

APPLE

# Scientific classification

- Kingdom : Plantae
- Phylum : Angiosperms
- Class : Rosids
- Order : Rosales
- Family : **Rosaceae**
- Subfamily : Maloideae
- Tribe : Maleae
- Genus : *Malus*
- Species : *M. Domestica*
- Binomial name: ***Malus domestica* Borkh.**
- **Other members : Pear, Quince, Loquat, Medlar**





# Introduction

- One of the most widely cultivated tree fruits, and the most widely known of the many members of genus *Malus*.
- Apples grow on small, deciduous trees that blossom in **the spring** and produce fruit in **the fall**.  
The tree originated in Western Asia, where its wild ancestor, *Malus sieversii*, is still found today.

- Apples have been grown for thousands of years in Asia and Europe, and were brought to North America by European colonists.
- In 2010, the fruit's genome was decoded, leading to new understandings of disease control and selective breeding in apple production.
- There are more than **7,500** known cultivars of apples, resulting in a range of desired characteristics.
- Different cultivars are bred for various tastes and uses, including in **cooking, fresh eating** and **cider (Fermented wine prepared from Apples)** production.

## Nutritional value per 100 g (3.5 oz)

<u>Energy</u>	218 kJ (52 kcal)
<u>Carbohydrates</u>	13.81 g
- <u>Sugars</u>	10.39 g
- <u>Dietary fiber</u>	2.4 g
<u>Fat</u>	0.17 g
<u>Protein</u>	0.26 g
<u>Water</u>	85.56 g
<u>Vitamin A equiv.</u>	3 µg (0%)
<u>Thiamine (vit. B<sub>1</sub>)</u>	0.017 mg (1%)
<u>Riboflavin (vit. B<sub>2</sub>)</u>	0.026 mg (2%)
<u>Niacin (vit. B<sub>3</sub>)</u>	0.091 mg (1%)
<u>Pantothenic acid (B<sub>5</sub>)</u>	0.061 mg (1%)
<u>Vitamin B<sub>6</sub></u>	0.041 mg (3%)
<u>Folate (vit. B<sub>9</sub>)</u>	3 µg (1%)
<u>Vitamin C</u>	4.6 mg (6%)
<u>Calcium</u>	6 mg (1%)
<u>Iron</u>	0.12 mg (1%)
<u>Magnesium</u>	5 mg (1%)
<u>Phosphorus</u>	11 mg (2%)
<u>Potassium</u>	107 mg (2%)
<u>Zinc</u>	0.04 mg (0%)

# Apple cultivation in India

- Important temperate fruit of the north-western Himalayan region in India and is predominantly grown in J&K(**leading apple producing state**), Himachal Pradesh (known as **Apple bowl of India**) and hills of Uttar Pradesh, accounting for about 90% of the total production.
- Cultivation has also been extended to Arunachal Pradesh, Sikkim, Nagaland, and Meghalaya in north-eastern region and Nilgiri hills in Tamil Nadu.



# India's apple-growing areas



Source: ESRIC Data & Maps, 2004 and USDA/ERS.

Depiction of international borders is not intended to be authoritative.



The wide adaptability of Apple is due to:

- Early and continuous **rains from April onwards do not favour** the production of quality fruits besides resulting in high incidence of diseases.
- The apple-growing areas in India do not fall in the temperate zone of the world but the prevailing temperate climate of the region is primarily due to snow covered in Himalayan ranges and high altitude which helps to meet the chilling requirement during winter season extending from mid-December to mid-March.

## Botanical origins:

- The wild ancestor of *Malus domestica* is *Malus sieversii*.
- It has no common name in English, but is known where it is native as "alma"; in fact, one major city in the region where it is thought to originate is called Alma-Ata, or "father of the apples".
- This tree is still found wild in the mountains of Central Asia in southern Kazakhstan, Kyrgyzstan, Tajikistan, and Xinjiang, China.

- Other species that were previously thought to have made contributions to the genome of the domestic apples are *Malus baccata* (Crab apple) and *Malus sylvestris*, but there is no hard evidence for this in older apple cultivars.
- These and other *Malus* species have been used in some recent breeding programmes to develop apples suitable for growing in climates unsuitable for *M. domestica*, mainly for increased cold tolerance.

# Soil

- Soil depth, drainage and pH determine the suitability of soil types.
- **Loamy soils**, rich in organic matter having a pH of **5.5-6.5** with **gentle to moderate slope, proper drainage and good aeration** are most suitable.
- Free from hard substrata and waterlogged conditions.
- If cultivation is done on flat soils, proper drainage channels need to be developed to restrict the incidence of collar rot, root-rot and other soil-borne diseases.

# Climatic requirement

- Typical temperate fruit.
  - Chilling requirement for bud break (**spur formation**)
- Most of the apple varieties require 1,000-1,500 hours of chilling at or below 7.2 °C during winter to break the rest period.
- These conditions are available at an elevation of 1,500-2,700 m above MSL in the Himalaya ranges.
- Average summer temperature should be around 21 -24 °C during active growth period.
- Optimum temperature for pollen germination and fruit setting is 21-26.7 °C (**Early drop** : Due to lack of pollination and competition)

- Areas with **frost-free spring and adequate sunshine** during summer without wide fluctuations in temperature are **most suitable**.
- Areas exposed to **high winds** particularly the hill tops are also **not suitable**.
- **Dry winds** during summer **desiccate flowers and hamper bee activity**, resulting in **poor fruit set**.
- Low temp. **below 15°C** during bloom **restricts bee activity** which is completely inhibited below 4.4°C, affecting fruit set.
- **Fully opened blossoms may be killed at temperatures below -2.2°C.**
- The **optimal temperature for pollen germination and fruit setting is 21.1-26.7 °C.**



# RAINFALL

- ◎ Well distributed rainfall of 100-125 cm throughout the growing season is most favourable for its optimal growth and fruitfulness.
- ◎ The long drought spells during fruit development and excessive rains and foggy conditions at fruit maturity hamper fruit size and fruit quality.
- ◎ Dry temperate areas suitable for apple cultivation in Himachal Pradesh and Jammu and Kashmir are most suitable for production of high-quality fruits having intense colour development, high sugar content and longer shelf-life.

# APPLE BOTANY

- ◎ The apple tree is small and deciduous, reaching 3 to 12 metres (9.8 to 39 ft) tall, with a broad, often densely twiggy crown.
- ◎ The leaves are alternately arranged simple ovals 5 to 12 cm long and 3–6 cm broad with an acute tip, serrated margin and a slightly downy underside.





# Flowering & Floral Biology

- Petals are white when open, but have red-pink undersides when opening, hence the "**pink**" bloom stage.
- The ovary is inferior, embedded in the floral cup or hypanthium, containing 5 locules, usually 2 ovules per locule.
- The inflorescence is a cyme of 4-6 flowers, with the center flower opening first; the central flower is often called the "**King bloom**", and has the potential to produce a larger fruit than other flowers.
- Flowers are produced terminally from mixed buds (containing both leaves and flowers) on spurs, or to a lesser extent on long shoots.
- Spurs form on 2-yr-old and older wood, and generally grow only a fraction of an inch each year.



