Propagation methods and use of rootstocks

- Plant Propagation- multiplication of plants by both sexual and asexual means.

- Study of plant propagation has three different aspects:
  - A knowledge of mechanical manipulations and technical skills - art of propagation.
  - A knowledge of plant growth and structures - science of propagation.
  - A knowledge of different kinds of plants and their methods of propagation.
Horticultural crops are grown from seeds for three principal reasons:

- To produce commercial crops
- To develop new varieties
- To grow rootstock for budding and grafting
Plant propagation involves the control of two basically different types of developmental life cycles SEXUAL and ASEXUAL.

**SEXUAL PROPAGATION**
- UNION OF MALE AND FEMALE SEX CELLS
- FORMATION OF SEEDS
- POPULATION OF SEEDLING INDIVIDUALS NEW AND SIMILAR AND DIFFERING GENOTYPES
Advantages of sexual Propagation

- Seedling trees - generally long-lived, bear more heavily and comparatively more hardy.
- Only means of reproduction, where asexual propagation is not possible or economical e.g. Papaya, phalsa, mangosteen etc.
- To develop new varieties
- For the production of chance seedlings of highly superior merits.
Polyembryonic character - some citrus species and some mango varieties. These nucellar seedlings are true to type.

Rootstocks are mostly raised from seeds.

Seedlings are cheaper and easy to raise.

Easily transported to distant places e.g. seeds.

Does not require high technical knowledge and skilled labour.
Disadvantages

⦁ Seedling trees - not uniform in their growth, yielding capacity and fruit quality.

⦁ Take more years to bear the first crop.

⦁ Become large for economic management.

⦁ Not possible to maintain the exact character of any superior selection.

⦁ Seed propagation can not be applied in many plants e.g. banana

⦁ Not possible to avail the modifying influence of rootstock on scion or scion on rootstock.
Advantages of Asexual Propagation

- True to type, uniform in growth, yielding capacity and fruit quality.
- Plants come into bearing earlier.
- Uniformity in fruit quality makes harvesting and marketing easy.
- Modifying influence of rootstock on scion can be profitably availed off.
- Possible to regulate the tree size, fruit quality, precocity etc. according to one’s requirements by using different rootstocks.
Cross pollination can be effected by grafting shoots of other suitable varieties (pollinizers) on some of the branches of self-unfruitful variety.

Grafting can be used to encourage healing of tree wounds caused by rodents, implements.

Composite tree can be raised.

One can correct to some extent the initial mistakes of planting inferior or unsuitable varieties.
Disadvantages

- No new variety can be evolved.
- Sometimes more expensive.
- Comparatively short lived.
Propagation of Fruit Crops

Sexual Propagation - Seed

- Stratification
  - Moist cold treatment
  - 35 to 40° F for 60 - 90 day
- Rootstocks of peach, apple, apricot etc.
**Scion:** Short piece of detached shoot containing several dormant buds, which, when united with the stock, comprises the upper portion of the graft and from which the stem or branches or both grow. It should be of desired cultivar and free from diseases.
Rootstock: is the lower portion of the graft, which develops into the root system of the grafted plants. It may be seedling, rooted cutting, or a layered plant.
**Interstock**: a piece of stem inserted by means of two graft unions between the scion and the rootstock. It is used:

- To avoid incompatibility between stock and scion
- To make use of winter hardy trunk
- To take advantage of its growth controlling properties.
**Cambium**: Thin tissue of the plant located between the bark (phloem) and the wood (xylem). Its cells are meristematic.

**Callus**: Mass of parenchyma cells that develops from and around wounded plant tissues. It occurs at the junction of a graft union, arising from the living cells of both scion and stock.
Asexual

Budding (one bud and a small section of bark with or without wood is used)

- Join bud with rootstock
- Time of year
  - Active growth season
- Methods
  - T-budding, Inverted T-budding, Chip budding, patch budding, annular budding
Propagation of Fruit Crops

- Asexual

  ▶ Grafting (art of connecting two pieces of living plant tissues together in such a manner that they unite and subsequently grow and develop as one plant)

    ▶ Join stem piece with rootstock

    ▶ Time of year
      - End of dormant season

    ▶ Methods
      - Tongue, Side Veneer, cleft, epicotyl, soft wood
Budding and Grafting

