

Week 2: Cultivation of Apple

Objective:

This lecture will deal with introduction of apple, area and production, soil and climatic requirements, varieties, rootstocks and propagation techniques, planting density, training and pruning systems.

INTRODUCTION

Taxonomic classification of apple

Order	=	Rosales
Family	=	Rosaceae
Sub-family	=	Pomoideae
Genus	=	Malus
Species	=	domestica
Basic chromosome	=	17
Somatic no's = 34, 51, 68		

INTRODUCTION

- The apple (*Malus x domestica* Borkh.) is an important temperate fruit and is grown in areas where winter are cold, springs are frost free, summer are mild.
- The genus *Malus* has 25 species.
- The primary center of origin of apple is thought to be the region which includes the South Western Asia , the Caucasus, Soviet Central Asia and Hindu-Kush Himalayan region.
- In India, apple was introduced by Captain Lee in 1865 in Kullu Valley of Himachal Pradesh.
- Later on , red coloured Delicious group varieties were introduced at Kotgarh in Shimla district of Himachal Pradesh in 1917 by American missionary Mr Satya Nand Stokes.
- Apple fruit is rich in carbohydrate (15 %) protein (0.3 %) and nutrients like in K, P and Ca.

AREA AND PRODUCTION

- In India, Apple is grown on commercial scale in Jammu and Kashmir, Himachal Pradesh and Uttarakhand .
- It is also cultivated on limited scale in North-Eastern states like Arunachal Pradesh, Sikkim, Nagaland, Meghalaya and Manipur and Nilgiri hills of Tamil Naidu.
- In India, apple occupies an area of 2,82,940 hectares with a total production of 17,77,230 MT (NHB,2009-10).

Table 1 :Area and production of apple in India

State	Area (000hectares)	Production (000 MT)
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Jammu and Kashmir	138.10	1373.000
Himachal Pradesh	99.6	280.10
Uttarakhand	32.4	114.0
Arunachal Pradesh	12.8	10.0
Total	283	1777.10

Source : (NHB, Data base 2009-10).

Climate and Soil

- The apple is a typical temperate fruit and is generally grown in the temperate regions of the world.
- Northern aspect is considered most suitable for its cultivation.
- Most of apple varieties require 1000-1600 chilling hours during winter to break the rest period, however some low chill varieties require only 500-800 chilling hours.
- The average summer temperature should be around 21-24°C during active growth period.
- Low temperature below 15°C, rains and cloudy weather during bloom restrict the bee activity, which is completely inhibited below 5°C and adversely affect fruit set.
- The optimum temperature for pollination, pollen germination and fruit setting is 18 to 22°C.
- The areas with frost free spring and adequate sunshine during summer without wide fluctuation in temperature are most suitable for apple growing.
- Well distributed rainfall of about 100-125 cm throughout the season is considered most favorable.
- The long drought spells during fruit development and excessive rains and foggy conditions at maturity hamper fruit size and quality.
- Apple thrives best in loamy soils, which are rich in organic matter.
- A soil pH between 6.0 to 6.5 with good drainage and aeration are considered most suitable.
- The soil should be deep, fertile and free from hard substrates and waterlogged conditions.

• VARIETIES

• VARIETIES

- Table 2. Recommended varieties of apple in different states of India.

Season	Jammu and Kashmir	Himachal Pradesh	Uttarakhand
Early season	Irish Peach, Benoni	Tydemans Early Worcester(P), Michael, Mollies Delicious, Schlomit, Starkrimson, Anna	Early Shanburry(P), Fenny, Benoni, Chaubattia Princess
Mid season	American Mother, Razakwar, Jonathan(P)	Starking Delicious, Red Delicious, Rich-a-red, Vance Delicious, Top	Red Delicious, Starking Delicious,

	Cox ^o Orange Pippin(P), Queen's Apple, Rome Beauty, Scarlet Siberian	Red, Lord Lambourne(P) Red Chief, Oregon Spur, Red Spur, Red Gold(P), Silver Spur, Scarlet Gala, Well Spur, Super Chief, Scarlet Spur.	McIntosh(P), Cortland, Golden Delicious(P)
Late season	King Pippin, American Apirouge, Kerry Pippin, Lal Ambri, Sunheri Chamure, Golden Delicious(P), Red Delicious, Ambri, Baldwin, Yellow Newton(P),	Golden Delicious(P), Yellow Newton(P), Winter Banana, Granny Smith(P), Red Fuji, Coe Fuji	Rymer, Buckingham(P)