Corolla  
(Tepals)

Stamens

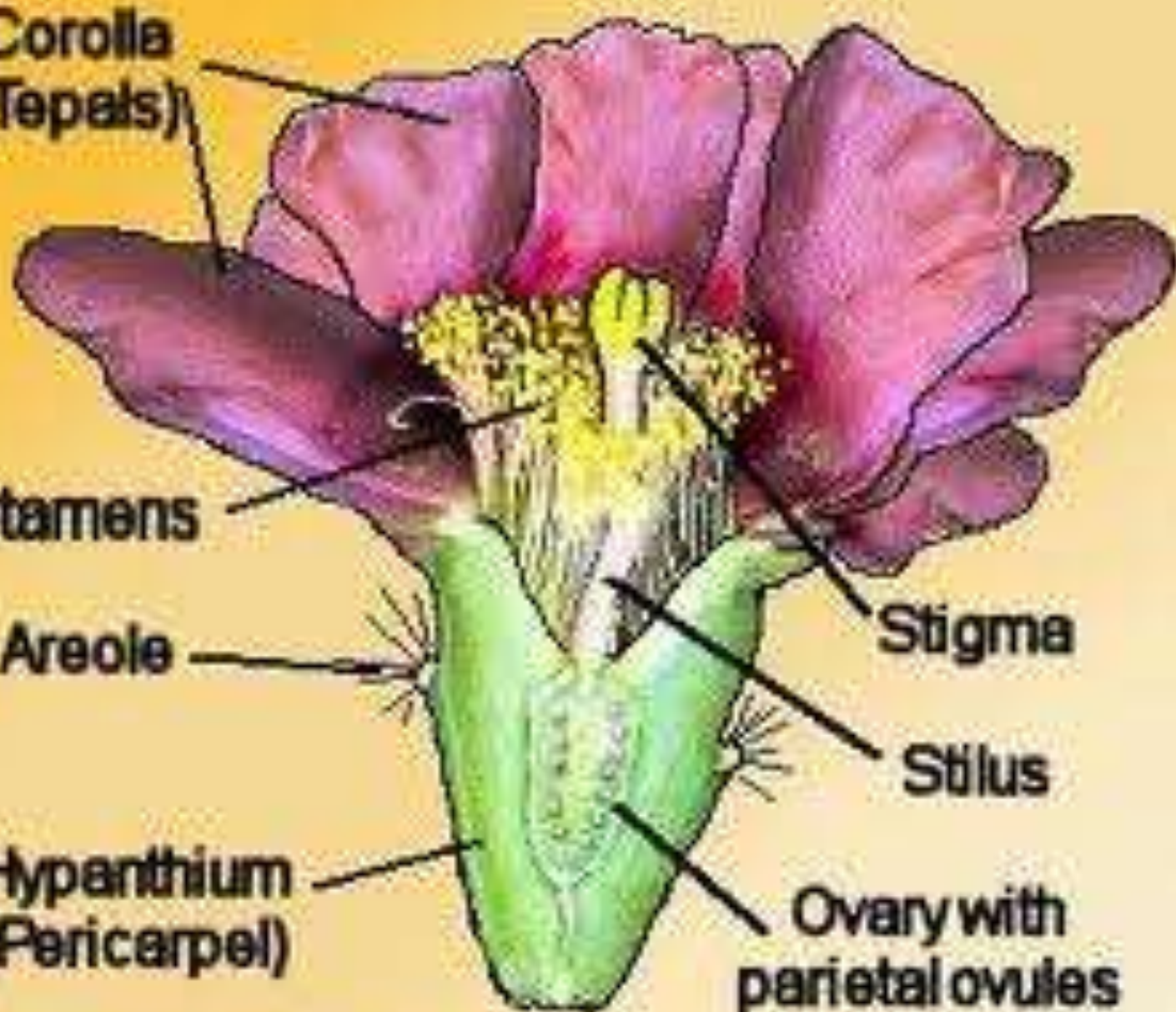
Areole

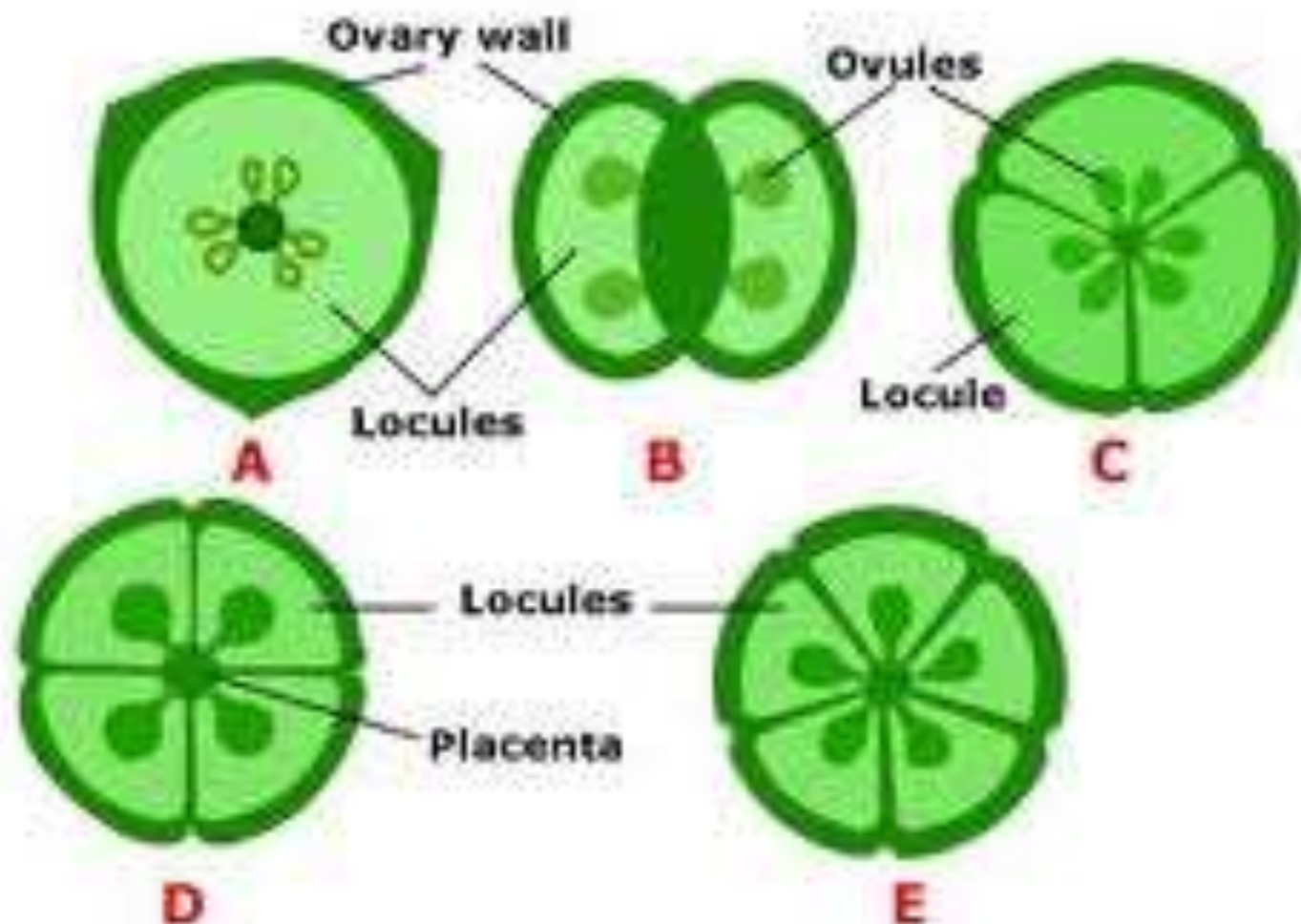
Hypanthium  
(Pericarpel)

Stigma

Stilus

Ovary with  
parietal ovules





T.S. of Gynoecium showing number of locules -  
 A. Unilocular, B. Bilocular, C. Trilocular,  
 D. Tetralocular, E. Pentagonal.







