

# **Apple cultivation**

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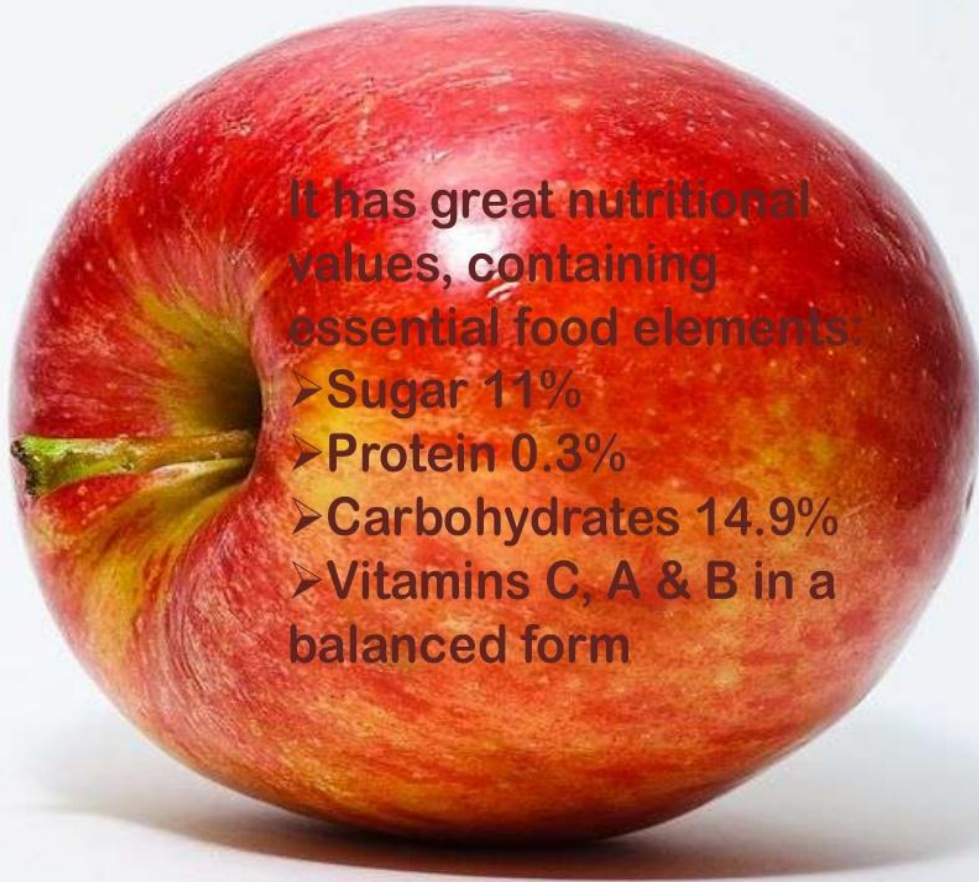
# Introduction of apple

- King of temperate fruit, symbol of health, premier fruit of the world.
- Deciduous fruit tree.
- Most widely grown temperate fruit of the world.
- Among the fruit apple have long storage life



# Nutritional value of apple

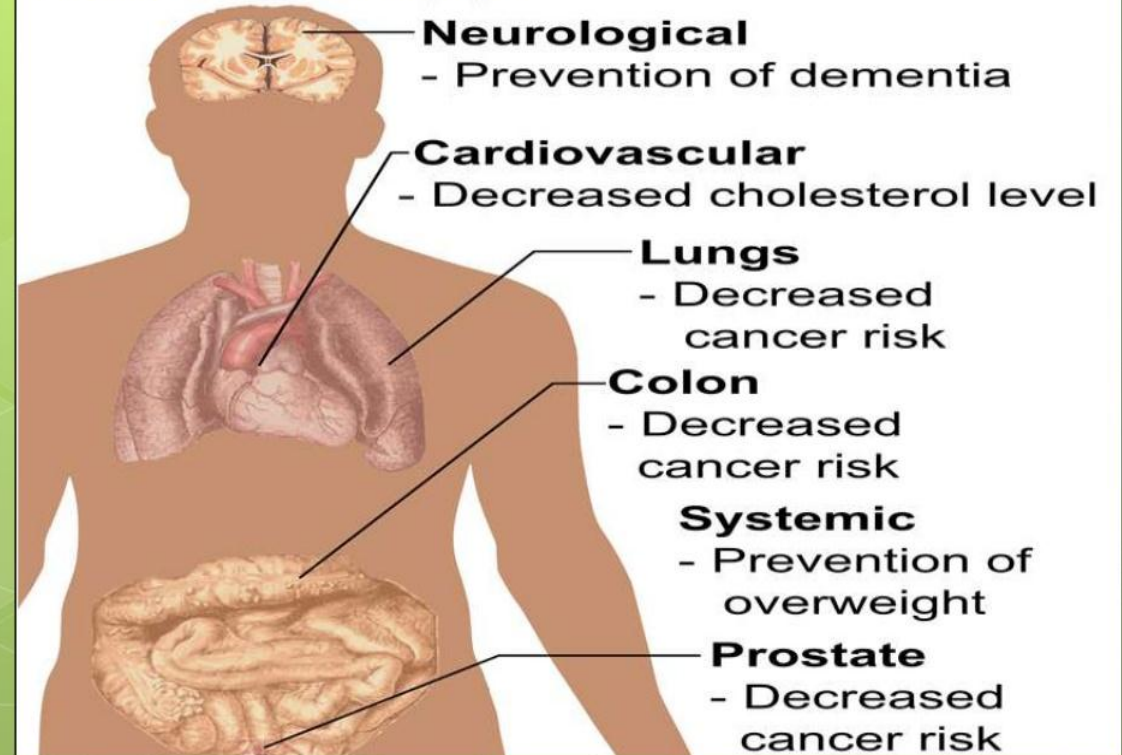
## Nutritive Values



It has great nutritional values, containing essential food elements:

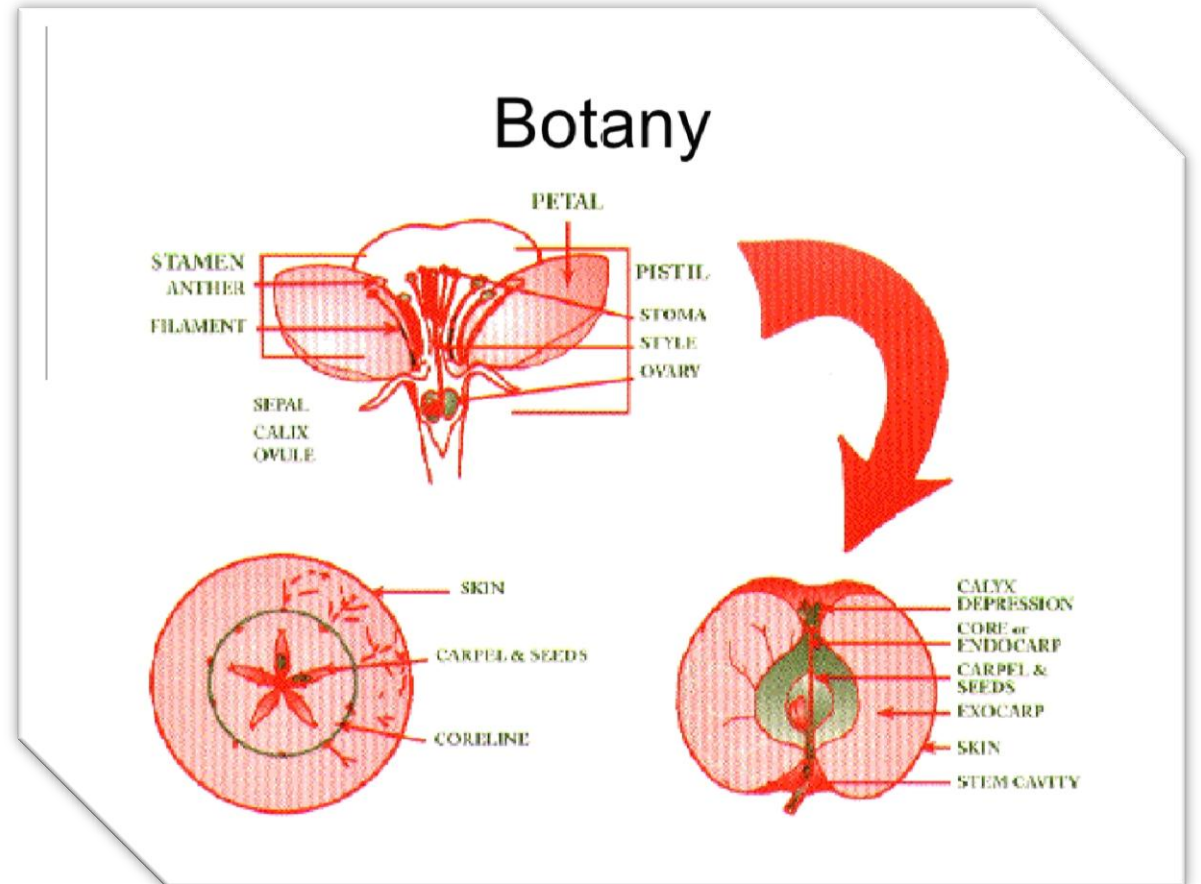
- Sugar 11%
- Protein 0.3%
- Carbohydrates 14.9%
- Vitamins C, A & B in a balanced form

## Health Benefits



# Taxonomy in apple

- B.N:-*Malus domestica*
- Family:-Rosaceae
- Sub-family:-maloideae
- $2n=34(x=17)$
- Origin:- South Western Asia
- Flower colour:-white to pink
- Type of fruit-pome
- Edible portion-fleshy thalamus(mesocarp)



## Area and production:-

- Apple account 55% area and 75% production of temperate fruits in india.
- China is the largest apple producing country in the world.
- Over 700 accessions of apple, introduced from USA, Russia, U.K., Canada, Germany, Israel, Netherlands, Australia, Switzerland, Italy and Denmark have been tried.
- Area in india: H.P., J&K and Uttrakhand.
- Other:-also been extended to Arunachal Pradesh, Sikkim, Nagaland, and Meghalaya in north-eastern region.



# Climate and soil

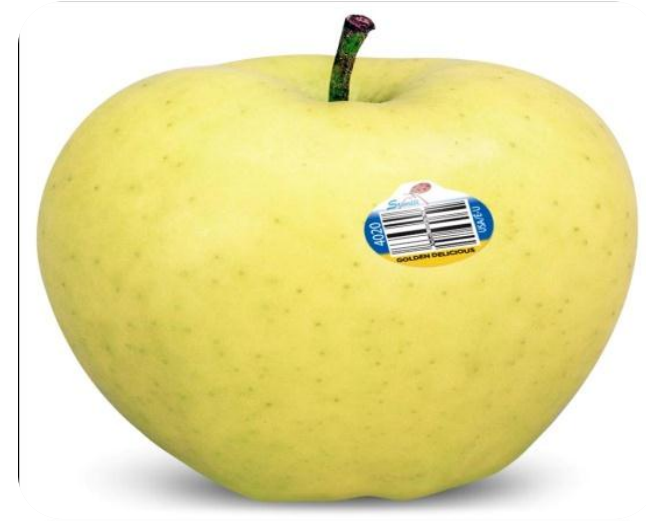
- MSL-1500-2700m
- Temp-21-24<sup>0</sup> C, fruit setting is 21.1-26.7°C.
- Rainfall-100-125 cm
- Chilling hour-1,000-1,500 hours of chilling (the no. of hours during which temperature remains at or below 7<sup>0</sup> C during the winter season)
- Soil pH-5.5-6.5
- Soil type-Loamy soils, rich in organic matter.