- *P = Pollinizer

- **Spur types and colour sports:** Red Chief, Oregon Spur-II, Silver Spur, Well Spur, Red Spur, Super Chief, Starkrimson, Hardi Spur., Schelet Spur, Ace Spur

- **Standard colour mutants:** Vance Delicious, Top Red, Skyline Supreme, Hardiman, Bright-N-Early.

- **Standard varieties:** Starking Delicious, Red Delicious, Rich-a-red

- **Low chilling varieties:** Michal, Schlomit, Anna, Vered, Tamma, Tropical Beauty and Parlins Beauty.

Pollinizing varieties: Golden Delicious, Red Gold, Tydeman's Early Worcester, Summer Queen, Golden Spur, Granny Smith, Winter Banana, McIntosh, Scarlet Gala and flowering crabs like Manchurian, Snow Drift and Malus floribunda

- **Scab resistant varieties:** Prima, Priscilla, Sir Prize, Florina, Flrdous, Shireen, Macfree, Coop-12, Coop-13, Liberty and Freedom.

Hybrid Varieties: Lal Ambri (Red Delicious x Ambri), Sunheri (Ambri x Golden Delicious) Chaubattia Princess and Chaubattia Anupam (Early Shanburry x Red

Delicious), Ambred (Red Delicious x Ambri), Ambrich (Richared x Ambri), Amroyal (Starking Delicious x Ambri).



Plate 3. Vance Delicious



Plate 4. Top Red

delicious, Red Delicious, Rich-a-red



Plate 5. Rich-a-red



Plate 6. Starking Delicious

ROOTSTOCKS AND PROPAGATION

Apple is propagated by asexual method of grafting and budding on rootstocks.

Rootstocks:

(1) Seedling rootstocks

- Seedling rootstocks are vigorous and not uniform in size.
- Seeds of crab apple (*Malus baccata*) or self pollinizing varieties like Golden Delicious and Granny Smith are used for raising seedling rootstocks.

(2) Clonal rootstocks

- Clonal rootstocks are precocious, uniform and resistant to some insect pests and diseases.
- In recent years size controlling clonal rootstocks are gaining popularity especially for establishment of high density.
- The promising clonal rootstocks of apple are:
 - M9 or EMLA9 and M26 or EMLA26 (Dwarf)
 - M7 or EMLA7, MM106 or EMLA106 (Semi dwarf)
 - MM111 or EMLA111 (Semi vigorous)
 - Merton 793 (vigorous)
- Malling series(M) rootstocks are size controlling but not resistant to woolly apple aphid.

- Malling Merton series (MM) are size controlling and resistant to woolly apple aphid.
- EMLA series rootstocks are virus free.