Flowers

Spurs





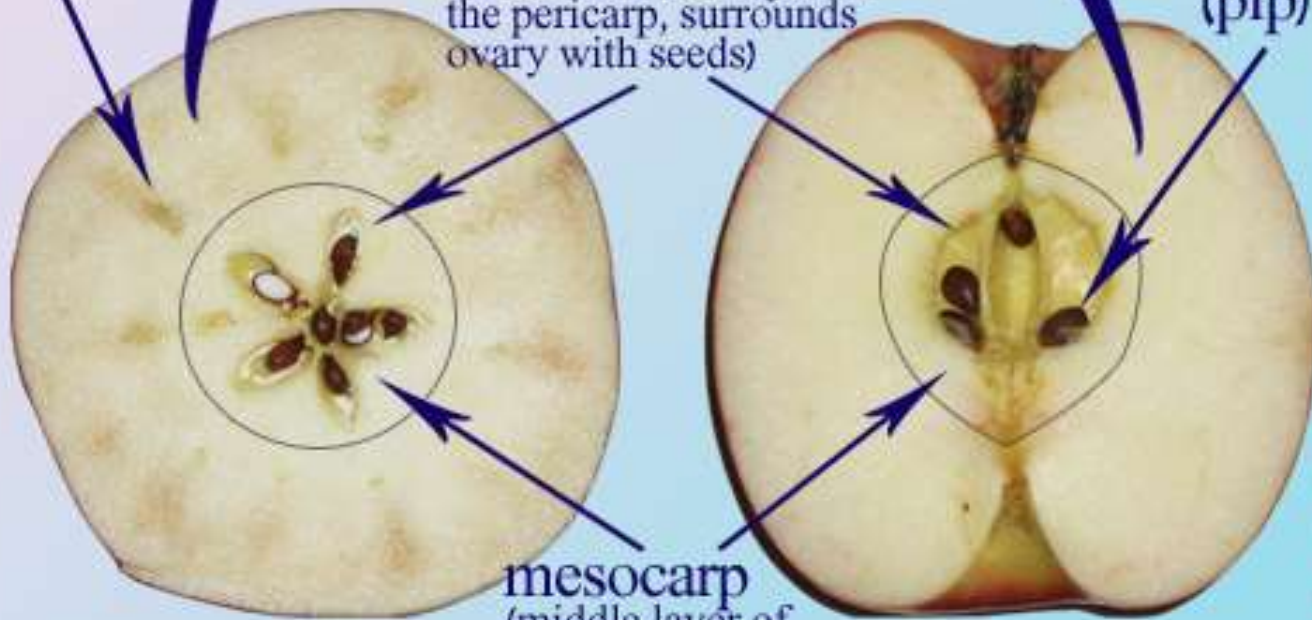
# Apple fruit (pome) anatomy

the dark spot is where one of ten stamen bundles was attached to the hypanthium

**hypanthium**  
(fruit flesh formed by fusion of the bases of petals and sepals and, in apple fruit, fused with the ovary wall)

**endocarp**  
(inner hardened layer of the pericarp, surrounds ovary with seeds)

**seed (pip)**



**mesocarp**  
(middle layer of pericarp, the mesocarp is surrounded with **exocarp**)

**Endocarp, mesocarp and exocarp constitute pericarp (apple core), which is frequently discarded.**

# Pollination

- Apples are self-incompatible; they must [cross-pollinate](#) to develop fruit. During the flowering each season, apple growers usually provide [pollinators](#) to carry the pollen.

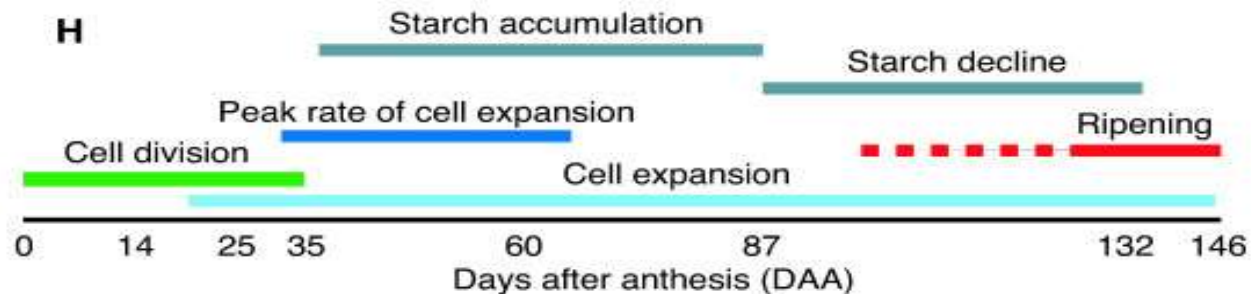
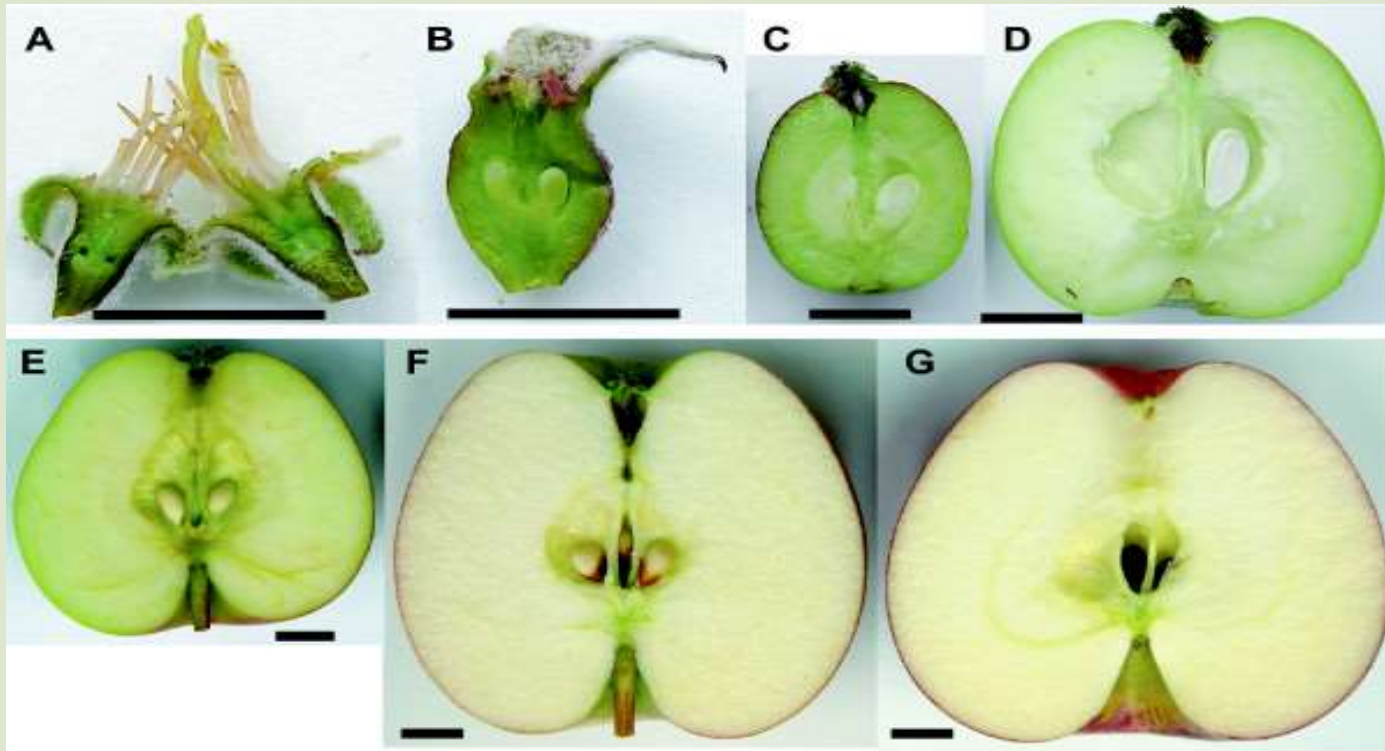
There are four to seven pollination groups in apples, depending on climate:

- Group A – Early flowering, May 1 to 3 ([Gravenstein](#), Red Astrachan)
- Group B – May 4 to 7 ([Idared](#), [McIntosh](#))
- Group C – Mid-season flowering, May 8 to 11 ([Granny Smith](#), [Cox's Orange Pippin](#))
- Group D – Mid/late season flowering, May 12 to 15 ([Golden Delicious](#), Calville blanc d'hiver)
- Group E – Late flowering, May 16 to 18 ([Braeburn](#), Reinette d'Orléans)
- Group F – May 19 to 23 (Suntan)
- Group H – May 24 to 28 (Court-Pendu Gris) (also called Court-Pendu plat)
- One cultivar can be pollinated by a compatible cultivar from the same group or close (A with A, or A with B, but not A with C or D).

- Varieties are sometimes classed as to the day of peak bloom in the average 30 day blossom period, with pollinizers selected from varieties within a 6 day overlap period
- *Malus floribunda* is a small-fruited species and a good pollinizer of apple.
- Honey bees are most commonly used. Orchard mason bees are also used as supplemental pollinators in commercial orchards.
- Bumblebee queens are sometimes present in orchards, but not usually in enough quantity to be significant pollinators.

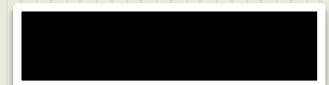


# Apple fruit development



# Varieties

Season	Himachal Pradesh	Jammu and Kashmir	Uttar Pradesh
<b>Early season</b>	<ul style="list-style-type: none"> <li>•Tydeman's Early (P)</li> <li>•Michael Molies</li> <li>•Delicious Schlomit</li> <li>•Starkrimson</li> </ul>	<ul style="list-style-type: none"> <li>•Irish Peach</li> <li>•Benoni</li> </ul>	<ul style="list-style-type: none"> <li>•Early Shanburry (P)</li> <li>•Fenny</li> <li>•Benoni</li> <li>•Chaubattia Princess</li> </ul>
<b>Mid season</b>	<ul style="list-style-type: none"> <li>•Staring Delicious</li> <li>•Red Delicious</li> <li>•Richared Vance</li> <li>•Delicious Top Red</li> <li>•Lord Lambourne (P)</li> <li>•Red Chief Oregon</li> <li>•Super Red spur</li> <li>•Red Gold (P)</li> </ul>	<ul style="list-style-type: none"> <li>•American mother</li> <li>•Razakwar Jonathan (P)</li> <li>•Cox's Orange</li> <li>•Pippin Red Gold (P)</li> <li>•Queen's Apple</li> <li>•Rome Beauty</li> <li>•Scarlet Siberian</li> </ul>	<ul style="list-style-type: none"> <li>•Red Delicious</li> <li>•Starking Delicious</li> <li>•MaIntosh (P)</li> <li>•Cortland</li> <li>•Golden Delicious (P)</li> </ul>
<b>Late season</b>	<ul style="list-style-type: none"> <li>•Golden Delicious (P)</li> <li>•Yellow Newton (P)</li> <li>•Winter Banana</li> <li>•Granny Smith (P)</li> </ul>	<ul style="list-style-type: none"> <li>•King Pippin</li> <li>•American Apirouge</li> <li>•Kerry Pippin</li> <li>•Lal Ambri</li> <li>•Sunhari Chamure</li> <li>•Golden Delicious (P)</li> <li>•Ambri Baldwin</li> <li>•Yellow Newton (P)</li> <li>•White Dotted Red</li> </ul>	<ul style="list-style-type: none"> <li>•Rymer</li> <li>•Buckingham (P)</li> </ul>





Cortland



Ida Red



McIntosh



Granny Smith



Golden Delicious



Rome or  
Rome Beauty



Northern Spy



Gala



Winesap



Jonathan



Macoun



Rhode Island  
Greening



Empire



Fuji



Red Delicious

Macoun

Rhode Island  
Greening

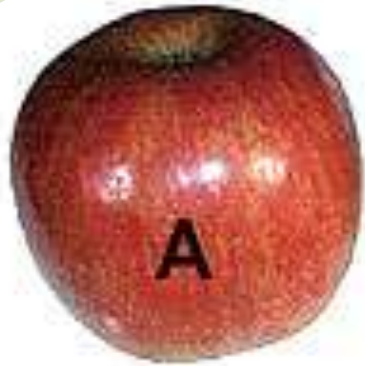
Empire

Fuji

Red Delicious

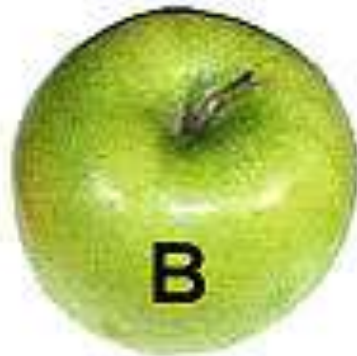
# High-colouring and early and early-maturing sorts of apple

<b>Super type</b>	<b>Standard colour mutants</b>
Starkrimson	Vance Delicious
Well Spur	Top Red
Red spur	Skyline Supreme
Oregon Spur-II	Hardiman
Red Chief	Bright-n-Early
Miller's Sturdy Spur	
Hardi spur	
Silver Super	



**A**

**'Fuji'**



**B**

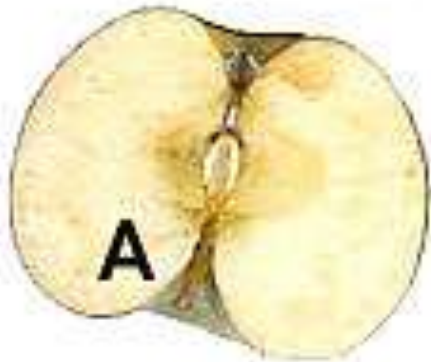
**'Granny Smith'**



**C**

**'Braeburn'**

© W.P. Armstrong 2002



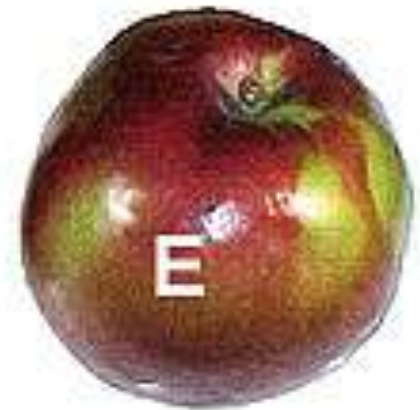
**A**

**'Fuji'**



**D**

**'Red Delicious'**



**E**

**'McIntosh'**

**'Fuji'**

**'Red Delicious'**

**'McIntosh'**



Legana



Cox Orange  
Pippen



Belle de  
Boskoop



Red  
Delicious



Rome  
Beauty



Golden  
Reinette



Granny  
Smith



Classic  
Pippen

BEAUTY  
ROME

REINETTE  
GOLDEN

SMITH  
GRANNY

PIPPEN  
CLASSIC



## Low-chilling varieties

- Michel
- Schlomit
- Anna
- Tamma
- Vered
- Neomi
- Tropical Beauty
- Parlin's Beauty