Objectives

- Produce desired scion
- Top work to change scion in established orchard
- Introduce proper pollinizer
Budding and Grafting
Components of Success

- Graft compatibility
  - Cambium of scion and stock need to be in contact
  - Proper physiological stage
  - Healthy and actively growing
  - Prevent desiccation
  - Proper after care
    - Control shoot growth from stock
    - Support scion shoot
Preparation of rootstocks

Rootstock

Slanting Cut on rootstock

Upward pointing tongue is made in the upper half of this slanting surface

Preparation of scion

Scion stick

Slanting Cut Made on scion

Downward pointing tongue is made in the upper half of the slanting surface

Joining of rootstocks and scion

The cut surfaces of the scion and stock are now placed together so that the tongues interlock

Cambial contact

Scion and stock are firmly tied together with a plastic strip

Fish. Basic steps in performing tongue grafting
Preparation of root stock

The top of the stock should be cut off.

This split is made by pounding the knife.

A vertical split of 5-8 cm down the center of the stock.

At the basal end of each scion a smooth, long, sloping wedge cuts of 5 cm is made.

Preparation of scion

Placement of scion with proper contact of cambium layer of scion and stock.

Scion and stock are firmly tied together with a plastic strip.

The scion are inserted in a stub into the vertical split.

Fig. Basic steps in performing cleft grafting
Preparation of root stock

A shallow downward and inward cut of about 4.0 - 5.0 cm long is made in a smooth area of one side of the rootstock.

Preparation of scion

The scion is prepared with a long cut along one side and very short one at the base of the scion on the opposite side.

Inserting scion in such a way that the cambium layer is closely matched.

After the union has healed, the rootstock is cut back above the scion either in gradual steps or all at once.

Scion and stock are firmly tied together with a plastic strip.
**Preparation of root stock**

- A vertical cut about 2.5 cm long in the stock.

**Preparation of scion**

- A horizontal cut is made through the bark about 1/3 the distance around the stock.
- The shield piece / bud is cut out of the bud stick.

The shield is then removed from the stick leaving a back strip that facilitates insertion.

The insertion of the shield piece containing the bud into the incision in the stock plant by pushing it downward under the two flaps of the bark.

The bud union is then tightly tied with polythene strip.

**Fig. Basic steps in performing T-budding**
Preparation of root stock

A complete ring of bark about 3.5 cm wide is removed from the stock by giving two transverse cuts and a vertical cut to connect the two horizontal cuts.

Preparation of scion

A similar ring containing a healthy bud in the centre, is then removed from the bud stick.

The ring of bark containing the scion bud is fitted on the stock.

A vertical cut through the width of ring opposite to the scion.

The budded portion is tied tightly with polythene strip leaving the bud naked.

Fig. Basic steps in performing Annular budding
A rectangular patch of bark approximately 2.5 cm x 1.5 cm, with a bud in its centre is removed from the stock.

The patch of bark containing the scion bud is fitted tightly on the stock.

The budded portion is tied tightly with polythene strip leaving the bud naked.

Fig. Basic steps in performing patch budding
Preparation of root stock

Trim the rootstock to give the clean stem beyond the budding height.

Preparation of scion

A chip of bark along with wood is removed from the smooth portion between nodes.

The chip is lifted between thumb and knife blade and fitted tightly on the rootstock.

Similar size chip of bark along with wood containing bud in its center is removed from the scion stick.

The budded portion is tied tightly with polythene strip leaving the bud naked.

Fig. Basic steps in performing chip budding
Propagation through cuttings

A portion of a stem, root or leaf is cut from the parent plant and is placed under certain favourable environmental conditions to form roots and shoots. Thus a new independent plant is produced which in most cases identical with the parent plant.
Advantages of Propagation through cuttings

- Many new plants can be started in a limited space from a few stock plants.
- Inexpensive, rapid and simple.
- Does not require special techniques necessary in grafting and budding.
- No problem of compatibility with rootstock or of poor graft unions.
- Greater uniformity.
- Parent plant is usually reproduced exactly, with no genetic change.
Types of Cuttings

❖ Stem cuttings

❖ **Hardwood** (matured, dormant hardwood after leaf fall and before new shoots emerge in spring.) - grapes, fig, quince, olive, currants, kiwi, pomegranate, plum and apple rootstocks

❖ **Semi-hardwood** (woody, broadleaved evergreen species but leafy summer cuttings taken from partially mature wood of deciduous plants can also be considered) - citrus and olive
Types of Cuttings

೫ Stem cuttings

● **Softwood** (Soft, succulent, new spring growth of deciduous or evergreen species) – Fruit plants not commercially propagated but – apple, peach, pear, plum, apricot and cherry under mist.

