fig	Moraceae
2.	*Zizyphus mauritina*	Ber	Rhamanceae
3.	*Punice granatum*	Pomegranate	Punicaceae
4.	*Psidium guajava L.*	Guava	Myrtaceae
5.	*Anona squamosa*	Custard apple	Annonaceae
6.	*Citrus sinensis*	Sweet orange	Rutaceae
7.	*Citrus reticulata*	Mandarin orange	Rutaceae
8.	*Citrus aurentifolia*	Kagzi lime	Rutaceae
9.	*Mangifera indica*	Mango	Anacardiaceae
10.	*Carica papaya*	Papaya	Caricacae
11.	*Achras sapota*	Chiku	Sapotaceae
12.	*Emblica officinatis*	Aonla	Euphorbiaceae
13.	*Tamarindus indica*	Tamarind	Leguminesae
14.	*Eugenia jambulana*	Jambul	Myrtaceae

II) Vegetable Crops

S.N.	Botanical Name	Common Name	Family
1.	*Allium cepa*	Onion	Liliaceae
2.	*Allium sativum*	Garlic	Liliaceae
3.	*Beta vulgaris*	Indian spinach	Chenopodiceae
4.	*Brassica olerecea (Var. capitata)*	Cabbage	Crucifereceae
5.	*Brassica oleracea (var. botrytic)*	Cauliflower	Crucifereceae
6.	*Raphanus sativus*	Radish	Crucifereceae
7.	*Cucurbita moschata*	Pumpkin	Cucurbitaceae
8.	*Cucumis sativus*	Cucumber	Cucurbitaceae
9.	*Luffa acutangula*	Ridge gourd	Cucucbitaceae
10.	*Luffa cylindrical*	Sponge gourd	Cucurbitaceae
11.	*Memordica charantia*	Bitter gourd	Cucurbitaceae
12.	*Legenaria siceraria*	Bottle gourd	Cucurbitaceae
13.	*Pisum sativum*	Pea	Leguminaceae
14.	*Dolichas lablab*	Common bean	Leguminaceae
15.	*Vigna sinensis*	Cowpea	Leguminaceae

16.	*Trigonollus foinumgracum*	Methi	Leguminaceae
17.	*Abelmoschus esculentus*	Bhendi	Malvaceae
18.	*Solanum tuberosum*	Potato	Solanaceae
19.	*Solanum melongena*	Brinjal	Solanaceae
20.	*Lycopersicum esculantum*	Tomato	Solanaceae
21.	*Deucus carota*	Carrot	Umbelliferaceae
22.	*Cyamopsis tetragonaloba*	Cluster bean	Leguminaceae

III) Medicinal Plants

Sr. No.	Name of the Medicinal Plant	Botanical Name	Family
1.	Adulsa	*Adhatoda vasica* Nees	Acanthaceae
2.	Kaju	*Anacardium occidentale* Linn.	Anacardiaceae
3.	Bibba	*Semicarpus anacardium* Linn.	Anacardiaceae
4.	Mango	*Mangifera indica* Linn.	Anacardiaceae
5.	Karvand	*Carissa carandas* Linn.	Apocynaceae
6.	Sarpagandha	*Rauwolfia serpentina* Benth	Apocynaceae
7.	Sadaphuli	*Vinca rosea* Linn.	Apocynaceae
8.	Kunda	*Holarrhena antidysenterica* Wall.	Apocynaceae
9.	Vacha / Vekhand	*Acorus calamus* Linn.	Araceae
10.	Kavali	*Gymnema sylvestre* R. Bv.	Asclepiadaceae
11.	Shavar	*Ceiba pentandra* Linn.	Asclepiadaceae
12.	Guggul	*Comiphora mukul* Engl.	Burseraceae
13.	Apta	*Bauhinia purpurea* Linn.	Caesalpiniaceae
14.	Senna	*Cassia angustifolia* Vahl.	Caesalpiniaceae
15.	Malkangani (Jyotishamati)	*Celestrus paniculatus* Wild.	Celastraceae
16.	Hirda	*Terminalia chebula* Retz.	Combretaceae
17.	Arjun Sadada	*Terminalia arjuna* Wight and Avn.	Combretaceae
18.	Ain	*Terminalia tomentosa* Wight & Wvn.	Combretaceae
19.	Kinjal	*Terminalia paniculata* Roth.	Combretaceae
20.	Beheda	*Terminalla balerica* Roxb.	Combretaceae
21.	Nagarmotha / Lavala	*Cyperus rotundus* Linn.	Cyperaceae
22.	Indian yam (Kadukaranda)	*Dioscorea floribunbda* Mart & Gel.	Dioscoreaceae
23.	Amla	*Emblica officinalis* Gearth	Euphorbiazceae
24.	Khair	*Acacia catechu* Wild.	Leguminosae
25.	Bahawa	*Cassia fistula* Linn.	Leguminosae
26.	Shatavari	*Asparagus racemosus* Wild.	Liliaceae
27.	Korphad	*Aloe barbadensis* Mill.	Liliaceae
28.	Kadevi / Kallavi	*Glorisosa superba* Linn.	Liliaceae
29.	Jasvand	*Hibiscus rozasinesis* Linn.	Malvaceae

30.	Atibala	*Abutilon indicum* Mill.	Malvaceae
31.	Gulvel	*Menispermum cordifolium* Wild	Menispermaceae
32.	Jambhul	*Syzygium cuminii* Linn.	Myrtaceae
33.	Nilgiri	*Eucalyptus citriodora* Hook.	Myrtaceae
34.	Pangara	*Erythrina suberosa* Roxb.	Papilionaceae
35.	Karanj	*Pongamia globra* Vent.	Papilionaceae
36.	Gunja	*Abrus precatorius* Linn.	Papilionaceae
37.	Psyllium (Isabgol)	*Plantago ovata* Forsk.	Papilionaceae
38.	Chitrak	*Plumbago zeylanica* Linn.	Plumbaginaceae
39.	Dhotra	*Datura metel* Linn.	Solanaceae
40.	Ranwangi	*Solanum viarum* Clarke	Solanaceae
41.	Ashwagandha	*Withania somnifera* Dunal.	Solanaceae
42.	Halad	*Curcuma longa* Linn.	Zingiberaceae.

IV) Aromatic plants

Sr. No.	Name of Aromatic Plant Species	Botanical name	Family
1.	Bakul	*Minusops elengi* Linn.	Sapotaceae
2	Chandan	*Santalum album* Linn.	Santalaceae
3	Nilgiri	*Eucalyptus citriodora* hook	Myrtaceae
4	Sabja	*Ocimum basilicum* Linn.	Labiatae
5	Tulas (black)	*Ocimum sanctum* Linn.	Labiatae
6	Surangi	*Calophyllum inophyllum* Linn.	Guttiferae
7	Pyrethrum	Chrysanthemum cinerariaefolim	Compositae
8	Geranium	*Pelargonium graveolens* L. Herit	Geraniaceae
9	Palmarosa / Rosha grass	*Cymbopogon martini* Wats.	Gramineae
10	Vetiver (Wala)	*Vetiveria zizaniodes* Linn.	Gramineae
11	Patchouli	*Pogostemon cablin* Benth	Labiatae
12	Night queen (Ratrani)	*Cestrum noctrumum*	Solanaceae
13	Mentha (Pudina)	*Mentha arvensis* Linn.	Labiatae
14	Lemon grass	*Cymbopogon flexuosus* Wats	Gramineae
15	Lawang (Clove)	*Eugenia caryophyllata* Thumb	Myrtaceae
16	Kali miri (black pepper)	*Piper nigrum* Linn.	Piperaceae
17	Dalchini	*Cinnamomum zeylanicum* Breyn	
18	Red sandle wood	Santalum rubrum	

V) Spices

S.N.	Botanical Name	Common Name	Family
1.	*Piper spp.* *i) Piper batel* *ii) Piper nigrum Linn.*	Black pepper	Piperaceae
2.	*Eugenia caryophyllata*	Clove (Lavang)	Myrtaceae
3.	*Cinnamomum verum*	Cinnamon	Lavaraceae
4.	*Zingiber officinalis*	Ginger (Adrak)	Zinziberaceae
5.	*Curcuma longa Linn.*	Turmeric (Halad)	Zinziberaceae

VI) Condiments

S.N.	Botanical Name	Common Name	Family
1.	*Coriandrum sativum*	Coriander	Umbeliferae

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VII) PLANTATION CROPS

S.N.	Common name	Botanical name	Family	Propagation	Harvesting	Varieties
1.	**Cashewnut**	*Anacardium occidentale*	Anacardiaceae	Softwood grafting	Mar.-Apr.	Vengurla No. 1 to 8, Vengurla 37-3
2.	**Coconut**	*Coccus nucifera*	Palmaceae	Nuts	Mar. Aug. Dec.	West coast tall, Laccadive dwarf T x D, Banavali 8-10 years require for fruiting.
3.	**Arecanut (Supari)**	*Areca catechu*	Palmaceae	Nuts	Oct.-Apr.	Mangala, Shrivardhani, and Phadia.
4.	**Markingnut**					
5.	**Tea**	*Camellia sinensis*	Theaceae	Seeds	December onwards throughout the year	China, Assam Pangara, Silver oak is planted and shade trees.
6.	**Coffee**	*Coffea arabica*	Rubiaceae	Seeds	When berries turn red	Olc chiks, Kents, S-288, 795 and 1934.
7.	**Cocoa**	*Theobroma cacao*	Sterculiaceae	Seeds	Sept. Jan. Apr. June	Forestera, Corioua.
8.	**Rubber**	*Hevea brasilensis*	Euphorbiaceae	Cuttings and gotie	-	Local
9.	**Beetle vine**	*Piper bettle*	Piperaceae	Cuttings	Harvested four times in a year	Local, Nagabatti, Kanigale, Devasan
10.	**Kokum (Amsul)**	*Garcinia indica*		Seed / Epicotal grafting	May-June	Local.

EXERCISE NO. 3
IDENTIFICATION OF HORTICULTURAL CROPS (II)

I) Study of some flowering Ornamental Annuals

S.N.	Botanical Name	Common Name	Colour of flower	Flowering season
1.	*Agaratum houstamanum*	Floks flower	Blue white	Rainy
2.	*Althaea rosea*	Holly hock	Various colours	Rainy and Winter
3.	*Antirrhinum majus*	Snap drogon	-do-	Winter
4.	*Amaranthus tricolor*	Amaranthis	Crimson gold and green	Winter
5.	*Callistephus chinensis*	Aster	White, Pink	Rainy and winter
6.	*Celosia cristata argenteo*	Cocks comb	Pink, yellow red and white	Rainy, winter and summer
7.	*Calliopsis sp.*	Ceriopsis	Various colours	All year round
8.	*Centaurea moschata*	Sweet sultan	Various colours	Winter
9.	*Chrysanthemum spp.*	Chrysanthemum (Sheventi)	White, Yellow	Winter
10.	*Cosmos bipinnaatus*	Cosmos	White, pink, yellow	Winter
11.	*Dianthus chinensis*	Pink flower	Red, white pink	Rainy and winter
12.	*Gaillardia pulchella*	Blanket flower	Yellow crimson	Rainy and winter
13.	*Gomphrena globosa*	Bachelors button	Pink purple white	Winter
14.	*Helianthus annus*	Sunflower	Golden yellow	Winter & summer
15.	*Impatiens balsamina*	Balsam	Various colours	Rainy
16.	*Iberis amara*	Candy tuft	White crimson	Winter
17.	*Delphinium sp.*	Darkspure	Various colours	Winter
18.	*Petunia hybrids*	Petunia	White, red, blue, pink	Rainy & winter
19.	*Phlox drumondil*	Phlox	Red, white, pink	Rainy & winter
20.	*Pimpinella manorica*	Ladies less	Pink	Rainy &

				winter
21.	*Salvia splendens*	Scarletsaug Salvia	Scarlet blue, purple pink	Rainy & winter
22.	*Tagetes sp.*	Merigold	Bright yellow, lemon yellow	Rainy
23.	*Zinnia elegans*	Zinnia	White, red yellow	All year round
24.	*Dianthus caryophyllus*	Carnation	Pink, white	Rainy and winter

II) Study of some Flowering Shrubs

Sr. No.	Botanical name	Common name	Method of propagation	Colour of flower
1.	*Artabotrys odoratissimus*	Green chafa	Seed and layers	Green and turning yellow
2.	*Coesalpinia pulcherima*	Peacock	Seed cutting	Yellow orange
3.	*Cestrum noctunum*	Night Queen	Cutting	Greenish white
4.	Cestrum diurnum	Day King	Cutting	White
5.	*Dombia angulata*	Ittan dona	Cutting	Rose pink
6.	*Gardinia grandiflora*	Dikemali	Cutting and layer	Crimy white
7.	*Hemelia patens*	Rat poison tree	Cutting	Red orange
8.	*Hibiscus rosa sinensis*	Jaswand	Cutting	Rose and bright red.
9.	*Ixora arborea*	Wile jasmin	Cutting and layer	Bright red
10.	*i) Jasminum sambac* *ii) Jasminum multiflorum*	Mogra Mogra	Cutting Cutting	Milky white White
11.	*Lajerstromia indica* *Lawsonia inermis*	Gul mehendi Mehendi	Cutting & seed Root cutting	Blue white pink White flowers
12.	*Euphorbia splendens*	Crown phorns	Cutting	Scarlet
13.	*Lantana camara*	Sweet sorch	Cutting and seed	White, red yellow
14.	*Russalia juncea*	Weeping merry	Cutting	Scarlet, bright red
15.	*Murraya paniculata*	Chinabox	Cutting and seed	White
16.	*Thumbergia erracta*	-	Cutting	Mauve
17.	*Nerium oleander*	Nerium	Cutting	Red, pink, white
18.	*Euphorbia Pulcherima* *Poinsettia Pulcherima*	Dudhi	Cutting	Scarlet