## Scab-resistant varieties

- Prima,
- Priscilla
- Sir Prize
- Jon free
- Florina
- Mac free
- Nova Easy Grow
- Coop 12
- Coop 13 (Red free)
- Nova Mac
- Liberty and Freedom
- Firdous
- Shireen



**Red Delicious**



**Jonathan**



**Granny Smith**



**Braeburn**



**Bonza**



**Pink Lady**



**Golden Delicious**



**Fuji**



**Gala**

Bonza

Pink Lady

Golden Delicious

Fuji

Gala

# Hybrids

- Hybridization programme of apple resulted in release of:
- **Lal Ambri** (Red Delicious x Ambri) and **Sunehari** (Ambri x Golden Delicious) in Jammu and Kashmir
- Chaubattia Princess and Chaubattia Anupam (Early Shan burry x Red Delicious) in Uttar Pradesh hills and **Ambred** (Red Delicious x Ambrich (Richared x Ambri)) and **Ambroyal** (Starking Delicious x Ambri) in Himachal Pradesh.
- **Ambrich, Ambroyal and Ambred have not gained popularity among the growers of Himachal Pradesh** because of very late maturity and extended harvesting period, whereas high-colouring and early-maturing cultivars are preferred by growers.

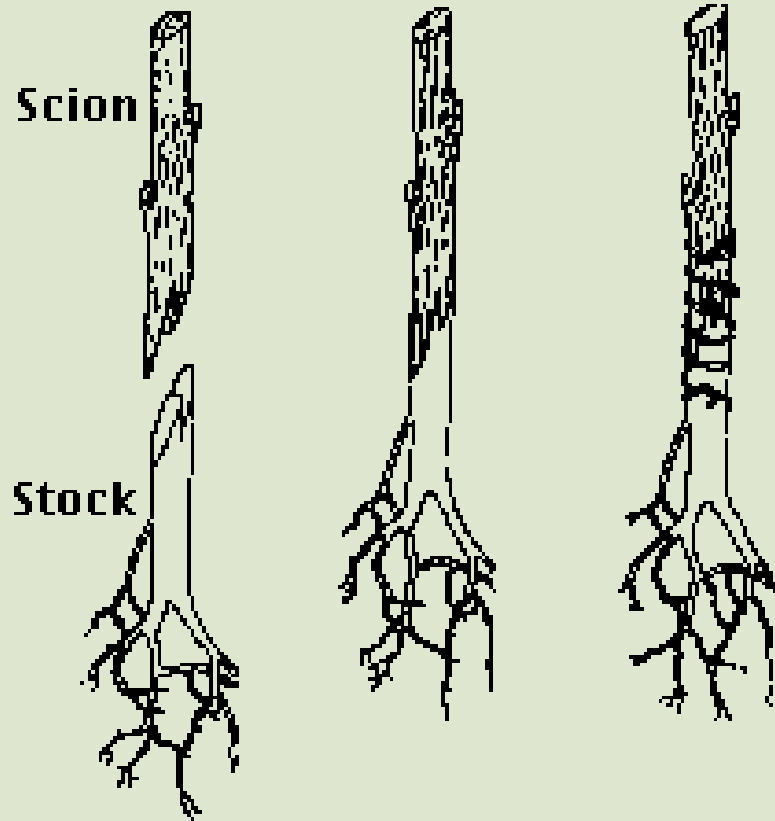
● France ● France ● France ● France

Illustration: Jean-François



# Propagation

- **Tongue grafting** is the ideal method of grafting more than 90% bud take success.
- The scion should be grafted 15-20 cm above the ground level. **February-March** is most suitable time of tongue grafting. **It should be just before the bud-break.**
- “T” budding during monsoon and chip budding during August can also be done for propagating scions with good bud-take success and smooth scion-stock union but the plant growth is poor in the Indian conditions.
- It takes one year for raising grafted plants, whereas two in case of budded plants of standard size.







# Rootstocks

## Seedling rootstock

- Apple seeds need stratification in moist sand at 4 -7 C for 60-90 days. The water-soaked seeds are placed between 2 and 3 cm thick layers of moist sand in wooden boxes or polythene bags during December.
- The stratification boxes or bags are placed in cool place where the required chilling temperature of less than 7 C for 1,000-1,500 hr is met in 60-90 days.