# VARIETIES OF APPLE



# APPLE CULTIVARS

- In fifties, the green English varieties-McIntosh, Jonathan ,Golden Delicious, Baldwin, Cox's Orange Pippin etc. –predominated





- **Coloured Delicious apples** replaced the English ones-  
(75% of the total area in HP,45% in J&K and 30% in UP)

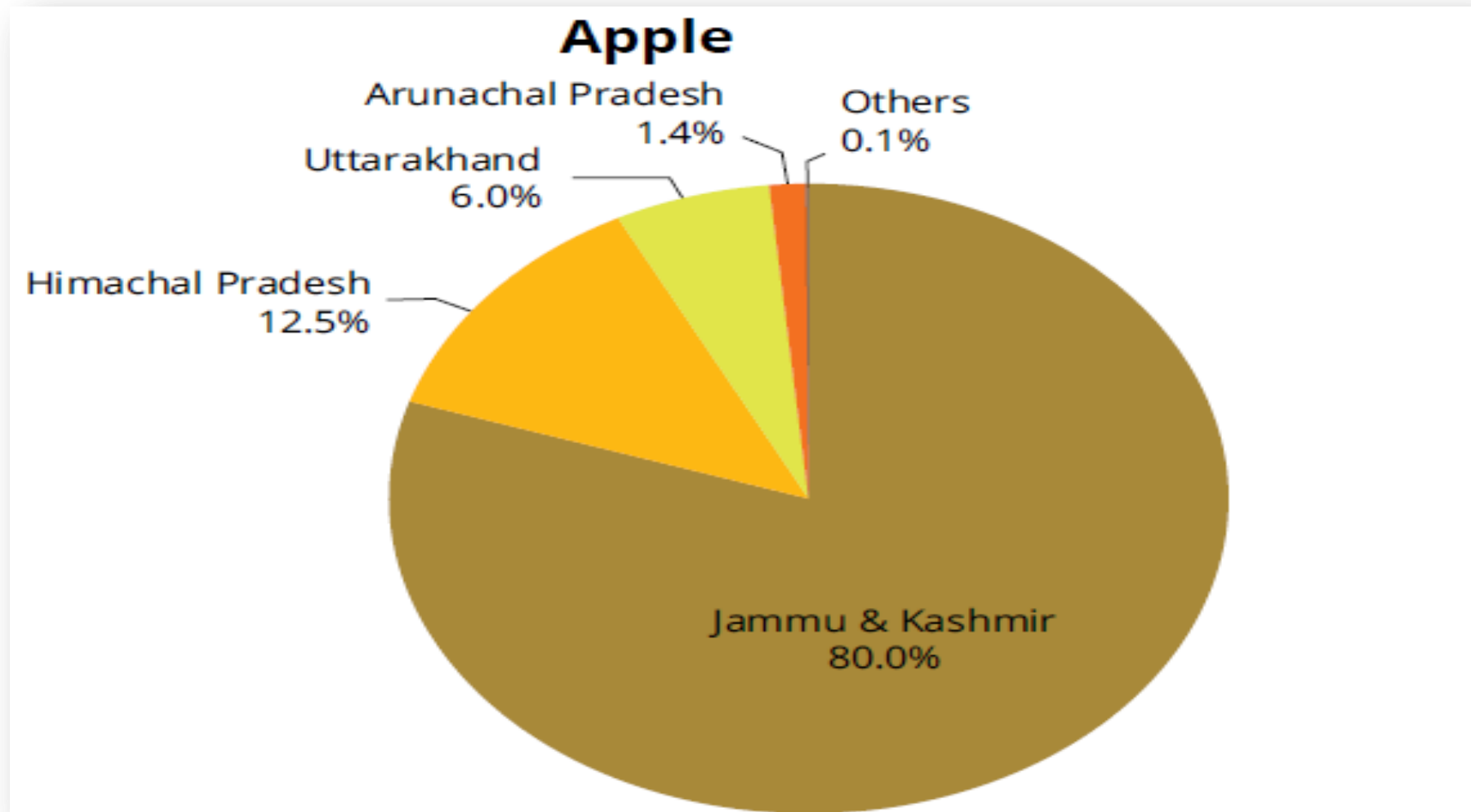


**RED DELICIOUS**



**ROYAL DELICIOUS**

# Indian Scenario



- Colour mutants and spur type cultivars are gaining more importance in the recent years (early maturity, precocious and prolific bearing habit)
- **Spur type cultivars:** Starkrimson, Well Spur, Redspur, Red Chief, Silver Spur
- **Standard colour mutants:** Vance Delicious, Top Red, Skyline Supreme, Hardiman, Bright-n-Early

# DELICIOUS

- Chance seedling
- Most widely grown and studied cultivar
- Fruit – conical, protuberance near calyx
- Flesh – firm, sweet & juicy
- Alternate bearing
- Maximum storage life – 180 days
- Susceptible to apple scab
- Resistant to powdery mildew