19.	*Nyctanthus*	Parijatak	Seed and cutting	Purely white with orange red sting
20.	*Tabernoemontana caronaria*	Tagar	Cutting	Milk white
21.	*Theveta nerifolia*	Yellow nerium	Cutting	Yellow
22.	*Tecoma stans*	Yellow olender	Cutting and seed	Yellow
23.	*Punica granatum*	Pomogranate	Cutting and layer	White scarlet red
24.	*Jatropha sp.*	Jatropha	Cutting	Scarlet flower

III) Study of Ornamental Foliage Shrubs

S.N.	Botanical name	Method of propagation	Foliage colour
1.	*Achalypha sp.*	Cutting	Radish
2.	*Aralia sp.*	Cutting and layers	Radish white
3.	*Codiacum sp. (Croton)*	Cutting	Various colours
4.	*Eranthemum sp.*	Cutting	-do-
5.	*Iresin sp.*	Cutting	-do-
6.	*Panax sp.*	Cutting	Various colours and shape
7.	*Dracaena sp.*	Suckers	Various colours
8.	*Pendanus sp. (Kewada)*	Suckers	Whitish
9.	*Maranta sp.*	Cutting (corm)	Greenish
10.	*Phyllanthus rosea*	Cutting and suckers	White pink, rosy purple colour

IV) Study of Flowering Trees

S.N.	Botanical name	Common name	Colour of flower
1.	*Bauhinia purpurea*	Kanchan	Purple
2.	*Bauhinia verigata*	Kanchan	White
3.	*Bombax malabaricum*	Red cotton tree	Bright red
4.	*Butea monosperma*	Flame of the forest	Orange
5.	*Calistemon lanceoletus*	Bottle brush tree	Bright crimson
6.	*Culvillen recemosa*	Calvillea	Orange red
7.	*Erythrina veregata*	Pangara	Red
8.	*Jacaranda acutifolia*	Blue gold mohar	Blue
9.	*Kigelia pinnata*	Saucer tree	Purple tabular
10.	*Lagerstromea speciosa*	Price of India	Mauve
11.	*Michelia champaka*	Champaka	Crimy yellow
12.	*Millingtonia hortenisis*	Indian cork tree	White
13.	*Peltophorum pterocarpum*	Copper pod tree	Yellow

14.	*Plumeria acumineta*	Temple tree (Chapha)	White with yellow shade
15.	*Delinox regia*	Sword Gulmohor or Red Gulmohor	Orange and Scarlet
16.	*Spathodiea campanulata*	Fountain tree	Orange red
17.	*Tabania spetabillis*	Tabenia	Yellow
18.	*Anthocephylus cadamba*	Kadamba	Crimson yellow

V) Study of Shade Trees

S.N.	Botanical name	Common Name
1.	*Acacia arabica*	Babhul
2.	*Albezia lebbat*	Sirish
3.	*Azadzichate indica*	Neem
4.	*Eugenia jambulana*	Jambhul
5.	*Ficus bengalensis*	Banyan tree
6.	*Ficus relegiosa*	Pipal tree
7.	*Dalbargia sisoo*	Shisum
8.	*Mangifera indica*	Mango
9.	*Pongamia glabra*	Karanj
10.	*Tamarindus indica*	Tamarind
11.	*Termonalia catappa*	Jangli badam
12.	*Samania saman*	Rain tree

VI) Study of Ornamental trees

S.N.	**Botanical name**	**Common Name**
1.	*Casurina equisettifolia*	Casurina
2.	*Eucalyptus citriodora*	Nilgiri
3.	*Gravillea robusta*	Silver oak
4.	*Polyathia longifolia*	Ashok
5.	*Polyalthia longifolia (Var. Pendula)*	Drooping Ashok
6.	*Putrangiva roxburghi*	Putrangiva
7.	*Parkia biglandulosa*	Tappu
8.	*Mimusops elengi*	Bakul
9.	*Thuja campacta*	Thuja

VII) Study of some important Climbers and Creepers

S.N.	**Botanical Name**	**Common name**	**Method of propagation**	**Colour of flower**
1.	*Allamanda grandiflora*	Allamanda	Layers and Gootee	Yellow
2.	*Antigonon leptopus*	Coral creeper	Cutting, bulbil root	Pink

13.	Plants suitable for growing in shade	Orchid, Coleus, Fern
14.	Plants suitable for pergola	Rangoon creeper, Railway creeper
15.	Plants suitable for along road	Azadirchata indica
16.	Plants suitable for conservatory	Fern, Orchid, coleus
17.	Plants suitable for avenue trees	Polyaltheia longifolia, Karanj, Bahunia.
18.	Plants suitable for shade trees	Mango, Tamarind, Ficus religiosa.
19.	Trees with ornamental foliage	Casuriana equisetifolia, Polyaltheia longifolia.
20.	Trees with scented flowers	Mimusops elengi, Michelia champaka
21.	Trees with yellow flowers	*Peltophorum pterocarpum*, Cassia siamea
22.	Trees with red flowers	*Delonix regia*, Butea monosperma
23.	Trees with white flowers	Millingtonia hortensis Bahunia, Gardenia gradiflora.
24.	Trees with blue flowers	Jacaranda mimosafoleia, Glyrcidia maculata
25.	Trees with pink flowers	Cassia nodosa, Cassiarenigera
26.	Shrub with ornamental foliage	Croton, Acalypha Eranthemum
27.	Shrub with scented flowers	Rose, Jasminum semback, nyctanthus arbortristis
28.	Shrub with white flowers	Tabernaemontana coronaria, Jasminum samback, Rose
29.	Shrub with red flowers	Russelia junceia, Ixora, Hibiscus rosa-sinensis
30.	Shrub with yellow flowers	Nerium, Tecoma stands, rose
31.	Shrub with blue Flowers	Barleria cristata, Duranta
32.	Shrub with pink flowers	Lagerstroemia indica, Nerium, Rose
33.	Shrub with orange flowers	Hameloa patens, Hibiscus rose
34.	Climbers with scented flowers	Jasminum officinale climbing
35.	Climbers with white flowers	Bouganvellia climbing rose
36.	Climbers with red flowers	Clerodendron splendens, Rangoon creeper
37.	Climbers with yellow flowers	Allamanda crandiflora, Bouganvellia
38.	Climbers with pink flowers	Antigonon leptopus
39.	Climbers with orange flowers	Bigoonia venusta, Campsis grandiflora.
40.	Climbers with blue flowers	Clitorea ternatea, Railway creeper
41.	Climbers with ornamental foliage	Pothas, asparagus
42.	Tub plants	Palm, Agave, Cactus
43.	Bulbous plants with flowers	Dahlia, canna, Tuberose, Gladioli, Spider Lilly
44.	Bulbous plants with ornamental foliage	Alccacia, Maranta, Caladium.

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EXERCISE NO. 4
PREPARATION OF SEED BED / NURSERY BEDS

Nursery is a place, where seedlings grafts, saplings or any other planting materials are raised and sold for planting in garden and orchard.

OR

Nursery is a place, where seedlings, saplings or other planting material, is propagated, cared and rated till its planting or sale.

Nursery plants are foundation of future orchard structure and it is the primary factor which determines the success or failure of the orchard. The main aim of nursery is production of healthy, strong, stout, pest and disease-free planting material to cater the need of farmers in that locality.

Factors to be considered for Nursery site :

Different factors such as (1) Topography (2) Climate (3) Locality for nursery business (4) Soil (5) Transport facilities (6) Irrigation facilities (7) Labour facilities and (8) Market facilities should be considered before establishment of nursery.

Advantages of Raising seedlings on nursery beds :

1. It is easy and convenient to look after the young tender seedlings grown in a small and compact area.
2. They can be timely protected against insects, pest and diseases.
3. The favourable conditions for growth of seedlings can be easily provided in the nursery.
4. Economy of land and more time is available for preparation of main field where transplanting is to be done.
5. Unfavourable conditions can be eliminated.
6. Economy is valuable and expensive seasonal flower seeds.

Factors / Units of Nursery :

A well established nursery should have following units or features :
(1) Seed bed (2) Nursery bed (3) Pot yard (4) Packing yard and store (5) Working shed and office (6) Progeny tree block (7) Rootstock trees (8) Established orchard (9) Green house (10) Net house (11) Mist propagation chamber (12) Compost pit.

Preparation of Seed bed and Nursery bed (Raised bed) :-

Initially nursery plants are raised on a seed bed. In this seed bed plants are raised from seed where maximum care is taken from the germination of seed to seedling stage. The beds are raised from the soil surface to provide effective drainage.

Later on these seedlings are planted in a nursery bed, where wider spacing is provided to the seedlings for budding or grafting purposes. Nursery beds are more extensive than seed bed but should also be well exposed and close to an irrigation source. Separate sections of nursery are allotted to the plants of each fruit variety or kind. Another section of nursery may be allotted for rooting of cutting, as well as

layering. Some section of nursery beds are allotted for raising of rootstocks like mango, citrus etc.

Open textured, well drained and fertile soil is required for preparation of nursery beds. Plants in the nursery are retained for longer time and thus soil get exhausted, so annual or frequent manuring is essential to maintain fertility of soil. Proper drainage system must be provided because young seedlings are sensitive to water logging condition. Nursery beds may be little raised during rainy season to avoid the stagnation of water.

Seed germinate is best in loose soil with open texture. In order to secure good germination seeds are specially raised in nurseries. The site selected for nursery should possess a fine and well drained soil. FYM or leaf mould is added to the soil to prepare nursery bed.

The nursery bed should be prepared by repeated ploughing and pulverising the soil to obtain a fine tilth. The nursery bed is raised 15 – 20 cm above ground level. Each bed is made 2 to 3 meters long and 1 meter wide. The surface is made smooth. The bed should have sub-channels on both sides for irrigation.

Raising of seedlings :-

The seeds are sown in well manured nursery bed in rows 10 to 15 cm apart. The depth of seed may vary from seed to seed or size to size of seed. After the seeds are deposited in the soil they are covered with a layer of sand or soil about ½ cm thick. The first irrigation after sowing is usually applied by sprinkling gently with water can. The next few irrigation are applied in a manner so that the raised bed is moistened through seepage. In summer seed beds are protected from Sun by shading them partially with bamboo screen or net. Over crowding of seedlings may be avoided.

Transplanting of seedlings :-

The seedlings of uniform vigour growth and height should be selected for transplanting. Dwarf and exceptionally vigorous seedlings and those with badly crooked roots are removed. This would ensure the uniformity of the stock and production of healthy and vigorous plants.

Before lifting the seedlings the nursery bed is copiously watered. The seedlings are lifted with entire roots with the help of small hand fork or digging fork.

Preparation of nursery beds

Material required : Spade , Measuring tape , rope, sticks, garden rake, sickle, .
Objective : to prepare nursery bed for raising seedling of cabbage
Types of nursery beds
There are four types of nursery bed
(i) Flat nursery bed
(i) Raised nursery bed
(iii) Sunken nursery bed
(iv)Ridge bed

(i) Flat nursery bed It is prepared (a) During spring-summer when there is no fear of rain.(b) In the area where the soil is light sandy to sandy loam where there is no

problem of water stagnation. The area proposed for nursery is well-prepared till the pulverization of land and well rotten FYM at the rate of 10 kg per sq. meter is well mixed in the soil. The field is divided into small size plots. Ridges are prepared around each bed which facilitate the cultural practices. In between two rows of beds, central irrigation channel is prepared through which each bed is connected. This is very simple and easy to practice.

Vegetables such a beet leaf, coriander, fenugreek, spinach, parsley, etc and root vegetables like carrot, radish, turnip, beetroot, etc are sown by broadcasting or line sowing. Peas, beans and okra are sown in lines as facilitates ease in intercultural operations and harvesting.

(ii) Raised Seedbed: These beds are prepared for raising cucurbitaceous crops like bitter gourd, bottle gourd, round gourd, smooth gourd, wax gourd, pumpkin, watermelon and snap melon during rainy season where stagnation of water becomes problematic, Beds of required size depending on crop to be grown are raised 15-25 cm high from the ground level with furrows of 30-45 cm width on either side for irrigation. The objective using such raised beds in rainy season is to provide protection to the fruits against rotting

(iii) Sunken beds :are prepared 10 to cm downwards from the soil surface and used for the production of beet leaf, radish and turnip in Leh and Ladakh area during winter season. The main objective of using these beds is to provide protection against cold desiccating winds. The seedlings are not hit by the cool breeze of the air. The crops like brinjal, cabbage, Malabar spinach, Basella alba and ridge gourd when planted adjacent to rice in raised or sunken bed the highest rice equivalent yield was achieved with rice cabbage- Malabar spinach (Kannan *et al*.. 2003)

(iv) Ridge Seedbed: The ridges are made with the help of spade at a suitable distance depending upon the crop, and sowing /planting is done on ridges, which avoid the risk of water stagnation during rainy season, The furrows should be sloppy so that water from the standing crop may drain out completely. Irrigation channels are formed across the furrow at convenient length. The crops like carrot, turnip, radish, potato, potato, tomato, brinjal, peppers, early cauliflower, beet leaf, arum, okra, yams, etc. are planted on ridges.