# Clonal rootstocks

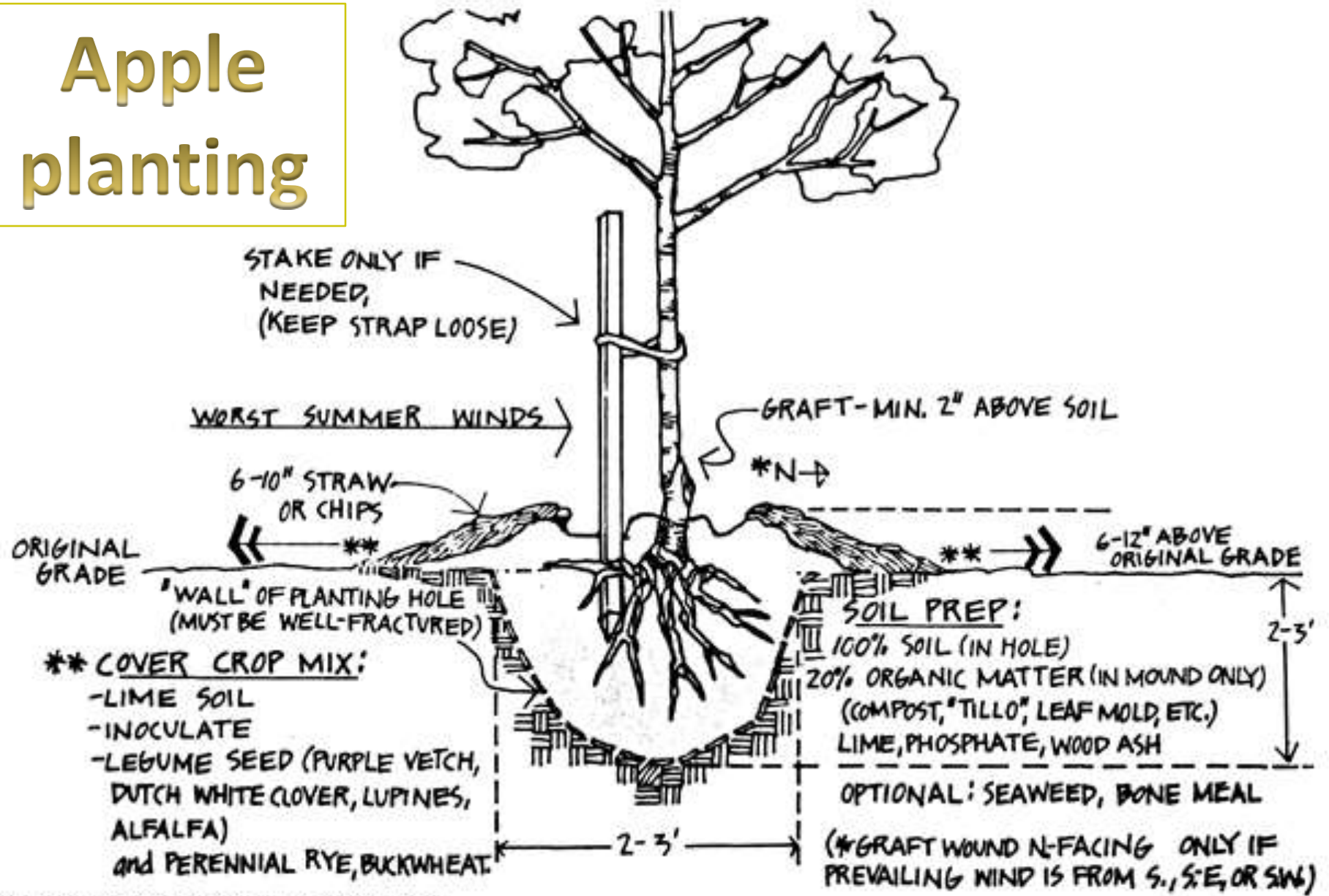
Category	Rootstock	Characteristics
Dwarfing	M 9	Short juvenile phase, weak anchorage, suitable for high-density planting in flat and irrigated areas only
Semi-dwarf	M 4, M7 and MM 106	Suitable for high-density planting and well-drained soils; resistant to wooly apple aphid but susceptible to collar rot
Semi-vigorous	MM 111	Tree size is 70% of standard, drought tolerant and resistant to wooly apple aphid
Vigorous	Merton 793	Wooly apple aphid and collar-rot resistant, early-fruiting, recommended for Kumaon hills of Uttar Pradesh

# Planting

- Before planting an apple orchard, proper decisions should be made on selection of varieties, rootstocks, tree size, spacing, placement of pollinizer and planting layout.
- The planting distance varies according to variety, vigour of rootstock, fertility of soil and climatic conditions. In flat and valley areas, the planting is done in square or hexagonal system of layout.



# Apple planting





# Planting distance

- The combination of rootstock and scion variety determines the planting distance and planting density.
- In standard plantations, the plants of standard varieties grafted on seedling stocks are planted at a distance of 6 -7.5 m , accommodating 180-250 plants/ha.
- The **planting distance can be reduced** according to the vigour of rootstock. The clonal rootstocks particularly dwarfing and semi-dwarfing root stock should be used where the soils are flat, fertile and irrigated.

## Spacing and planting density for different scion-stock combination

Scion/variety	Rootstock	Tree size (vigour)	Spacing (m x m)	Density (trees/ha)
Standard	MM 109	Semi-vigorous	6.0 x 6.0	278
	MM 111			
	MM 7	Semi-dwarf	4.5 x 4.5	494
	MM106	Dwarf	1.5 x 1.5	4,444
M 9				
Spur type	Seedling	Semi-vigorous	5.0 x 5.0	400
	MM 109	Semi-dwarf	3.5 x 3.5	816
	MM 111	Dwarf	3.0 x 3.0	1,111
	M 7			
	MM 106			

- On slopes, contour or terrace planting is preferred.
- The usual pit size is 1 m x 1 m x 1 m without any hard pan or rock at its base or on the sides.
- The pit should be dug and filled up one month before planting.
- The top soil and sub-soil should be piled separately while digging.
- Top soil must be filled first followed by sub-soil on the top to improve the fertility of lower layer of pit.
- While pit filling, 40-50 kg well-rotten farmyard manure and 500g of super phosphate should be mixed in soil and allowed to settle for one month before planting.
- An early planting of apple in December-January is desirable for proper establishment.
- Graft union should be kept 25 cm above the ground level to avoid collar-rot and scion rooting

# Training

- The plants are trained according to growth habit and vigour of the rootstocks.

## **Advantages:**

- Establish a strong framework of scaffold limbs capable of supporting heavy yield with quality fruits.
- Regulate annual succession of crops.
- Expose maximum leaf surface to the sun.
- Various cultural operations like spraying and harvesting become economical, protect the trees from sun-burn and promote early production.
- The training procedures for standard and dwarf plants differ.

**Unbranched  
whip  
2 - 3 feet**



**1st year**

**New leader**



**2nd year**

**Scaffold  
branch**

**New leader**

**New  
scaffold**



**3rd year**

**Old  
scaffold**

1st year

2nd year

3rd year



The standard trees are trained on modified central leader system. The ideal standard tree can be trained as:

## 1<sup>st</sup> Year:

- The plants are **pruned to 50-60** cm above the ground at the time of planting.
- **2-3 well-spaced scaffold limbs** are selected with lowest at 30 cm above the ground and others spaced vertically 10-15 cm apart in a **spiral fashion**.
- The growth of the unwanted shoots is depressed by **pinching** 3-5 cm of the **shoot tips** during mid-April-mid-May.
- The selected **primary scaffolds during summer are headed back to one –fourth to one-fifth** of the growth.

## 2<sup>nd</sup> year

- During second year dormant pruning, the central leader and primary scaffold branches are healed back similar to first dormant pruning.
- More scaffold branches are retained on the trunk at the vertical distance of 45-75 cm. A total of 5-7 secondary branches/trees usually two on each primary scaffold re also selected in the second dormant pruning which are directed partially out ward.
- The primary scaffold should have the crotch angle of 45 with trunk. The proper crotch angle can be developed by tying the branches with ropes or inserting the branch spreaders.

## 3<sup>rd</sup> year

- Third year training consists of **thinning of unwanted branches and heading** back others to desirable side limbs. Secondary branches often develop spurs during third growing season.

## 4<sup>th</sup> year

- By fourth year, training is largely completed. By this time, the **proportional growth of central leader and side scaffold branches should be attained which should be 1:1.5**. This will help in lateral growth rather than upward growth of plants favourable for proper spur development.

## 5<sup>th</sup> year onwards

- When the tree attains the height of 4-4.5 m, **the central leader should be headed back** near to moderate side growing shoot to check the height of the plant.
- **Dwarf plants are trained to spindle bush/slender spindle, i.e. one-year old plant is headed back to 45-60 cm** at time of planting.