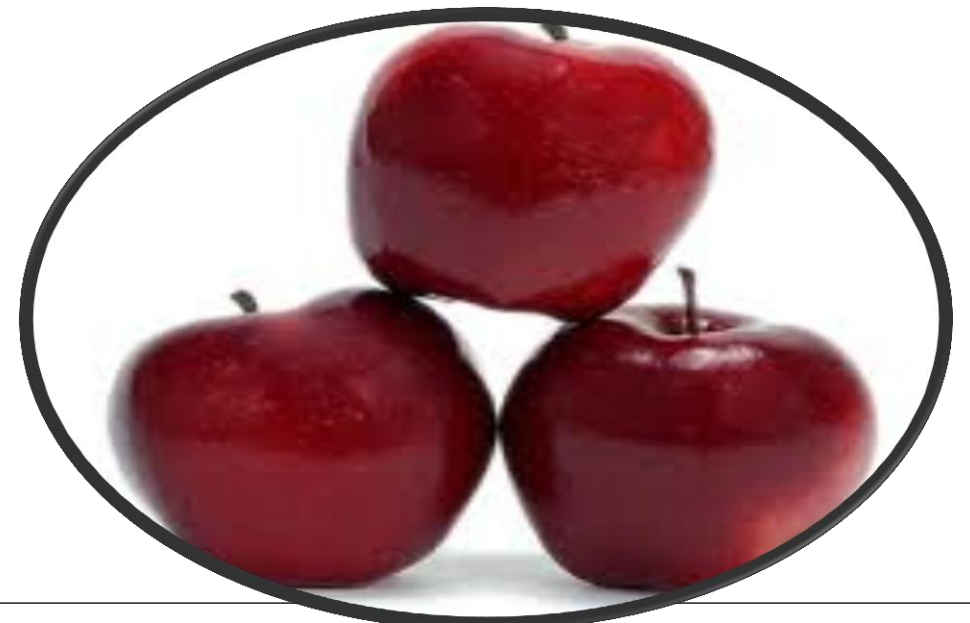
# Red Delicious

- Most popular variety of India
- Fruit: Long, conical with protuberance near the calyx, skin yellow with red stripes not all over the surface
- Flesh: Firm, sweet and juicy
- Does not develop superior red colour until fully mature but by that time apple losses its crispness



# Royal Delicious

- Syn. Starking Delicious
- A bud sport branch developed on a Delicious tree
- Early colouring than Red Delicious
- Fruits: Large, conical, yellow skin covered with red stripes all over the surface



# Rich-a-Red

- **Bud sport of Red Delicious**
- **Fruit: Large, conical, skin with red blush**
- **Colours earlier than Delicious but later than Starking.**
- **More completely coloured than Delicious**
- **Flesh – sweet, very juicy & of excellent flavour**



# Red Gold

- Fruits round to slightly oblong, skin highly red blushed, waxy and glossy.
- Flesh white with pinkish tint near the surface
- Regular and heavy bearing variety
- Used as pollinizer for Red Delicious and Starking Delicious





# Golden Delicious

- Commercial variety of USA and Europe
- Used as pollinizer for Delicious
- Fruit: Round, conical to oblong and golden yellow colour
- Cream, fine textured, crisp and juicy flesh with conspicuous pleasant flavour
- Suitable for processing



# McIntosh

- Leading variety of Canada
- Medium season variety
- Fruit: Small to medium, round, yellowish green with red blush
- Greenish, juicy and fairly sweet pulp
- Grown in Kulu and Kashmir



# Baldwin

- Large sized fruits with reddish colour and round to conical in shape
- Sour in taste
- Very good keeping quality



# Fugi

- Evolved in Japan
- Ralls Janet x Delicious
- Tree – large vigorous spreading
- Most promising late variety
- Colour resembles delicious
- Flesh- not attractive, very firm slightly coarse, very juicy, aromatic and sub acid
- Excellent for dessert



# Early Colouring Strains of Delicious

## Standard Types

### Vance Delicious

- **Bud mutant of Delicious**
- **Fruit: Conical, solid red skin**
- **Colours two weeks earlier to Red Delicious**

### Top Red

- **Bud sport of Delicious**
- **Fruit: Long with red streaks**
- **Matures three weeks before Starking Delicious**

## **Skyline Supreme Delicious**

- Bud mutant of Starking Delicious
- Fruit shape and colour are similar to Delicious

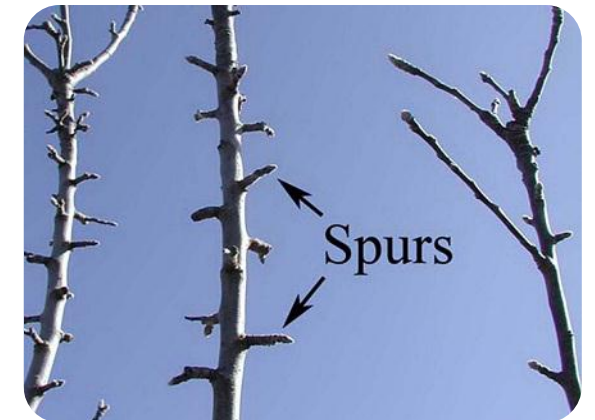
## **Hardeyman**

- Similar to Starking Delicious
- Tree is vigorous in growth

## New Spur Types

### Starkrimson Delicious

- Dwarf trees
- Fruit: Oblong, medium sized, deep red in colour, hard in texture, sweet and juicy
- Suitable for mid-hills