Methods of Direct Sowing :

Broadcasting: When the number of plants per unit area is more important than the definite spacing between plants, the seeds are sown by broadcasting method. It is referred to scattering or spreading of seeds in the main field by hand or by mechanized spreaders. It is cheap and simple method of sowing. It is followed under irrigated areas where land is limited. Seed rate is very high but sowing is easier and area coverage is also quicker.

Sowing behind country plough: The seeds are dropped in furrow opened during ploughing, and subsequently, covered while the next adjoining furrow is formed. In

method, the sowing should be done at appropriate soil moisture so that the depth of sowing develops uniformly.

Dibbling: In this method, the seeds or are placed in furrows, pits, or hole at predetermined spacing with dibblers, planters, or by hand. suitable fo spacing with dibblers, planters, or by hand. It is cultural at geometric area for the development of plant cano establishment require specific less and stand operations in the standing crop. rate is uniform and adequate. It is time consuming and expensive

Drilling : Seeds are put in a hole and covered with the help of seed drills or ferti-seed drills. It gives rapid and uniform germination. Requirement of seeds is less than the seeds required in broadcasting. Sowing can be completed can be carried out waiting for the subsequent rains, Cultural operations ease. It is well suited for intercropping.

Soil treatment : Soil contains several microorganisms which causes various diseases in vegetable crops. Soil treatment therefore is essential to protect vegetable crops from different diseases.

Heat treatment : The soil is exposed to very high temperature (82 0C for 30 minutes) either through stem or by using electricity or by burning dry plant material to kill all possible organisms like bacteria, fungi, nematodes, insects and weed seeds. Melander and Jorgensen (2005) observed that steaming the soil prior to crop establishment could be very effective method of preven ling weed seedling emergence on raitcd vegetable crops.

Fumigation: Formaldehyde is a good fungicide and is used for fumigating the soil effectively. It is water soluble and applied to the soil surface by sprinkling. About 250 ml formaldehyde is dissolved in 10 liters of water, which is enough to disinfect one meter area of nursery up to a depth of 15 cm. Soon after giving treatment, the soil is covered with polythene sheet of 200-300 gauge since covering allow the fumes to penetrate into the soil for killing the microorganisms and weed seeds. After 72 hr, the polythene is removed and raking of the soil is done until the fumes of formaline come out. The soil is left exposed for 2 weeks to remove the smell and effect of formaline.

Drenching: It refers to wetting of soil particles with chemicals like Thiram, Captan, Captafol, Caftaf, or Bavistin until full saturation to inhibit the growth of soil born fungi. Soil treatment may be done one or two days before sowing

Solarization: It is very effective and cheap method to make the nursery soil free from pathogens. This practice is very common in areas where temperature is not less than 35-40 0C and full sun is available along with dry weather. The soil temperature is raised by using polythene mulch, which does not allow long wave radiations to escape. Seedbeds are lightly irrigated before covering with polythene sheet of 200-300 mm gauge.

Summer ploughing: Repeated deep ploughing is done during hot summer months which causes killing of pathogens due to high temperature, and simultaneously, insects

are exposed to predators. The chemicals / fungicides used for treating the seed or soil are toxic to both man and animals therefore it is advised to take following precautious during seed /soil treatments and handling of treated seeds.

Read and follow the directions regarding application rates.

- Treat only those seeds that are ready for sowing.
- Seeds having low moisture content should only be treated.
- Avoid exposure of skin to chemicals and do not breathe fungicides during treatments.
- Avoid mixing of treated and untreated seeds.
- Do not feed treated seeds to livestock.

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EXERICE NO. 5
PRACTICE OF SEXUAL METHODS OF PROPAGATION

Sexual Propagation :

Multiplication of plants by using **seed** is called as **Sexual Propagation**.

Advantages :

1. The plants raised by seeds are longer lived.
2. They are hardy with deep root system. So they are vigorous in growth.
3. The possibilities are there to obtain change in seedling, the performance of which are better than their parents e.g. Mango variety like *Alphaanso, Dashehari*.
4. The polyembryony : The phenomenon of production of more than one seedling from a single seed, produces true to type, nucellar embryonic seedlings which could be used as rootstock for uniform performance, e.g. Mango var. *Olour* and *Bappakai*. It is also common in citrus and Jamun.
5. Seed propagation is necessary when vegetative propagation is unsuccessful or expensive e.g. papaya, coconut and arecanut.
6. Exploitation of hybrid, vigour is possible only when the hybrids are multiplied in the first instance through sexual propagation although subsequent fixing of heterosis is effected through vegetative propagation e.g. Sapota (Cricket Ball x oval) and Ratna Mango (Alphanso x Neelum).
7. Root stocks are usually raised by seed e.g. Rangpur lime and Jamberi for citrus.
8. When seedlings are required in large number, seed propagation is the only easy mean e.g. Dry land fruits, and *Forest* spp.

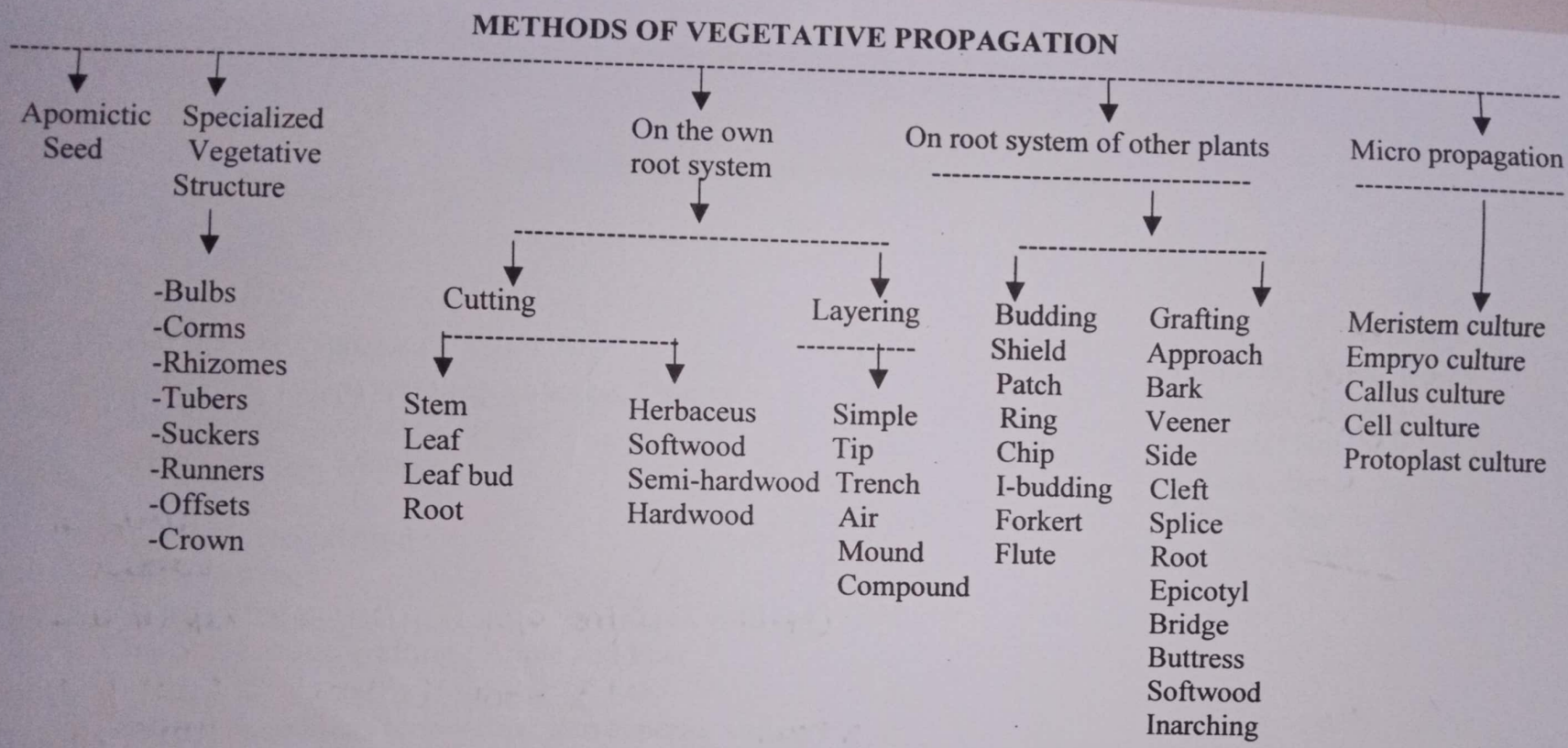
Disadvantages :

1. The progenies are not true to type and so they become inferior because in the commercial orchards, it is necessary to have uniform quality, growth and yielding capacities.
2. Choice tree or any hybrid trees cannot be perpetuated true to type by seed (except in Apomixis).
3. Seedlings have a long juvenile period. In crops like citrus, cocca and rubber the seeds must be sown afresh i.e. immediately after extraction. Many varieties are seedless.
4. Seeds loose its viability in short period.

Pre-germination Seed Treatments :

1. Chemical (Acid scarification) :

The purpose is to modify hard or impermeable seed covering generally soaking seed in concentrated Sulphuric acid is an effective method. The time of treatment may vary from 10 minutes to 6 hours according to species. After treatment seeds are thoroughly washed in clean water to make them free of acid and then are sown



Separate origin (on the roots of other plants)

Grafting

1. Scion attached method :
a. Inarching or simple approach : Mango, Chikoo
b. Tongue grafting : Mango, Grape
c. Saddle Grafting : Mango

2. Scion detached method :
a. Saddle grafting
b. Wedge grafting
c. Whip and Tongue grafting : Apple and Pear

3. Renovation methods (converting into superior variety)
a. Top working
b. Side grafting
c. Crown grafting

4. Rejuvenation or repairy methods :
a. Bridge grafting : Aerial portion
b. Buttress grafting : Root portion

Budding

1. Shield : Citrus, Roses
2. Forkert : Mango
3. Patch : Nut, Mango
4. Ring : Ber
5. Flute : Ber
6. Chip : Grape

8) Plant the cutting in slantwise direction, either in pot or in bed in such a way that 1/3rd length of the cuttings will be in the soil.
9) Water the pot or bed immediately.

Observations :

S.N.	Name of the cutting	Date of planting	Date of rooting	Date of sprouting of buds	Time required for rooting
1.	Grape				
2.	Pomegranate				
3.	Fig				
4.	Bouganvillea				
5.	Rose				
6.	Jasmine				
7.	Duranta				
8.	Hibiscus				

ii. Semi hard wood cutting :

Semi hard wood cutting is a portion of a growing branch including a woody portion which is immature or partly mature as is evident from the presence of discontinuous brownish streeks on stem.

Procedure :

1. Select healthy vigorous growing shoot which is in active state of growth from the terminal portion of the branch
2. Cover it from the mother plant and prepare the cuttings of 15 cms length.
3. The lower cut on the cuttings is made close to the node.
4. Retain few top most leaves.
5. If the leaves are bigger cut them half to check the transpiration.
6. Remove the lower leaves.
7. Plant the cuttings either in pots or in bed in upright position keeping at least 2/3rd of the portion in the soil.
8. Water the bed or pot immediately.

Observation :

	Name of the cuttings	Date of planting	Date of rooting	Time required for rooting
1.	Croton			
2.	Arelia			
3.	Acalypha			

iii. Soft wood or Herbaceous cuttings :

Soft wood cutting are is usually soft tender and succulent and are made mostly from green house plants that are herbaceous in nature.

Procedure :

1. Select a healthy and vigorous growing mother plant.
2. Cut the tender soft terminal shoot.
3. Remove the leaves from the base portion which is to be burried in the soil.
4. Plant the cutting in parali after making a cavity. Do not thrust the cuttings in the soil, press the sides firmly.
5. Water the pot.

Observations :

Sr.No.	Name of the cuttings	Date of planting	Date of rooting	Time required for rooting
1.	Coleus			
2.	Pilea			
3.	Portulaca			
4.	Geranium			
5.	Begonia			
6.	Alternenthera			
7.	Tradiscantia			

3. Preparation and planting of Leaf cuttings:

Leaf cutting consists of entire leaf or pieces of leaves and closely related parts which are used to propagate many common green hose plants.

1. Marginal buds 2. Use of petiole 3. Use of mid rib.

Procedure :

***Bryophyallum*: (Use of marginal buds)**

1. Select just mature leaf.
2. Avoid young or older leaves as younger leaves will spend energy for making their own growth, where as older ones are devoid or energy.
3. Keep a small stone to avoid dislodging.
4. Cover only the margins of the leaf with the soil.
5. Keep the central portion of the leaf exposed.
6. One plant arise at each notch in the margin of the leaf.

***Pepromia* (Use of petiole):**

1. Select just mature leaf.
2. Cut the petiole to about 1 – 2 cms length.
3. Insert the petiole in the soil keeping the blade exposed.
4. Roots will appear on the petiole.

***Begonia rex* : (Use of mid rib)**

1. Select just mature leaf.
2. Give the cuts with bail or knife at the junction of the main veins.
3. Plant the entire leaf in the soil so that the notched portion will be in contact with soil.

Observations :

Sr.No.	Name of the cuttings	Date of planting	Date of rooting	Time required for rooting
1.	Begonia			
2.	Bryophyllum			
3.	Perpomia			
4.	Snake plant			

B) LAYERING

Layering is defined as the mode of propagation in which a portion of the parent plant is induced to produce roots while still attached to the parent plant.

The different methods of layering are as follows.