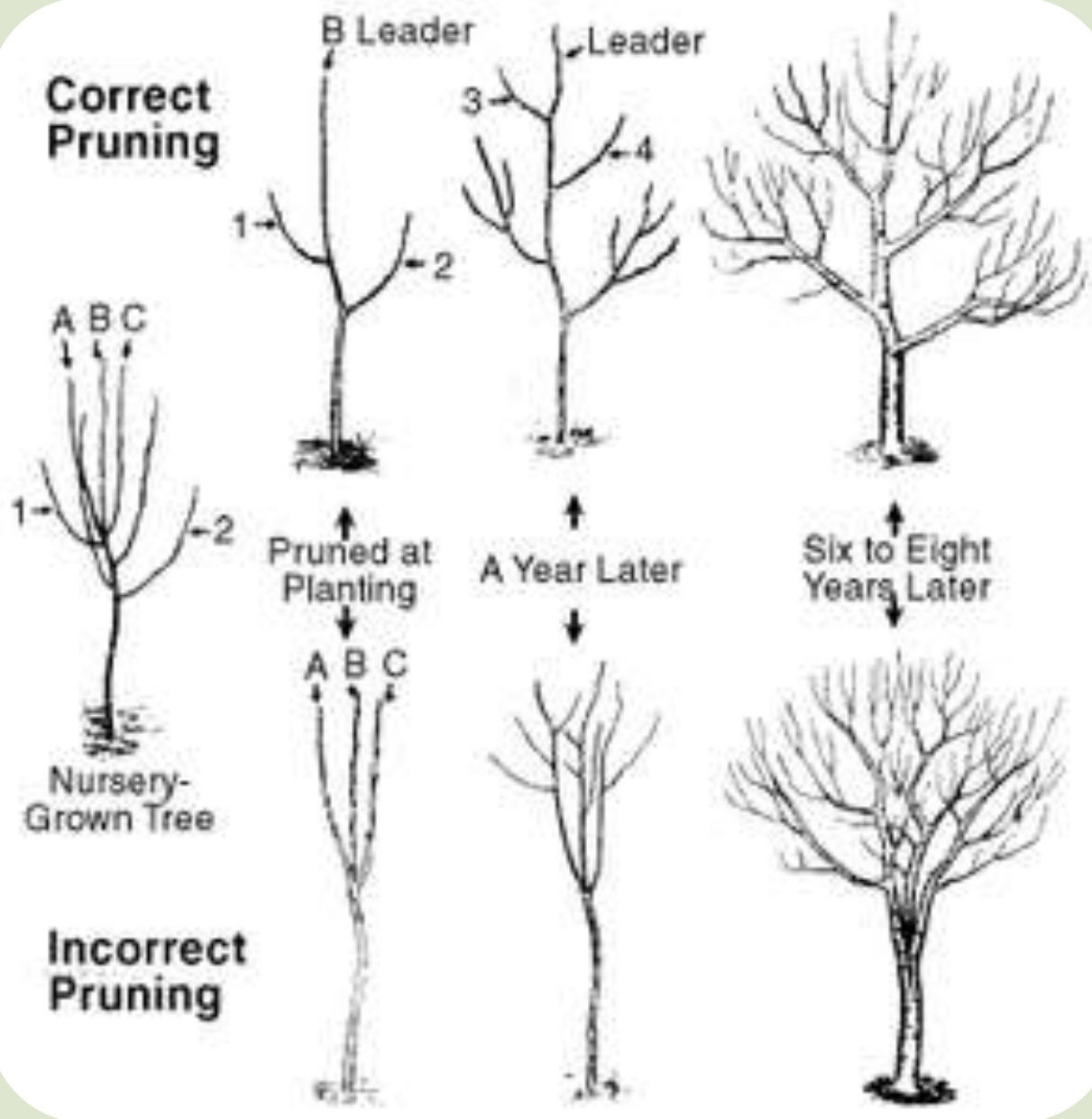
# Pruning

- Essential to maintain a proper balance between vegetative growths and spur development.
- Start pruning at the top of the trees and work and work downward.
- Cut upward growing limbs back to strong laterals.
- Remove the crowding branches and thin out the remaining leaving the vigorous fruiting wood well spaced along the length of limbs.
- Remove dead, broken and diseased wood.



- Remove parallel growing shoots causing crowding and shading and opposite growing shoots at a point on the stem.
- Remove all water sprouts except the occasional ones which may be needed to fill a vacant space in the canopy.
- While removing a thick branch, first small cut should be made on the under side of limbs to avoid bark peeling.
- Divert branches to open areas by pruning to desirable laterals.

**Correct Pruning**



**Incorrect Pruning**

# Manuring & Fertilization

- In an orchard of optimal fertility, N, P and K may be applied in the ratio of 70:35:70/ year age of the tree.
- The dose should be stabilized (700:350:700 g N: P: K/ tree) after 10 year of age.
- These applications may be supplemented with farmyard manure @ 10 kg/years age of the tree with the maximum of 100kg.
- As the crop load is low in an 'off' year, the standard fertilizer dose of NPK may be reduced to 500g, 250g and 400g respectively.

# Nutrients deficiency symptoms and corrective measures

Nutrient	Deficiency symptoms	Dose of chemical	Time of foliar application
Nitrogen	Shoot growth restricted, short, remain small, normal in shape, pale-yellow in colour and later orange, red and yellow tints. Older leaves are first affected. Fruits remain small.	Urea 0.5% (2 sprays)	After petal fall and 1 month later
Boron	First symptoms appear on fruits which do not develop normally and become misshapen caused by hard corky tissues. Fruit cracking may also occur. Leaves are dark green, thick and brittle starting at tip, appearance of purple pimples on young twigs, poor fruit set as a result of blossom blast.	Boric acid 0.1% (2 sprays)	Pre-bloom and post-bloom
Zinc	Buds along the shoot fail to develop, leaves remain small and narrow (little leaf) and form rosette at tips. Foliage is sparse. Older leaves may fall in severe cases. Fruit remain small and misshapen.	Zinc sulphate (0.5%)	After petal fall
Manganese	Chlorosis between the main veins starting near the margin of leaves and extending towards midrib. Early defoliation occurs on the top of the trees. Fruits develop poor colouration.	Manganese sulphate (0.4%)	After petal fall
Calcium	Upward cupping of margins of youngest leaves. Margins of older leaves become necrotic and shatter. Death of growing points followed by dies back. Bitter pit symptoms (corky depression) also appear near calyx-end of fruits.	Calcium chloride (0.5%)	30-45 days before harvesting

# Irrigation

- Apple requires uniform distribution of rainfall throughout the year or needs to be supplemented with irrigation during critical periods.
- The most critical period of water requirement in apple is from April to August, the peak requirement being after fruit set.
- In areas where irrigation is available, apple requires about 114 cm water during the whole year which can be scheduled in 15-20 irrigations.

- In critical summer months, the irrigations can be given at 7-10 days interval and rest at 3-4 weeks interval. At least 8 irrigation during critical period of water requirement are recommended for Starking Delicious apple.
- Drip irrigation system, irrigation can be extended to scarce water source areas and hilly slopes also.
- About 1,695 litres of water/tree is required during the season in drip irrigation compared with 3,840 litres/tree in the conventional method of irrigation.
- In drought-prone and water-scarce areas, the soil moisture can be retained by hay mulching or black alkathene mulching immediately after spring rains.



# Aftercare

- Clean basin management is the common practice of floor management in apple. The basins are kept clean by hand working, hay mulching or black alkathene mulching. In cool climates, black alkathene mulch is very efficient which not only controls weeds and conserves moisture but also improves the fruit quality.
- It should be avoided in warmer areas, as black alkathene absorbs the solar heat and increases the soil temperature, hampering root growth.
- Application of Glyphosate @ 800ml/ ha or Grammaxone/Paraquat (0.5%) as post-emergence herbicide suppresses the weed growth for 4-5 month.