## Oregan Spur

- Bud sport of Delicious
- Fruits are similar to Delicious in size and shape
- Pulp is light yellow,crunchy and sweet but a bit hard

## Red Chief

- Bud sport of Delicious
- Fruits are similar to Delicious

## Gold Spur Delicious

- Bud mutant of Golden Delicious
- Pollinizer for all spur types





## **Stark Spur Golden Delicious**

- Bears fruits similar to Golden Spur in shape, colour and appearance

## **Red Spur Delicious**

- Resembles to well coloured Rich-a-Red
- Tree with close internodal growth
- Grows to two-third size of standard trees

# New Pollinizers

## Tydeman's Early Worcester

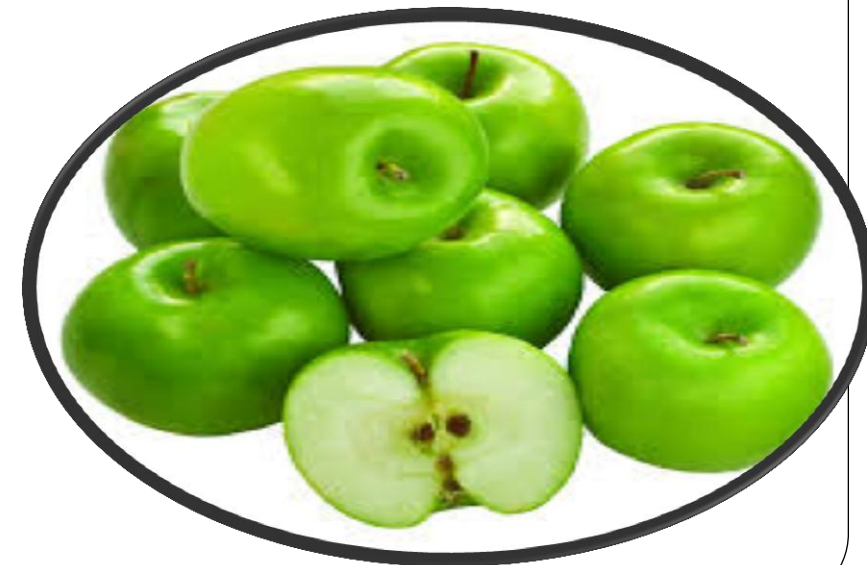
- One of the earliest variety which matures in mid-July
- Popular in mid-hills
- Used as pollinizer for Delicious varieties

## Lord Lambourne

- James Greeves X Worcester Peerman
- Regular bearer

## Granny Smith

- Mostly grown in Argentina, Australia and New Zealand
- Fruit takes 6-7 months to mature
- Fruits: Medium sized, round, skin grass green with whitish dots, subacid and not rich flavoured
- Suitable for processing
- Pollinizer for commercial varieties in India





## INDIAN VARIETIES OF APPLE

# Ambri

- Only indigenous variety grown commercially in India
- Originated in Kashmir as chance seedling
- Fruit – medium to large, oblong in shape
- Red streaks over a greenish yellow back ground
- Pulp – white, crisp & sweet
- Late season apple (ripening – Sept-Oct)
- Good keeping quality ( 4-5 months in ordinary condition and 10 months in cold storage)



- **Lal Ambri** (Red Delicious x Ambri)
- **Sunehari** (Ambri x Golden Delicious)
- **Chaubattia Princess** (Early Shanburry x Red Delicious)
- **Chaubattia Anupam** (Early Shanburry x Red Delicious)
- **Ambred** (Red Delicious x Ambri)
- **Ambrich** (Rich-a-Red x Ambri)
- **Ambroyal** (Starking Delicious x Ambri)



Ambroyal



Ambred



Chaubattia Princess

## Scab-resistant Varieties



**Prima**



**Sir Prize**



**Nova Easy Grow**



**Priscilla**



**Priam**



**Mac Free**





**Freedom**



**Jonafree**



**Liberty**

## Low-chilling Varieties

- Chilling period: less than 800hrs below 7° C
- Poor in dessert quality and shelf-life

Michal

Schlomit

Anna

Neomi

Tropical Beauty

Parlin's Beauty

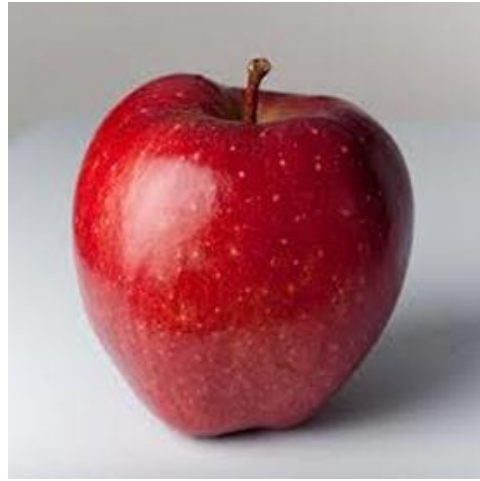
<b>s.r no</b>	<b>season</b>	<b>Himachal Pradesh</b>	<b>Jammu &amp; Kashmir</b>	<b>Uttarakhand</b>
1	<b>Early season</b>	<b>Tydeman's Early Michael Molies Delicious</b>	<b>Irish Peach Benoni</b>	<b>Early Shanburry Fenny Benoni Chaubattia Princess</b>
2	<b>Mid-season</b>	<b>Starking Delicious Red Delicious, Richared Vance Delicious Top Red Golden Red Chief ,Oregon Spur Redspur ,Red Gold</b>	<b>American Mother, Razakwar Jonathan Cox's Orange Pippin Red Gold ,Queen's Apple Rome Beauty ,Scarlet Siberian</b>	<b>Rea Delicious Starking Delicious McIntosh Cortland Delicious</b>
3	<b>Late season</b>	<b>Golden Delicious Yellow Newton Winter Banana Granny Smith</b>	<b>King Pippin, Kerry Pippin, Lal Ambri, Sunhari Chamure, Golden Delicious Red Delicious , Ambri, Baldwin Yellow Newton</b>	<b>Rymer Buckingham</b>