1. Tip layering
2. Simple or tongue layer
3. Continuous layering
4. Compound layering
5. Mound layering
6. Air layering of gooty

i) Tongue layering :

Procedure :

1. Select a well mature pencil thick branch of the previous seasons growth that can be easily bend to the ground.
2. Remove all the leaves on the basal portion of the branch where it is to be operated.
3. Make a slit of 2-3 cms length going leaf way through the thickness of the branch toward the tip on the lower side of the branch just below the node.
4. Insert a small piece of stick in the slit to keep apart the two splited portions.
5. Fill the parali in the normal fashion.
6. Prepare a notch in the rim of the para to fit the branch.
7. Burry the portion of the branch operated in the soil.
8. Keep a stone just above the burred portion to avoid dislodging.
9. Water the layer regularly.
10. Normal season of layering is monsoon but can be followed at any time when weather conditions are favour able and plant is in a vigorous growing condition.

Observations :

Sr.No.	Name of the cuttings	Date of planting	Date of rooting	Time required for rooting
1.	Guava			
2.	Jasmine			
3.	Nerium			
4.	Chiku			

ii) Air layer or gooty :

Procedure :

1. Select a healthy mature pencil size terminal branch of 60 to 70 cms length from the desired tree.
2. Give two circular cuts about 3 to 5 cms a part.
3. The upper circular cut should be near the bud.
4. Join the two circular cuts with a longituditional incision.
5. Remove the ring of bark.
6. If the plants are hard to root dust or paste with root inducing plant growth regulator.
7. Get a moistened spagnum moss and press it around the operated stem.
8. Prepare a 25 Sq. cms sheet of a polythene paper.
9. Wrap the polyethene paper around the moss in a over lapping fashion.
10. Tie the gooty, first at the top and then at the bottom with elastic rubber bands or just string.
11. After rooting sever off the gooty in stages from the parent plant just below lower end.
12. Plant it in the pot after removing the wrapped polythene paper.

Observations :

Sr.No.	Name of the cuttings	Date of planting	Date of rooting	Time required for rooting
1.	Guava			
2.	Bounganvellia			
3.	Pomogranate			
4.	Croton			

iii) Continuous or Trench Layering :

This method consists of completely covering a branch under soil. This method is adopted in the propagation of own rooted apple and pear. This method is also known as the etiolation method of layering. In this method about 1 year old plants intended to be multiplied are planted in a slanting position forming an angle of 40° to the ground. When the plants are established in this position, they are bent over and pegged down in a shallow trench and covered with a thin layer of soil. As the buds begin to swell along the buried parts of the stem. More soil is thrown over the stem gradually. This process is continued as the new shoots grow up and the soil covering is about 15 to 20 cm deep. The covered parts of the new growth thereby kept in the dark, get etiolated. From those blanched or etiolated parts roots emerge and the rooted growths are finally detached and planted out leaving sufficient number of the buds on parent plant for the formation of future layers. Thus, the layering beds when once established become more or less permanent, producing a succession of new plants. This method is not common in India

iv) Mound or stool layering : Diag

This is a modification of etiolation method. In this the plants to be multiplied are cut back to almost ground level. The fresh growths which result are etiolated by gradually heaping earth around them as they grow up. The new shoots are thus buried gradually upto not more than about half their length. After rooting they are detached.

v) Compound or Serpentine layering : Diag

Long shoots that are alternately covered and exposed over their entire length are known as compound layers. They normally form roots at each node where they are covered and Develop new shoots from buds at nodes that are not covered.

PLANT PROPAGATION BY SPECIALIZED STRUCTURES

1) Suckers :

A sucker is a shoot, which arises on a plant from below the ground. The most precise use of this term is to designate a shoot which arises from an adventitious bud on root However, in practice, shoots, which arise from the vicinity of the crown are also referred to as suckers even though originating from the stem tissues. The tendency to sucker is a characteristic possessed by some plants and not by other e.g. Banana, Red Raspberry, Blackberry and chrysanthemum.

2) Crowns :

The term crown is used to designate the part of a plant stem at and below the surface of the ground from which new shoots are produced. Division of the crown is an important method of propagation. And these divisions will be plants. e.g. African violet, strawberry.

3) Bulb :

Bulbs are produced by monocotyledonous plants in which the usual plant structure is modified for storage and reproduction. A bulb is a specialized underground organ consisting of a short, fleshy, usually vertical stem axis, at apex a growing point and enclosed by thick fleshy scales. Bulb scales morphologically are the continuous sheating leaf bases. The outer scales are generally fleshy and contain reserve food materials. Growing point develop in the axils of these scales, to produce minature bulbs known as bulbets. Aerial bulbets are called bulbils will be separated and used for propagation e.g. Onion, bulbous Iris.

4) Corms :

A corm is the swollen base of a stem axis enclosed by the dry, scale like leaves. (In contrast to the bulb, which is predominantly leaf scaleed a corm is a solid stem structure with distinct nodes and internodes. The bulk of the corm consists of storage tissue composed of parenchyma cells. In the mature corm, the dry leaf bases persist at each of these nodes and enclose the corm. This covering is known as the tunic and gives a protection against injury and water loss. Propagation is by new corms which will develop on the old corm. e.g. Gladiolus.)

5) Tubers :

A stem tuber is the short terminal portion of an underground stem which has become thickened because of the accumulation of reserve food materials. e.g. potato, propagation by tuber can be carried out either by planting the whole tubers or by cutting them into sections, each containing a bud tubers or by cutting them into sections, each containing a bud tubers or by cutting them into sections, each containing a bud or eye.

6) Tuberous roots :

Certain herbaceous perennials produce thickened roots which contain large amount of stored food. The tuberous roots differ from the tubers in that they lack nodes and internodes. Adventitious buds are present only at stem and or proximal end, fibrous roots are produced towards distal end. These fleshy roots are separated and used for propagation. e.g. Sweet potato, Dahilia.

7) Rhizomes :

A rhizome is a horizontal stem growing either underground or along the surface of the ground. Typically it is the main axis of the plant. Producing roots on its lower surface and extends leaves and flowering shoots above the ground. It maybe thick and fleshy or slender and elongated but it is always made up of nodes and internodes. e.g. Canna ginger, propagation by rhizomes consists of cutting or dividing the rhizome into sections each of which is capable of producing new shoot (It should have nodes) from nodes and roots from adventitious buds of lower surface.

8) Runners :

A runner is a specialized stem which develops from the axil of a left at the crown of a plant. Grows horizontally along the ground and corms a new plant at one of the nodes e.g. strawberry. In propagating by runners the rooted daughter plants are dug when they have become well rooted and then transplanted to the desired locations.

9) Stolens :

Stolen is a term used to describe various types of horizontally growing stems that produces advantitious roots when comes in contact with the soil. Specifically these are prostrate stems as found in Bermuda grass (*Cynodon dectylon*).

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EXERCISE NO. 7
PRACTICE OF ASEXUAL METHOD OF PROPAGATION - BUDDING

Budding is a form of grafting in which a scion having only one single mature bud is inserted in the stock plant between nodes in such a way so as to cause an intimate contact of cambium tissues for proper union.

Budding is classified to various kinds according to the manner in which the bark of the stock is prepared to receive the bud and the shape of the bud.

1. Shield " T " or " I " Budding.
2. Patch budding.
3. Ring budding.
4. Flute budding.
5. Chip budding.
6. Forkert budding.

1) Shield " T " or " I " Budding :

1. Select from desired tree fairly well matured pencil size thickness rounded bud stick of past season's growth having plumpy buds on it
2. Defoliate the bud stick leaving little portion of the petioles.
3. Select healthy vigorous growing erect pencil thickness root stock having 45 to 60 cm height.
4. Root stock seedling should be in sap flowing condition of ensure proper union
5. Perform the budding operation at 25 – 30 cm from ground level.
6. Make 2 to 3 cms long vertical cut followed by horizontal cut across top at right angle at upper end of the vertical with a sharp budding knife.
7. Remove a plumpy bud from the selected bud stick.
8. Take out the bud carefully with the wood and remove the wood from the bud.
9. Loosen the flap of the bark on the stock plant with the help of ivory end of the knife.
10. Insert the bud by pushing it downwards beneath the bark and hold it in position.
11. Tie the bud with polythene strip keeping the bud exposed.
12. Cut off the top portion above the bud union after about 4 to 5 weeks when the union is completed.

Observations :

S.N.	Name of the plant	Root stock used	Date of budding	Date of heading	Date of sprouting

2) Patch budding : Dig

Patch budding consists of inserting small bud with a patch of bark ½ to 1 cm wise over a thick rootstock seedling of over a year in age. At first, a patch of bark is removed from the stem of the root stock seedling. Next, a patch bud of exactly the same size is removed from a desired variety and fitted into the exposed area. A bandage of waded cloth or polythene film or banana fibre is tied to protect this bud. Later, the stock seedling is do headed above the inserted bud in gradual stages. This stimulates the sprouting of the inserted bud. This method has been found to be successful for mango in Punjab and can be adopted on a large scale by nurseryman, elsewhere in India.

3) Ring budding : Dig

The nature of method renders it useful only to small stocks of not more than 1.5 to 2.5 cm in diameter. This is more or less an extension of the flute method. The stock is completely injured and is replaced by the ring containing the bud of scion. Budding is done when plant parts are in sappy condition. A complete cylinder or ring of bark is removed around the stem of the stock in order to form matrix. Complete ring of scion with a prominent, plumpy, healthy bud is removed intact. When placed on stock it extends all round the stock. After placing the ring in position, tying is done in the usual manner. Failure of the bud to unite, results in the loss of terminal portions of the stock above the ringed portion.

4) Flute budding : D

This method makes use of the ring of issues adjoining the bud. Relatively thick backed trees thinner than 2.5 cm and in the active stage of growth are commonly budded by this method. It is successfully used in Ber and Cashewnut trees.

On the stock two horizontal cuts spaced about half to two inches are made through the bark down in the wood, preferably between nodes. These cuts are not to ring the stem or limb completely, but to extend approximately to three quarters of the way around the plant part. A vertical cut connects the horizontal cuts at both the ends of the cuts and the semi circular bark is removed and is placed against the corresponding cut portion of the stock. After the flute is positioned, tying is attended to in the usual way. The jute string is removed immediately after the union is complete.

If the flute bud does not unite the terminal portion of the under stock will not be lost, since it continuous between the top and the basal region. The operation is completed as quickly as possible. Any desiccation or injury to the exposed tissue will impair the chance of healing.

5) Double working : D

Double working is a practice in which the successive budding or grafting operations are performed on the same plant. After one scion has been placed on a stock second scion is grafted or budding into the first one.

Double working is useful not only to get over the difficulty of lack of congeniality but also to prevent a disease that is more or less characteristic of the rootstock trunk. It is also possible that the intermediate stem piece on which scion is worked may impart its own influences on quality, yield etc. of the final orchard tree. In

trials conducted at kodur it has been found that naturally shybearing Jahangir mango produced larger blossom crop when double worked on the prolific Neelam intermediate stem piece.

6) Forkert budding :

The method is being successfully practised in Java and Ceylon. In Maharashtra State, a fair degree of success has been achieved in mango. The favourable season for the operations is from July to September, when stock seedlings make excellent growth.

Buds are selected from a year old growth. The terminal shoots are removed from the parent trees after detaching the leaves but allowing the leaf – stalks to remain on the shoots. But stocks of mature trees are also obtained from distant places and stored in moist *Spagnum moss*. Buds with a piece of bark 2 to 3 cms. long and 1 cm. wide with ample wood chip are removed with the outer bark intact. The leaf stalk attached to the bud is shaved off just close to the bud with a sharp knife.

A rectangular piece of bark similar to the bud in size is removed from the stem of the stock seedling about four to six inches above the ground. First a panel is marked out by two parallel cuts on the bark. A transverse cut is then made joining the two cuts at one end the cut bark is pulled aside gently placed in the panel of the exposed region. The peeled bark is then brought back so as to cover the bud. The whole area is then bandaged with a wax cloth in order to prevent water and air getting into the bud joint.

In about three weeks the bud sprouts and the bandage is opened so as to allow the bud to grow. If on removing the bandage the bud is found green, the stock seedling is cut back just above the bud joint, otherwise the budding has to be done again in some other portion of the stock. In the next monsoon successful plants are lifted with a ball of earth and finally planate in the orchard. In sandy and light soils, plants do not come out with the ball of earth when lifted. In such soils, therefore, budded plants are first potted and rested and then taken to the main field for planting.

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EXERCISE NO. 8
PRACTICE OF ASEXUAL METHOD OF PROPAGATION - GRAFTING

GRAFTING :

Grafting is the process and operation of inserting a part of the plant into another in such a way that union will take place and the two parts joined together, would continue growth as normal plant.

The different methods of grafting are as follows :

1. Scion attached :
   1) Simple approach / Inarching.
   2) Tongue approach
   3) Saddle graft.
2. Scion detached :
   1) Saddle grafting.
   2) Whip or splice grafting.
   3) Wedge or cleft grafting.
   4) Stone grafting.
   5) Soft wood grafting

1. Grafting by Simple Approach or Inarching :

1. Select one year old terminal twig of about 45 to 60 cms. length having the same thickness as that of stock from the scion tree of known good performance of the desired variety.
2. Select a healthy well established stock.
3. The stock and scion should be of same thickness so as to bring about proper union.
4. Carry the selected potted seedlip (Stock) to the scion tree and keep on Mandava.
5. Hold the scion branch and mark the position where it can tightly be placed.
6. Remove a thin slice of the ark and wood about 5 cms long and 1 to 2 cms. in breadth and about 0.2 cms deep with a sharp grafting knife from both stock and scion branches.
7. The cut thus made should absolutely be flat clean even and smooth. Size of the cut varies with the thickness of the shoot used.
8. Bring the cut surfaces together under pressure face to face without leaving any hallow inter space between them.
9. Tie them with banana leaf sheath and then with a jute string (Sutali).
10. The Bandage is made water proof and air proof by pasting it with grafting wad or cow dung / plasture.
11. Water the root stock plants as required.
12. The union is completed in about two to three months.
13. Severe gradually the scion from the parent tree after the union is completed.
14. The original top of the stock plant above the graft joint is headed off after about a week.
15. Remove the graft to a shade place where it is properly nursed, hardened and cared for a period of about 3 – 6 months prior to its final planting.