# Green manuring

- ❖ In the initial years of plantations, green-manuring crops like sunflower and bean may be cultivated between the basins to improve the soil. Improved grasses like **orchard grass** (*Dactylis glomerata*), **tall fescue** (*Fescue arundinaceae*) and **timothy** (*Phleum pretense*) and nitrogen-fixing legumes like **red clover** (*Trifolium repens*) and **Lucerne** (*Medicago sativa*) can be introduced between the tree basin spaces in grown-up orchards.

# Heavy Bearing/Fruit thinning

- Heavy bearing in apple usually results in small-sized, poor-quality fruits and sets in alternate bearing cycle. Judicious fruits thinning at proper stage of fruit development not only regulate cropping but also fruits size and quality. The practice is essential in pollinizing.
- Carbaryl or Sevin @ 750-1,000ppm or NAA @ 10-20 ppm at petal fall results in optimal fruit thinning. Hand-thinning can also be done but it is very cumbersome and uneconomical procedure.

# Harvesting

- Since apple is climacteric fruit, the maturity of fruits does not coincide with ripening. The fruits usually do not attain fully ripe edible quality on the tree while harvesting. The fruits should be harvested at proper picking maturity to attain proper edible quality at ripening.
- Picking of immature fruits results in poor quality fruits lacking flavour and taste which shrivel during storage. Over-mature fruits develop soft scald and internal breakdown with poor shelf-life. There are several maturity indices which can be adopted in proper fruit harvesting.







# Maturity indices

- The TSS of fruit pulp
- ease in separation of fruit from spur
- change in ground surface colour from green to pale
- change in seed colour to light brown
- fruit firmness
- days from full bloom to harvest are some reliable maturity indices for apple which can be considered singly or in combination.





# Postharvest management

- Picked fruit should be placed softly in the picking bags or baskets.
- The fruits should be transferred carefully from picking baskets to boxes or baskets be transported to packing houses for grading and packing.

# Precooling

- After picking, the fruits should be placed in a cool and ventilated place to remove field heat before packing.
- Air cooler, cold water sprinkling or fruits washing with water also helps quick removal of field heat.
- Keeping fruits over-night near the tree basins for cooling down is another practical way to remove field heat.
- Fruit surface must be free of moisture before grading, wrapping or packing in cartons.

# Grading

- Apples are graded according to fruit size and fruit appearance or quality.
- On the basis of fruit size, apples are graded manually in 6 grades.
- On the basis of fruit colour, shape, quality and appearance, apple fruits can be graded in 3 or more quality grades. These grades are designated as AAA, AA and A; A, B, C; or extra fancy, fancy class I and fancy class II.
- For size grading, mechanical graders with washing and waxing facilities are available in India now.

# Packaging

- Apples are packed in wooden boxes.
- Size of wooden boxes used in different apple-growing areas of India is different and carry about 10 kg or 20 kg fruits in a box.
- Standard-sized wooden boxes are 45.7 cm long, 30.5 cm wide, and 25.4, 27.5 and 30.5 cm in height according to size of grade.

- CFB cartons are also available for packing apples. Such cartons are of 2 types-universal cartons and telescopic tray-pack cartons. The CFB cartons not only save the precious wood and forest wealth but result in very less fruit bruising (3.5%) which fetch good market price.
- The usual dimensions of CFB cartons with trays are 50.4 cm x 30.3 cm x 28.2 cm (outer jacket) and 50.0 cm x 30.0cm x 28.2 cm (inner case).



# Storage

- Apples have a longer storage life compared to other fruits but it varies with varieties.
- Deterioration of fruits starts after climacteric stage. However, shelf-life of apples can be prolonged by providing optimal storage conditions.
- The cold storage retards fruit deterioration and reduces decay from pathogens and shrivelling from water loss.

- The recommended storage temperature for apple is  $-1.1$   $^{\circ}\text{C}$  which is about  $0.8$   $-1.8$   $^{\circ}\text{C}$  above the average freezing point of most apple varieties.
- The relative humidity of 85-90% should be maintained in cold storages. Most apple varieties can be stored for 4-8 month after harvesting Ambri has the longest storage life.

# PESTS AND DISEASES

SYMPTOMS	POSSIBLE CAUSE
Grey powdery coating on leaves and young shoots.	<u>Mildew</u>
Distorted young shoots and leaves.	<u>Aphids</u>
Ribbon like scars on the apple skin	<u>Apple Sawfly</u>
Holes in the leaves	<u>Winter Moth</u>
Maggot inside apple	<u>Codling Moth</u>
White fluffy areas on the bark, looks like fungus	<u>Woolly Aphid</u>
Sunken, discoloured patches on bark	<u>Canker</u>
Small brown sunken areas on the skin of the fruit	<u>Bitter Pit</u>
Browning of the fruit, especially those in storage.	<u>Brown Rot</u>
Brown blotches on leaves and fruit.	<u>Scab</u>

# FRUIT DROP

- Most of commercial varieties experience 3 phases of fruit drop-early drop, June drop and preharvest drop. The early drop considered natural, occurs due to lack of pollination and fruit competition.
- The June drop is caused by moisture stress and environmental conditions which can be checked by maintaining soil moisture through irrigation or mulching.

- The preharvest drop cause serious economic losses, as the mature marketable fruits abscise before harvesting due reduction in level of auxins or increase in ethylene levels in fruit.
- Early-ripening varieties like Tydeman's Early, Red Gold and Pippins experience 40-60% drop, whereas in Delicious group loss occurs to the extent of 15-20% of crop load.
- Application of NAA (10 ppm) before the expected fruit drop or 20-25 days before harvesting checks the preharvest fruit drop effectively.

# PHYSIOLOGICAL DISORDERS





## Scald



- Scald is one of the storage disorders in apple. Light mottling on greener surface of fruits are initial symptoms of scald.
- Darkening become more severe with elapsed time and ultimately extends to red surface also. Scald usually affects the skin only but in sever cases it may extend to fruit flesh.
- The immature fruits are most susceptible to scald which is aggravated by warmer temperatures in storage.

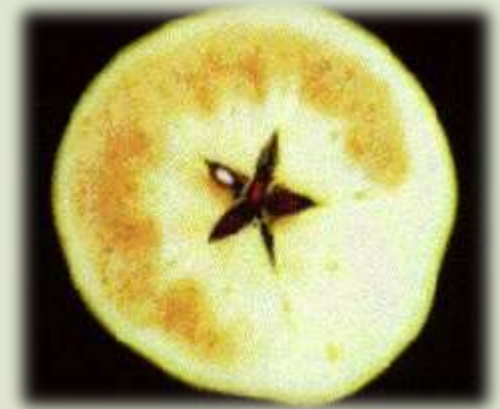
# Bitter pit



- ◎ Bitter pit is characterized by small sunken spots on the fruit surface which are more prevalent near the blossom-end.
- ◎ Initially small water-soaked areas appear which shrink and turn brown with the loss of water and ultimately become brown localized areas of the dead tissue.
- ◎ Unlike the name, these corky tissues are never bitter in taste. The immature picked fruits and large-sized fruits in 'off' year are most affected.
- ◎ Golden Delicious, Yellow Newton and Graven stein being most susceptible apple varieties.

# Internal browning

- Internal browning is associated with apple Yellow Newton and is characterized by brownish streaks radiating into flesh from the core.
- Controlled atmospheric storage with higher temperature can be helpful to control this disorder. Appearance of disorder is less at 1°C in cold storage.





# Whano

*Rhododendron, Redwood National Park, California*