Propagation

Propagation of rootstocks

(a)Seedling rootstock

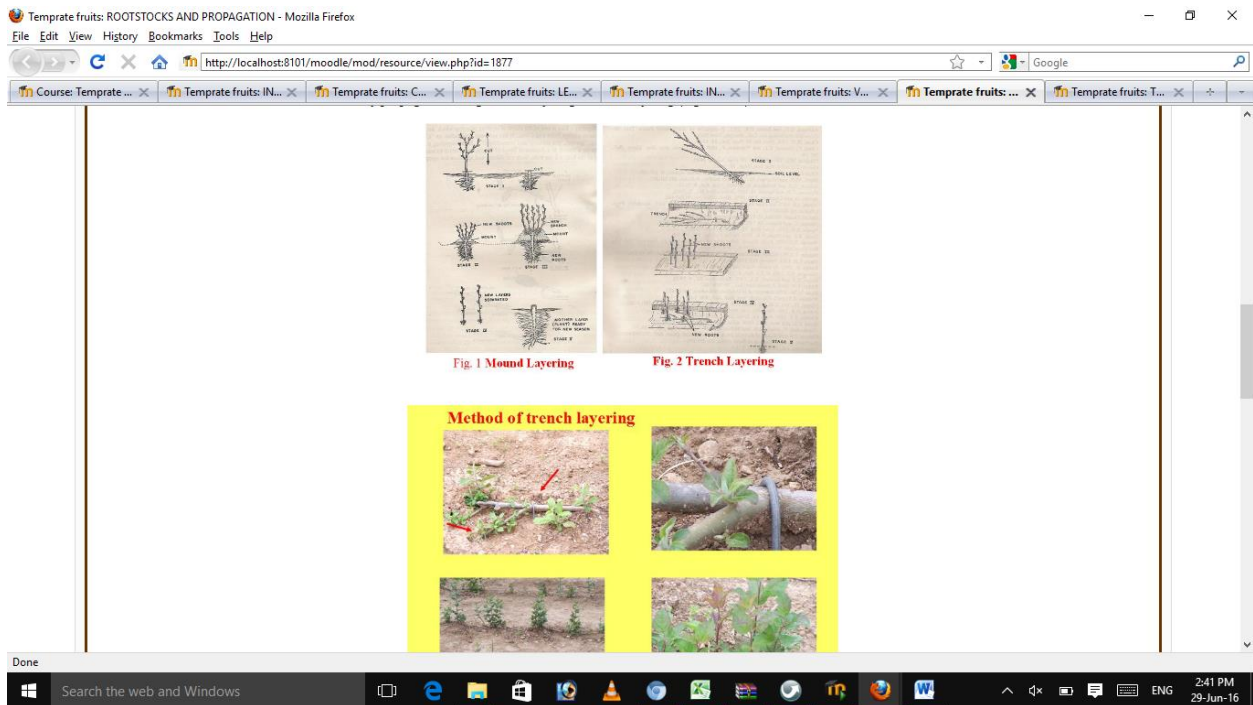
- Seeds of apple are dormant, which require stratification treatment (moist chilling) to break dormancy.
- Seeds are stratified for 60-70 days in alternate layers of moist sand at 4-6 oC during December to February.
- The stratified seeds are sown in nursery beds during March at a spacing of 8-10 cm from seed to seed and 15-20 cm from line to line.
- After sowing, the nursery beds are mulched with 10 cm thick dry grass and light irrigation is given to avoid desiccation of stratified seeds.
- Mulch is removed as soon as seed start germinating.
- Cultural operations like weeding, hoeing, irrigation and spray of insecticide and fungicides are done at regular intervals.
- The seedling rootstock attain graftable size of 15 mm diameter in a year.

(b)Clonal rootstock

- The clonal rootstocks are commercially propagated through mound layering or trench layering (Fig 1 and 2)

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Propagation of scion

- The commercial method of propagation of apple scion varieties is grafting and chip budding.
- For grafting and budding the scion wood should be collected from healthy, disease free, true to type mother trees during January.
- The scion wood is collected from one year old shoots and packed in moist sphagnum moss, after proper labeling of variety.
- These bundles of scion wood are stored in cold storage or buried deep in the soil at shady place till required for grafting .
- The best time of grafting of apple is February to March with tongue and cleft methods.
- Chip budding can also be done in March and July.

PLANTING AND PLANTING DENSITY

- The best time of planting of apple is January - February.
- The planting distance varies according to variety, rootstock and fertility status of soil.
- Before planting, orchard layout should be planned. In flat land square or hexagonal system of layout is adopted, whereas in sloppy land contour and terrace system of layout is done.
- After layout of an orchard, the pits of 1x1x1 m size are dug well in advance of planting.
- The pits are filled atleast one month before planting with soil in which 40-50 kg well rotten FYM and 1 kg single super phosphate are mixed.
- After planting, watering is done and tree basins are mulched with 10 cm thick dry grass, which helps in conserving the soil moisture and control the weed population.
- In apple, most of the varieties are self unfruitful, therefore, at the time of planting proper proportion of pollinizer varieties (25 or 33%) should be planted in the orchard.