Observations :

Sr. No.	Name of plant	Root stock used	Date of raising plants	Date of inarching	Date of severance of the graft.	Time required for grafting.
1.	Mango					
2.	Chiku					
3.	Guava					

2) Saddle grafting :

This method is sometimes followed in the case of mango though it is not so popular as inarching. As usual, care is taken to select the stock and scion of equal thickness.

Procedure :

The root stock is deheaded at a height of about 20 cm by taking two diagonal cuts opposite one another to meet at the centre to form a wedge shape. The length of such a wedge pointing upwards is about 2.5 to 3 cm. a cleft equal in length to that of the wedge of the stock is cut on the outer side of the selected scion branch to expose the cambium and fix in the widge of the stock. The depth of the cut in the scion may go more than half way through the scion. The joined parts are then tied over firmly. The proper season to do this operation is from August to October.

3) Whip grafting :

This method of grafting is used to join together plant parts which are under one inch in size. This method is not commonly used. It is useful when it is not convenient to take the stock seedling to a scion tree which maybe far away.

Procedure :

The stock and scion should be a equal thickness and in vigorous growth having the sap in a free flowing condition. The seedling stock is headed off at a height of 20 to 25 cm from base by taking a diagonal slantwise cut 3 to 5 cm in size. The scion branch of about 22 cm length from matured wood previously defoliated leaving a portion of the petiole is selected. It is also given a slantwise cut of the same size as that of stock piece and is then brought in contact with the stock and tied firmly at the operated part with the help of banana fibre (sopat) and jute string.

4) Veneer grafting :

Veneer grafting is now practised in West Bengal on Mango in performance to inarching. In this method the scion terminal shoots of 10 to 15 cm length and of pencil size thickness are cut to use as scion. Terminal shoots with plump and swollen buds that are about to sprout in a fortnight are considered ideal. The leaves are defoliated in these selected terminal shoots a fortnight prior to their cutting from the parent tree. Immediately after cutting, the scion shoot is given a slanting cut of 5 cm. long on one side of the cut end removing bark and wood to half its thickness. Skill is necessary in making a clean cut. A notch is made in a selected mango seedling upto 5 cm. deep in an

oblique manner on any convenient side. The cut end of the scion shoot is placed in position and wrapped very tightly with 1 cm. wide polythene film tape keeping the terminal shoot end free. The seedlings are kept moist so as to ensure good sap flow for promoting speedy union, September to October is considered favourable for veneer grafting. The scion shoot starts sprouting or swelling its buds, in about 3 to 4 weeks. The stock seedling bandage can be removed at this time. it takes about three months for veneer grafting plants to become ready for planting in orchard. Success in this method of propagation ranged between 75 to 80 percent.

5) Crown grafting :

This method is employed for renovating old trees. The tree which is generally old and of inferior variety is cut back to a height of 60 to 90 cm from the ground level with a saw. On the back, longitudinal cuts of 5 to 8 cm are made from the top with chisel. The bark is exposed in strips all round the circular stem. The best time for this operation is from August to October. The scion to be used for renovating the old tree is selected from a desirable variety.

One year old terminal shoots with swollen buds nine to twelve inches long are collected these shoots are cut with a grafting knife and the lower end is made into a wedge. The wedge is made by cutting the bottom of the shoot slantingly from the two opposite sides. These shoots are defoliated and inserted in slits between the bark and the wood on the old trees which have been cut back. Four to five scions are inserted on the main trunk depending on the thickness of the tree. After inserting these shoots all the openings in the bark of the stock are immediately closed by men as of sealing wax, resin and tallow in 1 : 2 : 1 proportion. The sealing wax keeps the joint waterproof and air proof. In order to produce humid conditions, a big earthern pot with a wide hole in its bottom is kept inverted over the grafted portion without touching the plant. A piece of glass is kept over the hole to admit light. Lose earth is heaped around the tree and the pot is allowed to rest inverted on this earth over the tree. The whole plant will finally took like a miniature pyramid in a earth with glass top in these weeks and glass be opened for a few hours daily to admit fresh air. When few leaves start sprouting, the glass can be removed and the plant allowed to grow.

This method is also known as top-working. In Malbar and Madhya Pradesh large inferior seedling trees have been converted into superior ones by adopting this method.

6) Side grafting :

This is another method of grafting in which the terminal shoots of scion plants are used. The scion shoot is first defoliated upto 10 to 12 cm length. A week before its separation. Then these shoots are cut away from the parent tree and grafted to the side of stock seedling of the same thickness. Two slanting cuts are made at the base of the scion shoot forming a sedge and this is fitted into a notch like cut made on the side of the stock seedling. A firm bandage is then made with raffia fibre or with a cloth strip dipped in paraffin. The scion material separated from the desired variety of mango should be kept moist by wrapping it with wet gunny cloth.

7) Bridge grafting :

It is not a means of propagation in the true sense as the other methods. It is principally employed to join living tissues of trees which are girdled partially or completely by rodents, animals. Implements, due to mechanical injury, colder cracking. Eventually all roots die since no food returns to them through the bark. The bridging of the damaged or injured portion of the limbs, stem or trunks of the trees is done to save it. The sap flow on both sides of the injury is thus established by causing congenial circumstances to unites the scions with the tree both above and below the ends. The girdle in such a way is bridged to fill the gap. This is commonly done when the tree is in sap flowing conditions.

The selection of the scion wood is practically done the same way as in other types of grafting. Congeniality is the pre-requisite. Scions are cut in such a way that, when they are in position, both ends extend well in the healthy tissues. Both the ends of the scion are joined to a length of 5 to 8cm. of the wounded tree.

Initially the rugged edges of the injured region are trimmed over by making a clean cut into the living tissue, above and below the wound. The portion so cut is slightly shorter than the length of the scion. A channel for each end of the scion is marked out at two inches interval around the trunk so that the entire wounded area is bridged and to facilitate a perfect fit the components are finally nailed in place.

The scion is inserted with larger diameter and towards the ground and thus both ends are nailed in position. Since the Scions are little longer than the channels cut to them, they how slightly. The scions and the injured surfaces are painted with the grafting wax to prevent drying.

After the union is complete, a few buds on the scion may sprout. Cut these off early. Interchange of elaborate food material manufactured in the leaves and nutrients absorbed by the root system takes place immediately.

8) Buttress grafting :

This is a well known method in Horticulture. It is used to rejuvenate old or ancient historic trees or trees of sentimental values. In this method young seedlings of the same age are grown in close proximity of the tree are combined with the disease free trunk of the old tree by inarching method. It is also followed to save orchard tree that are partially or completely girdled by foot rot or such other of scion trunk by number of seedling root stocks.

For older trees with very thick back, the bark in arch method or simple in arch method is used. At a time when the bark lifts freely from the wood, a small flap is removed equal to the diameter of the plant to be placed.

Seedlings are grown in close proximity of the main tree. After attainment of proper height and thickness, a longitudinal cut of 3 to 5 cm in length is made on the side of the seedling, adjacent to the tree. A blunt 45° angle cut, originating from the opposite side terminates the cut. The two opponents are fitted in laces, nailed and covered with grafting, wax and tied in the usual wax.

In buttress grafts, the method employed is the same as given in details under in arching.

9) Stone grafting :

Steps in stone grafting :

a. Collection and selection of mango stones for raising rootstock.
b. Raising of mango seedlings (root stock).
c. Selection and preparation of scion bud wood.
d. Grafting procedure.

a) Collection and selection of mango stones for raising rootstock :

Country mango seedlings are used as a rootstock for mangoes. For this the fruits from vigorous disease free and high yielding trees of seedling mangoes are collected during May-June. The Fresh stones are sown. Soon after it is removed from ripe fruit after thorough washing as they loose their viability very soon. It has been observed that mango stones give very low germination (nearly 12%), if they are sown after 2 months of their extraction from the fruit.

Before sowing, the stones should be immersed in water and only those stones are sown which sink (settled) in water is these are considered to be viable,. The stones which will float on the surface of water, should be rejected.

Thoroughly washed stones are immersed in 5% copper solution for 10 minutes and after that used for sowing in a bed or polythene bags.

b) Raising of mango seedlings (Rootstock) :

The stones are sown in the properly manured raised bed at the spacing of 22 x 45 cm. during May – June at the depth of 5 cm. the stones are placed in the soil with plumule up as it avoids distoration of seedlings and covered properly. The beds are irrigated immediately after sowing the stones and subsequent irrigation are given to keep the soil moist but not in too much wet conditions and after germination of stones those are transferred in a polythene bag of 15 x 22 cm. after grafting.

The stones can also be sown directing in the polythene bag of 15 x 22 cm size.

Stones germinate within a period of 1 month. When seedlings attend the age of 8 – 10 days and produce bronze colour leaves indicate that the seedlings are ready for grafting.

c) Selection and preparation of scion bud wood :

A 3 to 6 month old terminal bud wood having 4 to 6 mm thickness and 10 – 20 cm length is selected from a desired variety, which is free from past season and diseases and vigorous in growth. All the leaves are removed from such selected branch. Keeping 5 to 10 cm petiole attached to it. This branch should be allowed to remain as such on the tree at least 8 to 10 prior to grafting.

i) The drop of these petioles and swelling of terminal buds is a good judgment of preparation of scion wood.
ii) The usable life of scion bud wood is 2 to 3 days when packed in a wet cloth placed in polyethene bag.

d) Grafting procedure :

Grafting is done by cleft or wedge method. New bronze colour leaves stem of rootstock is deheaded to half of its length i.e. 7 to 8 cm. Vertical cut of 3 to 4 cm is

given on the stock. 3 to 4 cm slanting cut is guava on both the side of the scion shoot so that it will fit properly on the stock causing a good combial contact of stock and scion. Then this operated portion is tied firmly with polythene tape of 200 – 250 guage of 1.5 cm width. Near about 30 to 45 cm polythene tape is required.

Within 3 to 4 weeks bud will sprout and new growth of shoot will start within 1 to 1 ½ months. The grafted plants are then kept in a shady situation before final transfer to field. Presence of stored food material in stones and high meristematic activity help in proper healing and subsequent growth of the scion. Plant become ready for planting with 3 to 4 months after grafting.

Season : Best season for mango grafting is July to August.

Advantages :

1. Requires less time and less expenditure as compared to veneer, In arch grafting.
2. Quick method of mango multiplication.
3. Success is 70 to 80%.
4. No irrigation or water is required s grafting is carried out in rainy season.
5. Very suitable for costal region.

Disadvantages :

1. Stone grafting is carried out when a age of rootstock is 8 – 10 days only.
2. with advancement in age, of stock percentage of success is reduced considerably.
3. The survival rate of stone graft is very poor. Probably due to the inability of the stock to support the growing scion after the exhaustion of reserves in stones. Secondly high temperature and low humidity may cause excessive loss of moisture.

10) Softwood grafting :

Steps for soft wood grafting

a) Collection and selection of mango stones.
b) Raising of rootstock seedlings.
c) Selection and preparation of bud wood.
d) Grafting procedure.

are similar to stone grafting except the age of rootstock. In softwood grafting, the operation is carried out on a root stock of 1 year old mango seedlings and such method is usually followed for in situ grafting.

11) Flush grafting :

Steps 1 to 4 are similar to Stone grafting except, the age of rootstock.

In flush grafting fresh growth of second flush is used and as a result longer period is available for grafting.

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EXERCISE NO. 9
LAYOUT AND PLANTING OF ORCHARD PLANTS

A) Systems of Planting :

The plan showing the arrangement of plants in an orchard is known as "Orchard Layout". The plants are arranged in the garden in several ways, but the following are the most common system of planting.

I. Square II. Rectangular III. Quincunx IV. Hexagonal V. Contour.

I. Square system of planting :

This is very simplest of all systems. The distance between the rows and plants in the rows is same and four plants are planted on the four corners of square.

Procedure :

1. Draw a base-line parallel to the road, fence, boundary or the previous plantation at a distance of half the spacing that is to be followed.
2. On either side of the base line leave a gap equal to half the spacing from the road, fence and fix a peg on one end of the base line. This makes the position of the first plant on the base line from this peg measure the planting distance and put the second peg. Repeat the same till the total length of base line is covered.
3. From the first peg and last peg draw the perpendicular lines to the base line. The perpendicular lines maybe drawn by adopting any of the following methods.

A) Cross staff methods.
B) Principles of Pythogorus Theorum.
C) Bilateral or Isoscales Triangle.

Principles of Pythogorus Theorum :-

Adopting right angle triangle with the sides and hypotenuse in the proportions of 3,4,5 a perpendicular line can be drawn.

a) From the first peg on base line measure known distance proportional to 3 and make the point.
b) Measure a distance proportional to 4 and draw an arch away from the base line from peg No. 1
c) Measure a distance proportional to 5 and draw an arch intersecting the first arch from the point of previously marked base line.
d) Extend the straight line from the position of the first peg and the point of intersection of two archs.
e) This gives the perpendicular line on the base line from the position of peg No. 1
4) Mark the position of plants on these two perpendicular lines fixing a peg at each position.
5) Join the positions of the last pegs on these two lines with a straight line to form a parallel line to the base line and mark the position of plant on this line also.
6) Join these positions of the pegs on arch line with the corresponding positions of the pegs on the opposite line.
7) Fix the pegs at all the points of intersection of these lines and the position of the pegs show the planting positions.