# Other varieties

- **Spur types** - Red spur, Starkrimson, Golden spur, Red Chief and Oregon spur.
- **Color mutants** - Vance Delicious, Top Red, Skyline Supreme.
- **Low chilling cultivars** - Michal, Schlomit.
- **Early cultivars** - Benoni, Irish Peach, Early Shanburry, Fanny
- **Juice making cultivars** - Lord Lambourne, Granny Smith, Allington Pippin.
- **Scab resistant cultivars** - Florina, Firdous, Shirean.
- **Triploid variety**:-Baldwin,mutsu, bramlays,winesap.
- **Natural mutant variety**:-red elstar
- **New Hybrids** - Lal Ambri (Red Delicious X Ambri), Sunehari (Ambri X Golden Delicious), Amred (Red Delicious X Ambri), Chaubatia Anupam & Chaubatia Princess (Early Shanberry X Red Delicious) developed in India.
- **Note**:-pamapples = pear x apple (intergeneric hybrids) Developed by Ellis Marks in 1952 in John Innes centre.



ambri



Red delicious



Golden delicious



Grany smith



mcIntosh



Pink lady



Starking delicious



cortland

Fig:-different apple cultivar



baldwin



jonathan



liberty



Yellow newton



Winter banana



Northern spy



maharaji

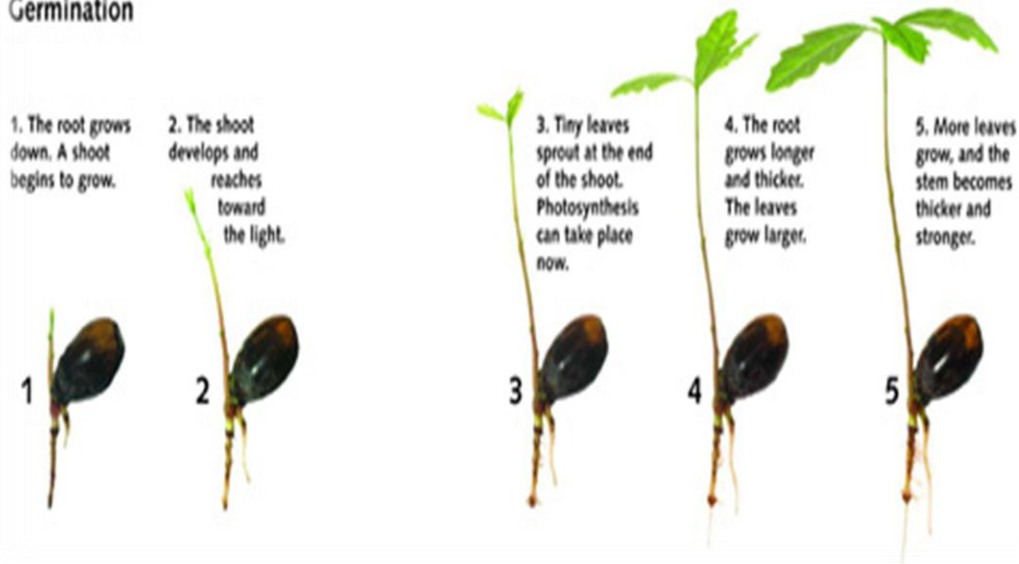
Fig:-different apple cultivar

# Rootstock

## Seedling rootstock

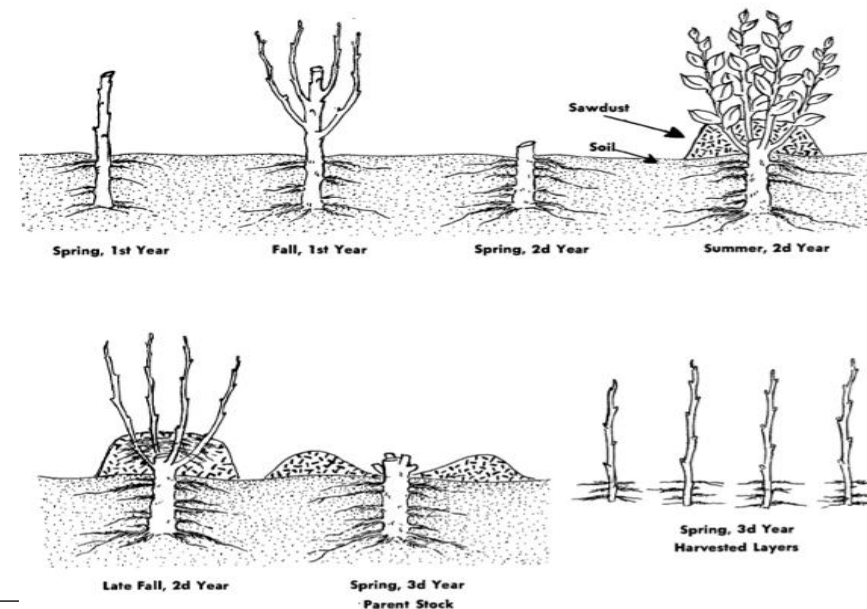
- For raising rootstock seedlings, seeds of crab apple (*Malus baccata*) or commercial cultivars are stratified during December for 2-3 months at 2-5°C.
- One year old seedlings are used

### Germination



## Clonal rootstock

- Clonal rootstocks are raised through mound or stool layering.
- Rooted layers are cut off close to the ground level and planted in nursery beds for grafting/budding.