Table 3 Spacing and planting density for different scion stock combinations

Fruit crop	Scion/variety	Rootstock	Tree size	Spacing (m)	Density (trees/ha)
Apple	Standard	Seedling	Vigorous	7.5 x 7.5	178
	Standard	MM111 and Merton 793	Semi vigorous	6.0 x 6.0	278
	Standard	MM106, M7	Semi dwarf	4.5 x 4.5	494
	Standard	M9 and M26	Dwarf	1.5 x 1.5	4444
	Spur type	Seedling	Semi vigorous	5.0 x 5.0	400
	Spur type	MM111, Merton 793	Semi dwarf	3.5 x 3.5	816
	Spur type	MM106, M7	Dwarf	3.0 x 3.0	1111

TRAINING AND PRUNING

Training and pruning are most important orchard management practices for proper canopy development and quality fruit production.

Training

- Training is done to shape or build a strong framework of the trees in order to support maximum crop when plant reaches bearing stage.
- There are several systems of training in apple especially for dwarf plantations like spindle bush, dwarf pyramid and cylinder spindle etc., but modified central leader system is most suitable for standard plantation.

Modified central leader system

- Generally, one – year – old whip without a single branch is planted in the dormant season.
 - Immediately after transplanting the tip of plant is headed back 60 to 75 cm above the ground level.
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Fig 3. Pruning at planting

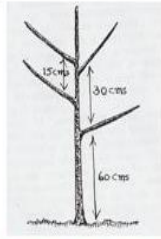


Fig. 4. Selection of primary branches

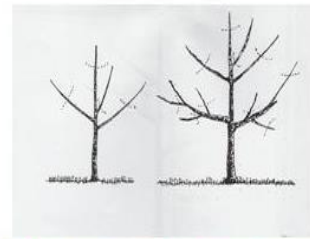


Fig. 5 First year pruning Fig. 6. Second year pruning



Fig. 7 Third year pruning



Fig. 8 Fourth year pruning

Fig.2-8 Modified Leader System of Training

- In the following summer, most of the buds on main branch will sprout.
- In order to develop clean stem up to 45 cm from the ground the sprouted buds are pinched off soon after their appearance.
- Three or four well spaced buds projecting in opposite directions are retained with lowest one 45 cm above ground . If summer pruning is not done, then 3-4 well spaced primary branches having wider crotch angle are selected during dormant pruning.
- The selected branches should be spaced 10-15 cm apart in spiral fashion. The branches emerging below 30 cm from ground level and other undesirable branches are pruned off.
- The selected branches are headed back to $\frac{1}{4}$ of growth to a bud projecting to the outer direction.
- The leader is also headed back to 30 cm above the last branch.
- During the second dormant pruning, 2-3 well spaced primary branches are selected on the leader.
- On the primary branches selected during previous year, two secondary branches which are growing outward direction should be selected.
- The selected primary and secondary branches are headed back to $\frac{1}{3}$ - $\frac{1}{4}$ of the growth.
- The secondary and tertiary branches selected should be spreading horizontally and upright or down ward growing branches should be removed.
- The third year training consists of thinning out of unwanted branches and heading back of desirable side branches.
- The central leader should be headed back to a bud or weak shoot, which will develop in the form of a side branch.
- By fourth year training should be completed.

Pruning

- The objective of pruning is to maintain a proper balance between vegetative growth and spur development.
 - The training is completed during initial 4-5 years after planting of plant, but pruning is continued after training throughout the life of tree.
 - In pruning, thinning out and heading back are two basic components. The pruning consists of thinning out of all upright laterals and those growing inside the trees and heading back of leaders and laterals.
 - In apple, the fruit is obtained not only spurs but also on fruit buds on young laterals. Therefore, pruning should be done in such a way that continuous supply of new, healthy shoots, spurs and branches are maintained.
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- While pruning, some part of tree is pruned and some left unpruned. The pruned parts produce shoot growth and unpruned parts will produce fruit buds.
 - The laterals which have left unpruned in one year, may be either shortened or left unpruned in the next year depending on the growth, spur formation and crop load.
 - Once the laterals have cropped and become weak, they must be severely shortened leaving them 5-6 cm long.
 - The severe shortening will promote the production of new growth from these stubs, which in two years will give a crop.
 - The whole cycle is accordingly repeated every year to ensure regular growth, spur formation and cropping.
 - At the time of pruning dead, diseased and broken branches are removed and on the cut surface Chaubattia or Bordeaux paste is applied to avoid any fungal infection.
 - The best time of pruning is during dormant season (December to January).
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