● **Herbaceous** (succulent, herbaceous plants) – geranium, chrysanthemum, coleus or carnations)
Types of Cuttings

- **Leaf cuttings** (leaf blade or leaf blade and petiole)
  - Begonia rex (leaf pieces), Africon violet (leaf blade + petiole)

- **Leaf bud cuttings** (Leaf blade, petiole and a short piece of stem with the attached axillary bud)
  - Black raspberry, boysenberry, lemon, Tea and Rhododendron

- **Root cuttings** (root pieces from young stock plants in winter or early spring)
  - Pecan nut, blackberries
Propagation Through Layering

**Layering** (adventitious roots are caused to form on a stem while it is still attached to parent plant. The rooted or layered plant is detached to become a new plant growing on its own newly formed roots).

**Uses of layering:**
1. Natural reproduction (black raspberry).
2. Propagation of clones whose cuttings do not root easily (Muscadian grapes, clonal rootstocks of apple & pear).
3. Producing large sized plants in short time.
4. Producing relatively small number of plants of good size with minimum facilities.
Factors affecting regeneration of plants by layering

- Nutrition
- Stem treatment (shoot bent, shoot cut, girdling)
- Light exclusion
- Physiological conditioning
- Rejuvenation

For root formation in layered plants factors like

- Continuous Moisture
- Good aeration
- Moderate Temperature in the rooting zone
Propagation Through Layering

- Tip layering (cover tips in late summer)
  - Blackberries, trailing
- Simple layering (tip not covered/girdle)
  - Grapes
- Compound or Serpentine layering (same as simple but branch is alternately covered & exposed along its length)
  - Muscadine grapes
- Air layering (girdle and moist cover)
  - Litchi, Guava, Lemon, Loquat, Fig
- Trench layering (branch or plant as a whole laid flat in trench)
  - Clonal rootstocks of Apple & pear; quince etc.
- Mound layering or stooling
  - Clonal rootstocks of Apple & pear; quince etc.
Apomixis

The occurrence of asexual reproductive process in place of sexual reproductive processes of reduction, division and fertilization to produce an embryo is known as apomixis.

Seedlings produced in this manner are known as apomicts

- Obligate apomicts: Plants that produce only apomictic embryos.
- Facultative apomicts: Plants that produce both apomictic and sexual embryos.

Apomictic seedlings are identical with its mother plant and are also completely free from viruses.
Types of Apomixis

- Recurrent Apomixis
- Non-Recurrent Apomixis
- Nucellar Embryony or Adventitious Embryony
- Vegetative Apomixis
## Apomixis

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Use of Rootstocks in Fruit Trees

• Primary function of rootstock is
  ▲ To provide anchorage by growing deep into the soil.
  ▲ To regulate the uptake of moisture and nutrients.
Effects of Rootstock

Rootstock exhibit great effect on:

- Vigour of the scion
- Anchorage of scion
- Precocity in bearing
- Flowering, fruiting, yield and fruit quality
- Impart resistance to biotic (diseases and insect/pests) and abiotic stresses (salt tolerance and water logging) of scion cultivars.
- Leaf nutrient status of scion
Ideal Rootstock

- Freestanding
- Precocious
- Dwarfing
- Graft compatible
- Easy to propagate
- Disease & Insect resistant
- Widely adaptable
- High Yielding
- High quality
Seedling Rootstock

- Raised from seed
- Advantages:
  - Production of seedlings is simple and economical.
  - Well adapted to mass propagation methods.
  - Most seedling plants do not retain viruses occurring in the parent plant (although some viruses are seed transmitted).
  - Root system of seedlings tend to grow deeper and more firmly anchored than vegetatively propagated rootstocks.
- Disadvantage: Genetic variation.
Clonal Rootstock

- Propagated vegetatively either by stool layering, rooted cuttings or by aseptic tissue culture method.