Area occupied per plant = Spacing^2

No. of plant/unit area = $\frac{\text{Total area}}{\text{Area occupied per plant}}$

II. Rectangular system of planting :-

This is similar to that of the square system in its layout except for the difference that the spacing between the rows and between plants in the rows is not equal. Spacing between the rows is greater than that between the plants of the same rows. On the basis of the square system the planting the layout of this method can be prepared.

Area occupied / plant = Plant to plant distance x Row to row distance.

No. of Plant / unit area = $\frac{\text{Total area}}{\text{Area required per plant}}$

III. Quincunx system of planting :-

This is also as known as Filler or Diagonal system. It is a modification of square system of layout to make use of empty spaces in centre of each square by planting another plant of short duration. This method is adopted only in widely spaced fruit crops. e.g. Papaya, banana, fig can be planted as filler during the initial stages of the permanent plantation of fruit crops (Main crops Mango, Tamarind, Sapota etc.).

In this system the plant population is nearly double than the square methods but it is difficult to carryout intercultural operations.

Plant / Unit area = $\frac{\text{Area}}{\text{Spacing (Main trees)}} + \frac{\text{Area}}{\text{Spacing (Filler trees)}}$

IV. Contour system of planting :-

This system of planting is usually followed on hills with high slopes. The layout is started on lowest level and Trees rows are planted along a uniform slope, at right angle to the slope with a view to reduce the loss of soil due to erosion.

V. Hexagonal system of planting :-

In this system the trees are set at the corners of equilateral tringles. This system differs from the square system in which the distance between the rows is less than the distance between the trees in the row, but distance from tree in six directions remains the same. In all, 7 trees are planted in each hexagon.

B. Procedure for Lay out :

1. Draw the base line and mark plant position on it.
2. By adopting the following method this system of layout can be laid out.

A) Equilateral Triangle with rings at the corners.
B) Two hard wires with three rings.
C) By the use of a prismatic compass.

Equilateral triangle with rings at the corner :-

Make the equilateral Triangle from hard wire equal to the distance provided for plant to plant spacing and three rings are fixed at the corner of the triangle from peg No. 1 on the base line the triangle is placed and the position of second plant is marked. The apex point is marked with the pegs, operated this way till the total base line is covered. The second line is determined, may be taken as base line and follow the same till the total plot is covered.

Systems of planting fruit crops

Formulae :-

1) 1 hectare area = 10,000 Sq.mt.

2) 1 acre area = 43,560 Sq.mt.

3) Spacing = (Row to Row distance) OR (Plant to Plant distance)

4) Area of a plant = Row to row distance x Plant to Plant distance.

5) Area of field or plot = Length of field or plot x Breadth of field or plot.

6) Number of plants per unit area = $\frac{\text{Area of a field}}{\text{Area of a plant}}$

$$= \frac{\text{Length of field x breadth of field}}{\text{Row to row distance x Plant to Plant distance}}$$

Number of plants by Square system $= \frac{\text{Total area of field in Sq. Mt.}}{\text{Row to row distance x Plant to plant distance}} \times \frac{\text{Total area of in Sq. Mt..}}{(\text{Spacing})^2}$

8) Number of plants by Rectangular system $= \frac{\text{Length of field X Breadth of field}}{\text{Row to Row distance X Plant to Plant distance}}$

9) No. of plants by Rectangular system = No. of Main trees + No. of filler trees

$$= \frac{\text{Area occupied by main trees}}{\text{Row to Row distance} \times \text{Plant to Plant distance}} = \frac{\text{Area occupied by filler trees}}{\text{Row to Row distance} \times \text{Plant to Plant distance}}$$

$$= \frac{\text{Length of field} \times \text{Breadth of field}}{\text{Row to Row distance} \times \text{Plant to Plant distance}} + \frac{\text{Length of field} - \text{Row to Row distance} \times \text{Breadth of field} - \text{Plant to Plant distance}}{\text{Row to Row distance} \times \text{Plant to Plant distance}}$$

10) Area of a field by quincunx system OR Area occupied by filler plants :-

$$= \frac{\text{Length of field} \times \text{Breadth of field}}{\text{(Row to row distance)}} \text{ (-) Plant to plant distance}$$

11) Number of filler plants by quincunx system :-

$$= \frac{\text{Length of field - Row to Row distance x Breadth of field - Plant to plant distance}}{\text{Row to Row distance X Plant to Plant distance}}$$

12) No. of plants by Hexagonal system :-

$$= \frac{\text{Total area of a field}}{\text{Row to Row distance X Plant to Plant distance}}$$

a) In this system Row to Row distance is not known and it is to be calculated by using Pythagoras Theorem.

By Pythagoras theorem, perpendicular distance or Row to Row distance.

$$= AC^2 = CD^2 + AD^2$$

$$= AC^2 - CD^2 = AD^2$$

b) In hexagonal system, Row to Row distance is usually less than plant to plant distance, hence accommodates 15% more plant than square system of planting.

c) Row to Row distance is equal to a perpendicular distance between two rows.

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EXERCISE NO. 10
TRAINING AND PRUNING OF FRUIT TREES

A) Training of Fruit Crops

In fruit trees the process or practice of controlling the direction in which the stem grows is termed as training. It determines the general character of plants out line, its branching, shape and frame work. The fruit plants are allowed to grow in natural way without training and pruning then they grow wild and do not bear abundantly. The training is achieved by cutting the branches with secateur or pruning saw.

Objects of Training :

i) To admit more sunlight and air in the centre of the tree and to expose maximum leaf surface to sunlight for photosynthesis and better colouration and maturity of fruit.

ii) To develop satisfactory frame work and growth of the tree so that various cultural operations such as spraying, picking, pruning etc. are facilitated.

iii) To protect the tree trunk from sun burning and wind damage.

iv) To secure a balanced distribution of fruit load on branches to bear large crops without their breaking.

v) To develop strong crotches and well spaced limbs to bear heavy crops without their breaking.

Height of Head :

The region on the main trunk from where main branches are allowed to grow is know as 'Head'. Height of head is the distance from the ground at which scafold branches emerges from the main trunk. The trees in which the scafold limbs come out within ¾rd to 1 meter from the ground are known as low headed. In which they come out from the trunk above 1 metre from the ground are high headed. The height is established by cutting of the top. In the older orchard high headed trees is the rule. High heading facilitates cultivation and other orchard operations. Low heading facilitates pruning, spraying, thinning, picking etc. low headed trees, are less subject to sunscald and suffer less damage from high winds and storms. A moderate number of five to eight main scafold limbs makes a tree mechanically strong and at the same time open enough to facilities necessary orchard operations and there is less damage of breakage of the limbs at joints due to normal crop load Mango, Chiku, Ber, Grapes etc. are trained to high headed, where as santra, lime, mosambi, pomegranate, fig custard apple etc. are trained as low headed.

Methods of Training :

Training is type of top pruning. It is particularly important in the many fruit trees. Fruit trees are trained to develop a frame of scaffold limbs sufficiently strong to bear heavy crops of fruit without breaking. Thus the development of strong crotches and well spaced limbs is essential. Generally this is done by heading back, the young tree. The practice should be efficiently performed. The various methods or forms to

which trees are trained are of three general types : (1) Central leader (2) Open centre or vase (3) Modified leader.

1) Central leader : Dig.

in this system the main stem is allowed to grow unchecked. Since the main stem has the advantage of special dominant it grows vertically i.e. upwards. A serious of well spaced branches are allowed to grow laterally.

Generally 5 to 6 well spaced branches in all directions around the trunk are retained. The apical dominance of the lateral branches resulting in a robust close centered tall tree. Its main advantage is the development of strong crotches due to the junction of the limb and the trunk. Such a tree bears fruits at the top while the lower branches remain more or less shaded and become ultimately less vigorous and less fruitful e.g. Mango, Sapota.

2) Open centre or vase : Dig

The open centre or vase type of tree has no main or central branch but a series of well spaced co-ordinated lateral branches. These laterals are given the same dominance. All the co-ordinated branches make growth each year. The main advantages of this tree form are that light penetration becomes sufficient for the fruiting of inner branches. Low headed tree facilitates operations like pruning, thinning, spraying and picking. Its main disadvantage is that the tree develops week crowded crotches which frequently break under severe stress and strain like heavy bearing of fruits e.g. Apple, Pear, Peach, Plum.

3) Modified leader : Dig.

The training of trees under modified leader is between the central leader and open centre. The central leader is allowed to grow for a few years and then headed back. The modified leader trained type of tree thus has low and well spaced limbs, with distributed fruiting wood and is sufficiently close to the ground to facilities many of the orchard operations of the other two types.

B) Pruning of fruit trees

Pruning is the scientific art of cutting away or removing certain undesirable portion of plant with the following objects :

1) To develop manageable frame work of tree (Training)
2) To control the height of the tree for convenience of horticultural operation like pruning, spraying, tillage observations etc.
3) To influence vigour, growth, flowering, fruitfulness.
4) To spread fruiting area uniformly on the tree.
5) To produce more and superior quality of fruits.
6) To encourage regular bearing.
7) To remove barren wood in old trees.

Methods of puning :

There are two methods of pruning (I) Heading back and (II) Thinning out. In heading back terminal portion of every twig, canes and shoots are cut retaining basal

portion. In thinning out some twig, canes or shoots are removed from their point of origin retaining other. Out of these two methods only thinning out is practiced in most of the fruit trees. Heading back is often followed in pruning of headges ornamental shrubs, grapes, phalsa etc.

Bulk or severe pruning :

Large limbs are cut as contrast to removal of large number of small branches. In this case severe heading back of major limbs of tree is done. Fine or light pruning means the removal of small branches or twigs by secateur from the entire plant as contrast to removal or large limbs. In heavy pruning large portion of wood from the plant is removed.

1) Mango :

It produces flowers on terminal shoots of at least one season old. Flower may be produced on the shoots which may be more than one season old. Thus for maximum number of flowers there must be maximum one year old shoots and thus pruning required to be done in mango is restricted to the removal of diseased, dead and over crowded branches.

2) Citrus :

The flowers are borned terminally or laterally on the shoots of current season growth, and as such no pruning is required to regulate the flowering except the removal of dead branches, water sprout, suckers. Pruning is followed in early stage for development of framework.

3) Guava / Sapota :

It produces the flowers, terminally on the current season growth which arises from past season growth. in various with upright growth the flowers are produced only on terminal end and the lower portion of a shoot remains more or less barren. Pruning trials in tall and erect growing variety indicate that if heading back of old wood or past season growth is done, then it resulted in poor yield although fruit quality and size is improved. Hence to obtained higher yield in tall varieties bending is recommended. Pruning is not essential in natural spreading varieties like L-49 or Sardar.

4) Chikoo :

Fruits are borne in the axil of leaves towards the terminal portion of the shoot and branches which are borne all along the length of old branches of many years and as such no pruning is practiced for bearing.

5) Grape :

The fruits are borne laterally on the current season growth which arises from the portion of past season growth or the mature cane. The mature cane of past seasons are severely pruned or headed back leaving a stump containing 3–4 buds. These stumps are called as spur, which bear fruits in current season.

6) Pomegranate :

Fruit buds are produced laterally or terminally on the spurs produced all along the slow growing mature wood.

Pruning is done 1) to develop a strong framework of a plant and to produce a single stem plant, 2) for removal of suckers.

7) Fig :

In fig, fruits are borne laterally on current season growth and therefore, heading back of 1/3rd portion of terminal growth of past season follower annually.

8) Phalsa :

Fruits are borne laterally only on new growth hence severe annual pruning is recommended for encouragement of new growth.

9) Ber :

Ber produces the flowers in cluster laterally pas season growth in August to September. Pruning is done for fruiting in May and also requires frequent attention to change the irregular shabby growth and to remove dead wood.

Observations :

Type of inflorescence	Fruit bud terminal	Fruit bud lateral
1) Pure		
2) Mixed		

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EXERCISE NO. 11
TRANSPLANTING AND CARE OF VEGETABLE SEEDLINGS

Direct sowing is an uneconomical practice in those crops whose seed cost is very high or which require excessive thinning. To get optimum stand of seed propagated crops, transplanting is the best method. **When seedlings are raised in nursery beds and planted in the main field, the term transplanting is used.** The crops like brussels sprout, broccoli, cauliflower, cabbage, Chinese cabbage, kohlrabi, kale, tomato, brinjal, hot pepper, sweet pepper, onion, sweet potato, pointed gourd, etc, are transplanted after raising seedlings in nursery beds. Seeds of these crops are not directly sown in the main field because of small size seeds and very thin seed coat. Direct sowing of such seeds does not make it possible to maintain uniform depth of placement, and due to more soil and environmental variability, *i.e.* , moisture and temperature, the seeds do not germinate uniformly. Many seeds do not geminate, if germinate, the seedlings do not emerge, if emerge do not survive due to vagaries of environment desiccation on account of heat and radiation and damage due to rains and winds, and as a result, they die. For these reasons, such seeds are sown in nursery beds in a well protected small area where the seedlings are taken care of until they become sizeable to handle and get ability to withstand the external conditions. The seedlings during transplanting get shock due to harsh environmental conditions in the field, therefore, this operation should be accomplished as soon as possible after the first few true leaves appear since the ability of plant to recover and replace its root system is greater and more rapid at this stage of growth. Transplanting needs bit more care attention and investment than the direct seeding. Irrigation facilities appear essential for transplanting to be more beneficial. Based on ease in transplanting, the vegetables are classified into three groups given below;

1. Easy to transplant : The crops, which are having adventitious roots system, are easy to transplant, and the examples are tomato, eggplant, cabbage, cauliflower, broccoli, brussels's sprout, kohlrabi, kale, lettuce, etc.