# Clonal rootstock of apple

Category	Rootstock	Characteristics
<b>Dwarfing</b>	M 9	Short juvenile phase, suitable for high-density planting in flat and irrigated areas only
<b>Semi-dwarf</b>	M 4, M7 and MM 106, M24	Suitable for high-density planting and well-drained soils; resistant to wooly apple aphid but susceptible to collar rot
<b>Semi-vigorous</b>	MM 111 & MM-104	Drought tolerant and resistant to wooly apple aphid
<b>Vigorous</b>	Merton 793	Wooly apple aphid and collar-rot resistant, early-fruiting, recommended for Kumaon hills of Uttar Pradesh
<b>Ultra dwarf</b>	M-27(M-13xM-9)	Suitable for HDP



## Spacing and planting density for different scion & rootstock combination

Scion & variety	rootstock	Tree size	Spacing (m)	Density(tree/ha)
Standard	MM109, MM111	Semi vigourous	6x6	278
	M7,M106	Semi dwarf	4.5x4.5	494
	M9	dwarf	1.5x1.5 3.0x3.0	4444 1100
Spur type	Seedling	Semi vigourous	5x5	400
	MM109	Semi dwarf	3.5x3.5	816

# Propagation

- Propagation method:- whip and tongue method of grafting.
- root-stocks :- *Malus baccata* (crap apple), *M. prunifolia*, *M. sikkimensis* or their hybrid derivatives or seedling progenies of cultivated varieties