- Advantages:
  - Uniformity
  - Special characteristics and specific influences of rootstocks on scion cultivars such as growth, flowering habit or disease resistance are preserved
Apple Rootstocks

- Vigorous: M1, M13, M25, MAC-4, MAC-24, O.11, Alnarp 2, Robusta 5, Novole, seedlings
- Semi-vigorous: M2, M4, MM106, MM111, P18, O.1, O.2
- Semi-dwarf: M7, P1, MAC-1, Northern Spy
- Dwarf: M9, M26, P2, P16, Bud. 9, MAC-9
- Ultra dwarf: M27
Dwarfing Rootstocks

- Apple: M9, M26, P 2, P 16, Bud. 9, MAC-9
- Pear: OHxF 51, Oregon 211, Oregon 249, Quince C
- Apricot: Prunus besseyi
- Cherry: Colt, Charger
- Peach: Siberian C and Rubira
- Plum: St. Julien K and Pixy
Pear rootstocks

- Seedlings of different *Pyrus* species - most widely and most commonly used rootstocks.
- In India, most commonly used rootstock are:
  - seedlings of Kainth and Shiara
  - Quince - clonal rootstock
Stone Fruit Rootstocks

- Peach: wild peach
- Plum: wild peach, wild apricot,
- Apricot: wild apricot, wild peach
- Almond: wild peach, bitter almond, behmi
- Cherry: Paja, Colt, Mazzard, F12/1
Walnut rootstocks

- Seed propagated
- *Juglans regia*
- *J. nigra* - Black walnut
- *J. hindsii* - Cal. Black walnut
- *Paradox* - *J. regia* × *J. hindsii*
Pecan rootstocks

- Seed propagated
- Seedlings of commercial cultivars (Burkett, Calaro, Mahan, Apache, Moore, Western Schley, Riverside etc.)
- Selected according to
  - Soil adaptation
  - Cold hardiness
Cherry Rootstocks:

- Paja
- Sour cherry
- Colt: dwarfing clonal rootstock
- F-12/1
- Charger: semi-dwarf
- Gisela-10: dwarfing
- Other rootstocks: Mazzard (*Prunus avium*)
  - vigorous
- Mahaleb (*Prunus mahaleb*)
  - somewhat dwarf, cold hardy
Rootstocks Resistant to Drought

- Apple: MM111
- Pear: Oregon 211 and Oregon 249
- Peach: GF 557 and GF 677
- Plum: Myrobalan 27
Rootstocks Resistant to Nematodes

- Pear: Oregon 211, 249, 260, 261 and 264
- Peach: Nemaguard, Nemared, Okinawa, Flordaguard
- Plum: Mariana 2624, Mariana GF8/1
- Almond: GF 557, Alnem 1, Alnem 38, Alnem 201, Hansen 536, Hansen 2168
Rootstocks for Mango

- Creeping: dwarfing
- Kurukkan: Polyembryonic and salt tolerant
- Olour: Dwarfing
- Rumani: Dwarfing
- Totapuri Red Small; dwarfing
Citrus Rootstocks:

- Rough Lemon: commonly used in H.P.
- Trifoliate orange: cold hardy
- Cleoptra mandarine
- Sour orange
- Rangpur lime
- Sweet orange
Rootstocks for fruit crops

Grape:
- Dogridge: Resistant to *Phylloxera*, nematodes and salts
- Salt Creek: Resistant to salts and nematodes
- Rupestris St. George: Resistant to *Phylloxera*
- Riparia Gloire: Resistant to *Phylloxera*
- Temple: Impart resistant to scion against Pierce disease, anthracnose and downy mildew
Rootstocks for fruit crops

Ber

- *Zizyphus nummularia*

Guava

- Chinese guava (*Psidium friedrichthalianum*): impart resistance against guava wilt and nematodes, induces dwarfness
- Pusa Srijan (aneuploid No. 82): Induces dwarfing and show field resistance against guava wilt
- *Psidium pumilum*: used for induction of dwarfing
Rootstocks for fruit crops

- Sapota
  - Khirni (*Manilkara hexandra*)
- Persimmon
  - Amlook (*Diospyros lotus*)
  - *Diospyros virginiana*