2. Transplant with care: The crops that can be transplanted with little care are onion, leek, hot pepper, sweet pepper and celery.

3. Not transplanted : The crops that are having taproot system ~~any~~ not be transplanted, and the examples are okra, beans, peas, root crops and leafy vegetable crops., cucurbitaceous vegetables.

Factors Influencing Transplanting

The success of transplanting depends upon the age of plant, type of plant and condition at the time of transplanting and environmental factors such as humidity and temperature.

- The success of transplanting depends upon how rapidly the plant is able to regenerate those areas of root system that were damaged during transplanting. Cole crops like cabbage, cauliflower, kohlrabi, broccoli, Brussels sprout, kale and solanaceous crops such as tomato, eggplant, hot pepper and sweet pepper develop adventitious roots quickly, which increase their rate of survival.

However, cucurbits, peas and beans develop a supersize layer preventing formation of root hairs and lateral roots, thus, reducing water absorption.

- Age of transplants also affects success of transplanting. Older seedlings have decreased rate of root replacement. Also, if allowed to grow in the nursery beds they become weak and lanky and start flowering.
- Clipping or pruning transplants should be avoided. Although shortening of roots or trimming of foliage is sometimes recommended to make the plants easier to handle and to reduce stress on the plants but this reduces the plants capacity to recover. Pruning removes tissue carbohydrates resulting in diminished root regenerative capabilities, thus, avoid trimming as far as possible. Heavy pruning also causes reduction in early and total yield.
- Shading is also detrimental and should be necessary to provide only in the hottest weather.
- For better survival of transplants, transplanting should be done in the late afternoon since high temperature in the mid noon is detrimental. Relative humidity is also higher in late afternoon, reducing desiccation of transplants.

Optimum Age and Pulling Out of Seedlings

The seedlings are ready for transplanting when they are about 4-8 weeks old, 10-15 cm tall and have formed 3-4 true leaves. Beds must be watered 24 h before uprooting the seedlings so that they may not suffer from desiccation. The plants should be removed with care without damaging the roots. The approximate length of time from seeding to transplanting is shown in the Table 1 given below;

Nature of crop	Vegetable crops	Time taken (weeks)
Cool-season crops	Brussels sprout, broccoli, cabbage, cauliflower, kohlrabi, lettuce etc.	4-6
	onion, leek, shallot, etc	8-10
Warm-season crops	Tomato, hot pepper, sweet pepper, eggplant, etc.	4-6
Vine crops	Cucumber, muskmelon, watermelon, pumpkins, gourds, squashes, etc.	3-4

Hardening :

Before transplanting, the plants are prepared for transferring to field by reducing their rate of growth or hardening them. Hardening is the process of gradually acclimating the tender plants to the outside environment. Physiologically, hardening reduces growth rate, thickens the cuticle, increases waxy covering on leaves of the certain crops, increase resistance against plasmolysis and deplasmolysis, increases the percentage of dry matter, increases the percentage of water holding colloids, increases chlorophyll content (makes the plants dark green), decrases the percentage of freezable water and develop hardening increases the adaptability of the transplants to field conditions, which may include excessively cool or warm temperature, water stress, wind, pestilence, etc. Generally, hardening is done anywhere from 7 to 14 days prior to transplanting by subjecting the seedlings to cool weather or insufficient water, which

prevents rapid growth. Hardening should not involve any treatment such as nutrient stress that reduces the rate of photosynthesis.

The term "hardening" or "hardening off" is applied to any treatment given to the seedling s results in firming or hardening of tissues of the plant that increases adaptability to the harsh field conditions at transplanting time, which may include excessive low or high temperature, blazing sun, water stress, or hot dry winds.

Techniques of Hardening : The hardening is done in the following ways ;

- When plants are grown at high temperature, hardening is accomplished by withholding watering. To increase the percentage of seedling stand in the field under stress conditions, heat hardening at 40^0 C for 6 h daily for 2-3 days before watering for 2-3 times is advisable.
- To withstand drought conditions, the seeds are subjected to drought hardening or hydrolisation. The treatment involves maintaining seeds in an imbibed state for a short period, and then retired. One or more wetting and drying cycles are when subjected to seeds before sowing, increased subsequent yield of crops.
- The plants should be exposed to more sunlight, which causes the plant to produce more cuticles, thereby reducing water loss.
- Cabbage, lettuce, onion and some other crop plants can be hardened to withstand frost except tomato, peppers and eggplant. Hardening is done by exposing the plants to low but non-injurious temperature. When the frost hardy species are subjected to low temperature above 0^o C, there cytoplasmic membrane becomes more permeable, thus, able to withstand freezing.
- Hardening can also be achieved by growing plants in an atmosphere containing less oxygen than normal. Cucumber seedlings grown from seeds in an atmosphere of only 2% oxygen survived freezing at -10^0C, whereas, air grown seedlings perished.
- Application of sodium chloride 4000 ppm with irrigation water or spraying of cycocel 2000 ppm makes the seedlings hard and stiff.

Effect of Hardening

- Hardening reduces seedling growth rate.
- Hardening allows an accumulation of carbohydrates within the tissues. This increase in carbohydrates and the corresponding increase in percentage of dry matter within the seedling are beneficial as these carbohydrates serve to drop the point at which the tissue will freeze (Which is particularly important in cool season crucifers) effectively.
- Hardened plans tend to be hard, stiff and not succulent.
- Hardening improves quality and modifies the nature of colloids in the plant cell enabling them to resist the loss of water.
- Hardened plant can withstand better against unfavourable conditions like hot dry winds or low temperature.
- Hardened plant contains leaves that are smaller and darker green than non-hardened plant.
- Hardened plant induces a pink colour especially in the stems, petioles and veins of the leaves as in tomato and cabbage. The purple pigment in the leaves is an

indication of high sugar content, which leads to rapid formation of new roots after transplantation.

Care Before Transplanting :

The nursery soil should be thoroughly soaked about 6-12 h before the seedlings are lifed. This is done to avoid injury to the roots during uprooting of seedlings. In addition, it enables the seedling to take up plenty of water and be in a turgid condition. The seedlings should be removed from the nursery bed with as much of their root system as is practicable and replanted with the least possible delay. The soil should be forked well to loosen it in between the little seedling rows so that plants may come out easily. Plants should be pulled singly from nursery beds and bundled so that the operators can handle them easily. Very small, abnormal, or diseased plants must be discarded. It is vitally important that the soil borne diseases should not be transferred from nursery beds to the growing fields. Some pre-planting chemical treatments with fungicides should be done immediately prior to transplanting. The seedlings should be protected in the mean time by wet sacks, damp moss, or some other moist insulating material or are kept in the shade. Smoothies, the leaves or portion of the leaves is removed from seedlings to reduce the area transpiring water at transplanting time. This is for establishing a better balance between the intake of water by roots and its loss from leaves. This is very useful in cabbage, cauliflower, onion and leek. The land into which the plants are to be set should be prepared sometimes before forking or ranking is given just before planting.

Care during Transplanting :

The soil for transplanting should be of good fertility and high organic matter. It must provide nutrients for growing plant, well aerated and water retentive for root development. Before transplanting, the soil should be prepared thoroughly. In the field where transplanting is to be down, holes are made with the help of a sharp pointed peg. Dibbers or flattened trowels are also used for making holes into which the seedlings are to be planted. The seedlings are placed vertically in the centre of hole made in the field, and they should be set I the holes slightly deeper than they stood in nursery beds. Soil near the roots is pressed down with fingers to make the soil firm followed by immediate watering . Pressure should be exerted towards the plant and downwards so that the soil is pressed around the entire root system to prevent air pockets near the roots. Watering soon after transplanting settles the soil around the roots. Transplanting should be done in the evening so that plants may establish themselves in the cool atmosphere at night and recover from transplanting shock before the sun rises. Transplanting during hot and windy weather should be avoided as it increases water loss from plants. A balance mixture of major nutrients is applied around the plant to allow easy uptake by damaged roots. Plants for gap filling should be kept aside.

Care after Transplanting :

To keep the soil moist, regular watering is necessary after transplanting. Transplanting checks are reduced, if irrigation is applied immediately, and establishment of seedlings is quicker if starter solutions are added to the irrigation water. Starter solutions are the nutrients solutions applied at the time of transplanting.

Starter solutions increase yield of the crops, especially when grown on land that is not well fertilized. It is applied roughly at 250 ml per plant. Starter solutions should not be used if dry fertilizers have been applied in band. Use of too strong solutions should be avoided nice they will kill the roots of transplants. Starter solutions with greater concentrations of phosphorus rather than nitrogen or potassium are preferred. Phosphorus helps in stimulating early crop root development.

Some seedlings die after transplanting and creates gap, which should be filled up as soon as possible. Birds and vermin can cause serious damage soon after transplanting by pulling the plants out of the ground and leave them on the surface. However, firm planting reduces this problem, which will cease altogether, when new roots form and anchor the plants. The antitranspiratants like abscise acid and phenyl mercuric acetate are also used to increase the root; shoot ratio. Once the crop is established, proper care is required to control weeds. Soil around the plants is to be stirred to control weeds and provide aeration. Adequate measures are taken to avoid lodging of tall growing crops, so staking is done. The vines or indeterminate plants are trained with the help of bamboos and sticks. Staking helps to escape the fruits from direct contact with wet soil, which is responsible for rotting of fruits. Staking has certain advantages like fewer incidences of insect-pests and disease, increases plant stand per unit area and facilities spraying or dusting, intercultural operations and rapid picking and collection of fruits. However, staking the plants add to the cost of cultivation .

Gap Filling and Resowing :

Gap filling is done in case where germination is poor. It is common that a gap exists in rows of the crop due to several reasons like poor quality seed, formation of soil crust just after sowing, very shallow or deep placement of seeds, very low or very high moisture content in soil, etc. Gap filling is done to maintain optimum plant population per unit area. The transplanted seedlings not doing well due to certain reasons are removed and replaced by new ones, however, gap filling or resowing is not recommended for quick growing short duration crops. The plants around the gaps grow better if the gaps are not filled to compensate the yield loss. If gaps are more than five at stretch or entire row is missing, there is possibility of some advantages by gap filling. Gap filing is advantageous for slow growing long duration and widely spaced crops.

Hoeing and Weeding :

Hoeing is and intercultural operation to loose the soil near root zone 10 days after transplanting and one weeding after 30 days of transplantation was found quite suitable for most of the transplanted crops. Hoeing also helps in conserving moisture and soil temperature, and lastly, increases the absorption and retention of heat. It is seen that the weeds are the major problem in vegetable cultivation as they compete with crop for soil nutrients, light, water and space. Weeds are also responsible for reducing yield and harboring the insect-pests and disease. Weeds can be controlled by cultivation, scrapping or mulching at the right time. Simple scrapping of soil at appropriate soil moisture and wed growth avoids further growth of weeds. Weeds can also be controlled with selective herbicides. reported that direct sown tomatoes immediately after glyphosphate application suffered no injury but transplanted tomatoes showed various injury symptoms.

Mulching is known to help in the conservation of moisture and control of weeds. In addition, this may ad organic matter to the soil (where plant wastes are used as mulch0, improve the quality of vegetables and help in the control of certain insect-pests and disease. Straw, leaves, other crop wastes, different types of paper, or polythene may be used for mulching.

Advantages of Transplanting :

- For expensive seeds such as hybrids, the transplants conserve seeds.
- It reduces cost of cultivation by saving expensive seeds, number of irrigations, number of weeding, etc.
- Transplanting increases land use efficiency.
- The seed germination rate is higher, and more high-quality transplants can be produced.
- Sowing seeds under protected conditions extends the growing season. This is important for early yield since the plants can be ready to set out immediately after reasonable risk of frost is past.
- Earlier harvest is more attainable by using transplants than by direct seeding in the field. Generally, earlier harvest is more valuable to the market.
- Transplanting facilitates intercropping and relay cropping
- Through transplanting, it is easy to adjust suitable date of planting and to harvest the crop according to market demand and price.
- Effective control of insect-pests and disease from the time of seedling emergence by prophylactic measures is possible.
- The crop raised through transplanting is uniform in maturity.
- Selection of true to type healthy seedlings helps in rising good crop in the field.

Disadvantages of Transplanting :

- Transplanting of seedlings requires more labour as compared to direct seeding. sowing.
- Nursery raised in infected soils carry the inoculums to the field areas where diseased seedlings are transplanted, thus, causing problem in larger areas.
- Maintenance of soil moisture near the root system is necessary as most of the transplanted crops have shallower and fibrous root system.

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EXERCISE NO. 12
MAKING OF HERBACEOUS AND SHRUBBERY BORDERS

Herbaceous Border :

The planting of annuals in the border of a plot is called as herbaceous border. Due to wide range of flowers available in winter it becomes a site of attraction in the garden. The concept of herbaceous border has been introduced in India gardens by Britishers and now it has become a common feature.

The herbaceous border can be of two types *i.e.* Single and Double face. Single face herbaceous border is made when border is situated on one side of plot and having some background like wall or shrubbery border. Annuals are arranged in the border according to their height *i.e.* simple tall plants in back; medium in center and dwarf in front line. Double face border is more ideal when border is to be made in between a big plot. In such border, there is no background and tall annuals are planted in the center, medium and dwarf on both sides in descending order so that beauty can be watched from both sides.

The selection of site for herbaceous border is very important and desired picturesque effect may not be obtained if site is not selected properly. The site should be open sunny and facing towards south side so that plants get sufficient sunlight for maximum hours of the day. If this direction is not available, it should face east and last choice is for the west.

Back and fore grounds. To make an effective herbaceous border, there should be suitable back ground as well as fore ground. Back ground may be of dwarf flowering trees, shrubbery border or back ground made by training of sweet peas, brick wall in combination of both. For ground is generally of turf grass which may or may not have other garden ornaments like lily pool, sun dial, statue etc. Green turf in front of herbaceous border is a living green carpet which serves a place for enjoying beauty of flowers while resting.

Size of the border :-

The size of border depends upon the availability of space. The border can be of any length but width should be about 1-1.5 m or more depending upon the area of fore ground available. Therefore, the width can be adjusted accordingly.

Colour scheme of the border :

The arrangement of these annuals according to colour scheme conveys the mood and feelings of the gardener, Dominance of a particular colour in border is suggestive quality of the colour. Hence, the arrangement of these annuals should be done very carefully. In nature green colour being the colour of foliage dominates in garden throughtout the year. Warm colour like red dominants in winter whereas yellow colour in spring.

There are three main colour schemes according to which these annuals can be arranged.

1. Monochromatic scheme
2. Analogous or harmonious colour scheme
3. Contract colour scheme

Monochromatic colour schemes restrict the use of single colour or its shades which may be available in the same or different annuals. For example, if blue colour is to be used, annuals like blue corn flower, blue larkspur ,ageratum, anchusa etc. can be used. For yellow colour annuals like yellow dahlia, yellow antirrhinum, yellow calendula, yellow nasturtium, yellow marigold, yellow annual chrysanthemum, yellow coreopsis etc. can be used. The difficulty may be in getting the seeds of pure colours.

According to analogus colour scheme, annuals are arranged according to the nearest wave length of colour. This arrangement harmonizes with the surrounding beds and, hence, it is called a harmonious colour scheme. The arrangement of colours will follow the order as white, cremish yellow, light yellow and finally deep yellow which will follow the same but in descending order. If red colour is to be used the order will be light pink, deep pink, light red, deep red and crimson and colours will descend in the same order.

In contrast colour scheme, the opposite colour of colour wheel are used and plants of contrast colours are planted accordingly *e.g.* red dahlia against the background of green or next to blue corn flowers creates a good contrast. For yellow colour, violet, blue and red contrast. Yellow gamolepis, red phlox or petunia and white alyssum can be planed for a brilliant contrast. The width of the border is roughly divided into three parts I nproportion of 5:3:2 or 6:3:1 for tall, medium and dwarf plants. Similarly, the plots are made lengthwise. The front line of border is not a straight line, but it is made curvaceous and thus plots become irregular in shape. In these plots planting is also done irregularly at an approximate distance so that border looks natural at the time of bloom.

Shrubbery border . The area of the garden devoted exclusively to shrubs is called as shrubbery border.

In the garden, to secure privacy and provide partition, formal hedges are used. The labour and cost of maintaining hedges is much more than keeping a well planned shrubbery. Therefore, the shrubbery is preferred which also adds beauty to the garden. In planting shrubberies, consideration of foliage and colour effect should be kept in mind before planting.

Prior to laying out shrubbery border, the following points should be kept in mind.

1) By keeping shrubbery in front of the trees, a very pleasing effect will be obtained.
2) Best result is achieved by facing east or south.
3) Allow greater width where greater height is desired. Greater height is necessary when shrubbery is away from the house. But when it is near to the house, the low height is needed.
4) The shade of trees should be avoided as far as possible.

5) Shrubbery is also used to limit the gardens especially in case of large gardens.

Planning a shrubbery border : The general principles are described earlier which should be kept in mind before planting a shrubbery.

After deciding site for shrubbery, first of all a paper plan should be prepared which will help in final planting.

Arrangement of shrubs

1) **According to height :** Shrubs are divided into three groups *i.e.*, tall, medium and dwarf shrubs. *Tall shrubs* should be planted 30-45 cm away from the edge of the bed. On very large area two or more shrubs may be planted in a group for better results. The *intermediate* or *medium shrubs* should be planted in group of 3-4 plants and 30 cm away from the inner edge of the bed. The *dwarf shrubs* should be planted in group of 4-6 plants.
2) ***Double face shrubbery border :*** Just to get the pleasing effect of the shrubbery border from both the sides, double face shrubbery border is preferred. In this type, tall shrubs are planted in the center followed by medium and dwarf shrubs both the ways.
3) **According to colour :** The flowering shrubs produce a nice colour effect if planted carefully. Before actually planting, consideration of colour scheme should also be kept. It depends upon gardener to use colour contrast scheme or dominance of one colour.

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EXERCISE NO. 13
PREPARATION OF POTTING MIXTURES, POTTING AND REPOTTING

A) Preparation of Pot Mixture

Filling of earthen pots with garden compost :-

Material required :- Pot, garden compost, chemicals, spade, pots, shread leaf mould.

Procedure :-

Select well baked and sound flower pots of the proper size (the size will depend on age of the plant and purpose for which the pots are filled). Wash the pot both inside and outside, with clean water, place a large crock on the drainage hole . Now put several smaller crocks to a depth of 5 to 10 cm. depending upon the size of the pot. Put 1.25 to 2.5 cm. layer of coarse sand or coconut fibre. This is necessary to check the washing away of the fine soil particles. Fill the pot with soil mixture or compost. When half full, press the mixture firmly. Continue filling up to the rim of the pot. Press the potting mixture again, and finally fill and press mixture to a point where a room of 2 to 3 cm is left for holding water.

B) Potting and Repotting of Plants :

Potting : When a plant is transferred from a seed bed or a flat bed to a pot the operation is known as potting.

Repotting : Reporting is the act of transfer of plants from one pot to another pot.
Depotting : Removal of plants from the pot is known as depotting.

Objects :

1. Change of containers.
2. To remove the pot bound condition of the plant.
3. To change depleted or exhausted soil from pot.
4. For separation or division of plants.

Procedure :

1. Repotting should always be undertaken in the beginning of growing season.
2. Water the plants to be repotted an hour or two prior to the operation.
3. Loosen the soil around the rim.
4. Invert the pot.
5. Keep the right hand palm under the surface of the soil with the plant stem between the two middle fingers.
6. Tap the rim sharply but gently with a wooden matter as against on hard surface.
7. Take out the plant along with the root ball.
8. Safely loosen the excess soil between the root and shake out the excess soil.
9. Remove decayed and dead roots with a sharp secateur.

10. Keep the plant with the ball of earth in position in the new pot.
11. Fill the remaining pot with new, potting mixture and press it uniformally.
12. Add few soil at the top and level the surface.
13. Clip off few leaves to check transpiration.
14. Water thoroughly with a fine rose spray.
15. For week or two keep the pots under partial shade.

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EXERCISE NO. 14
FERTILIZER APPLICATION IN DIFFERENT CROPS

Fertilizer :

It is a chemical substance which is manufactured artificially. Fertilizer is rich source of nutrient and applied in crop production to supply a particular nutrient in which soil is deficient.

Categorization of Fertilizers :

1. Straight Fertilizer : It contains only one major nutrient eg. Urea, Single Super Phosphate.

2.**Complex /Compound Fertilizer** : It contains at least two major nutrients eg. D.A.P.

3. **Mixed Fertilizers** : It consist of mixing of single/straight fertilizers so as to supply more than one nutrient at a time.

4. **Complete fertilizer** : It contains all three major nutrient i.e. N, P & K.

5.**Incomplete Fertilizer** : It contains one or two major nutrients only.

6. **Low analysis Fertilizer** : Such fertilizer contains less than 25% of primary nutrients. e.g. S.S.P. Ammonium Sulphate.

7. **High analysis Fertilizer** : The nutrient content in such fertilizer is more than 25% e.g Urea, Murate of Potash.

Types of Fertilizers :

1. Nitrogenous Fertilizer : Such type of fertilizer contains only nitrogen. eg. Urea, Ammonium Sulphate etc.

2. **Phosphatic Fertilizer** : Such fertilizer contains phosphorus only eg. SSP, Rock Phosphate etc.

3. **Potassic Fertilizer** : Such fertilizer supply K as a major nutrient eg. Murat of potash

4. **Complex Fertilizers** : It supplies at least two major nutrients to the crop.

5. **Micronutrients :** As the name indicates these nutrients are required in small quantity by plants. Their requirement vary from 0.1 to 5.00 ppm.

Application of Fertilizers ;

For maximized efficiency, fertilizers should be applied in root zone of the plant. Following are the few methods of application of fertilizers to the crops.

1. **Broad casting :** Application of fertilizers uniformly in the entire filed is termed as broadcasting. In this technique, wastage of nutrient is maximum.

2. **Top dressing** : It implies to application of fertilizers in standing crop. Nitrogen & micronutrient fertilizers are administered to the plant using this method.

3. **Localized placement** : In this technique, fertilizers are applied close to the seed or plant. This technique is very much economic & less quantity of fertilizers is required for the purpose of applying nutrient.

4. **Contact Placement** : In this technique, seeds and fertilizer are applied simultaneously at the time of sowing.

5. **Band Placement** : In this method, fertilizers are applied in band. This is especially useful in widely spaced crops like fruits and plantation crops.

6. **Row placement :** It consists of placing the fertilizers along the rows of crops. This technique is suitable for application of fertilizers in vegetable crops.
7. **Pellet Placement** : In this method soil and fertilizers are mixed in the ratio of 1:10 to form pellet. These pellets are placed in root zone of plants.
8. **Starter Solution** : It is mild solution of NPK in the ratio of 1:2:1 used for soaking the seeds, dipping roots and spraying ones seedlings for early start of the crop.
9. **Fertigation** : Application of fertilizers along with irrigation water is called as fertigation are given in splits to support production.
10. **Foliar Spray** : Mild solution of nutrient is applied over foliage.

Fertilizers Dose :

Fertilizer dose is calculated based on requirement of crop for it's various physiological activities. While applying fertilizers nutrientional status of soil is taken into amount. After deducting contribution of soil, rest amount is replenished externally using fertilizers.

Time of fertilizer application :

Unlike the manures, the fertilizers are applied at the time of active growth of plant so that the nutrients may be absorbed by the roots generally, the plants remain active during February, march and July and new growth emergence of plant during this times, fertilizers must be applied. In case of bearing plants, the manures and fertilizers are applied to cope with nutritional requirement. Under such circumstances, the manures and fertilizers must be applied one month before the commencement of flowering in plants phosphatic fertilizers being less soluble, should be applied about 20 days before the commencement of new growth. Nitrogenous fertilizers being highly soluble and hence prone to leaching losses, should be applied in split dose. Half of the recommended dose of nitrogen should be given before commencement of flowering and rest half dose is given after set. This holds true especially in case of fruits. In case of vegetables, the recommended dose of fertilizers are applied at the time of sowing, transplanting & also drying growing. Nitrogenous fertilizers are given in splits to support production.

Problem :

Formula :

Desired fertilizer = Nutrient required x Conversion factor required.

Problem :

1. Calculate the quantity of urea, when 50 kg 'N' is applied to vegetable crop.
2. Calculate the quantity of nitrogen, which 108.5 kg urea is applied to vegetable crops.

i) Desired fertilizer (urea) required = Nutrient required x factor

108.5 kg = 50 x 2.17

ii) Nutrient required = Desired fertilizer (-) factor required

50 kg = 108.5 (-) 2.17

Foliar spray:

1. 1 kg urea/DAP in 100 litres water = 1% concentration.
2. 100 g urea/DAP in 10 litres water = 1% concentration.
3. 100 g urea/DAP in 1 litre water = 1% concentration.
4) Concentration of solution or stock solution in %

$$= \frac{\text{Wt. of fertilizer in kg}}{\text{Vol.of water in litre}} \times 100$$

5) Vol. of stock sol.= $\frac{\text{Required conc.of soln. (\%) x Required vol of water in ml}}{\text{Conc. of stock sol in \%}}$

Problem : 3 kg of urea is dissolved in 40 litres of H_2O from this solution prepare 10 litres of solution of 1.5 % strength.

1. Concentration of $= \frac{\text{Weight of fertilizer in kg}}{\text{Vol. of } H_2O \text{ in litre}} \times 100$

$$= \frac{3 \times 100}{40} \times 100 = 7.5\ \%$$

1. Vol. of stock solution $= \frac{\text{Required conc. of solution in \% x Required vol. of } H_2O \text{ in ml}}{\text{Conc. of Stock solution in \%}}$

$$= \frac{1.5 \times 10 \times 1000}{7.5} = 2000 \text{ ml} = 2 \text{ litre.}$$

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1. 46 kg N. — 100 kg urea
50 kg N — ?

$$= \frac{50 \times 100}{46} = \frac{5000}{46} = 108.6 \text{ kg urea}$$

2. 100 kg urea – 46 kg N
108.5 kg urea – ?

$$\frac{108.5 \times 46}{100} = 50 \text{ kg N}$$

EXERCISE NO. 15
VISIT TO COMMERCIAL NURSERIES

EXERCISE NO. 16
VISIT TO COMMERCIAL ORCHARD