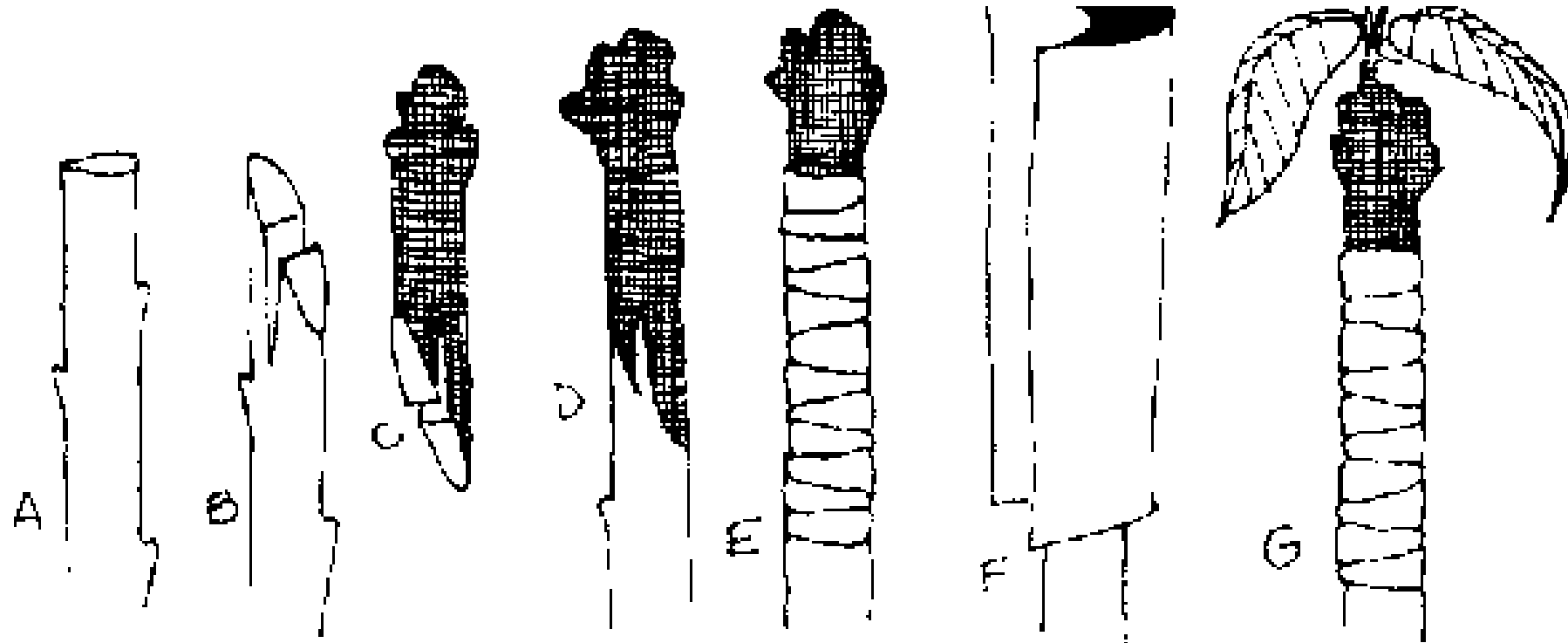


Fig:-process of tongue grafting in apple

# Planting

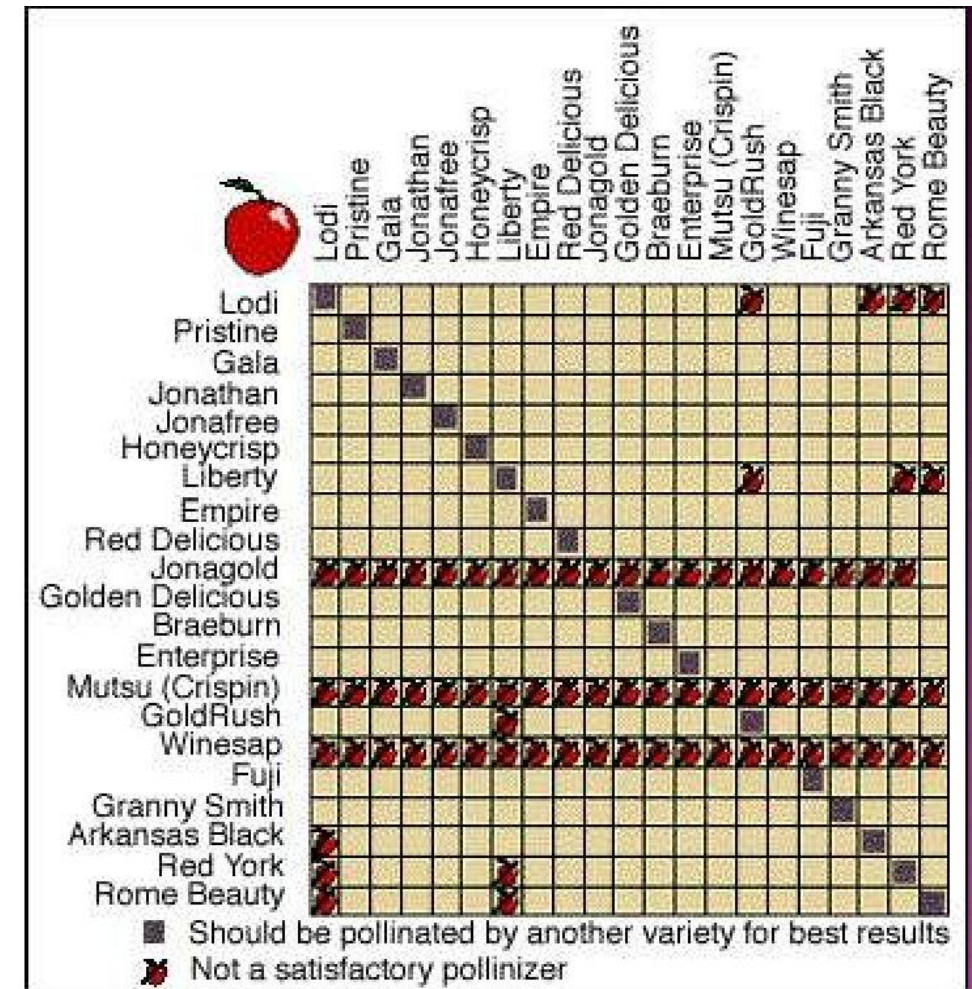
- Pit size-1m x1m x1m
- Planting system:-square or hexagonal planting system.
- Planting time:-January and February.
- The average number of plants in an area of one ha. can range between 200 to 1250.
- Four different categories of planting density are followed viz.
  - a) low (less than 250 plants/ha.),
  - b) moderate (250-500 plants/ha.),
  - c) high (500-1250 plants/ha.) and
  - d) ultra high density (more than 1250 plants /ha.).

Note:-during planting 20-25 kg. of FYM, 1 kg of Single super phosphate and 50 g. of Malathion dust are added after mixing properly in each pit.



# Pollinizer plant

- Apple is self unfruitful due to self incompatibility.
- Pollinizer plant is recommended in India is 11-30%.
- Pollinator plant:- In Royal Delicious variety plantation, Red Delicious and Golden Delicious as pollinators is recommended



# Fertilizer application

- FYM:- 10 kg./ year age of tree is applied .
- N:P:K-70:35:70 g./year (age of the tree)  
700:350:700 g(10<sup>th</sup> years age of tree)  
500:250:400g/year an “off” year (when the crop load is low)

**Table 4. Corrective Measures for Nutrient Deficiencies in Apple**

Elements	Chemical & Dose	Time of Spray
N	Urea, 5.0%	Pre-petal fall
Ca	Ca Cl <sub>2</sub> , 0.5%	30-45 days before harvest
Zn	ZnSO <sub>4</sub> , 0.5%	After petal fall
Mn	Mn SO <sub>4</sub> , 0.4%	After petal fall

# Irrigation

- Critical stage of apple:-fruit set.
- The water requirement of apple is 114 cm. per annum (15-20 irrigations).

In summer, irrigation is provided at an interval of 7-10 days .

while in winter it is given at an interval of 3-4 weeks.

note:-At least 8 irrigations are to be provided during critical period(April-August)



# weeding

- application of glyphosate @ 800 ml./ha. or Gammaxone /Paraquat (0.5% ) as post emergence herbicide suppresses weed growth for 4-5 months.

# Mulching

- **Mulching with hay or black alkathene is found to be effective in controlling the weeds in cool climates and also in conserving moisture.**
- **Use of dry grass or oak leaves has also been found to be effective in conserving soil moisture**





# intercropping

- Green manuring crops viz. sunflower and bean may be cultivated in the early years of plantation in order to improve soil texture and nutrient status of soil.



# fruit drop

- In apple, there are three distinct fruit drops,
  - i) early drop (improper pollination or unfertilized blossoms)
  - ii) June drop (due to moisture stress and fruit competition) and
  - iii) Pre-harvest drop. (most serious economical loss)

Management:-

Pre-harvest drop can be controlled by spraying NAA @ 10 ppm. (4 ml. of Planofix dissolved in 15 liter of water) about a week before the expected drop.



Fruit drop in apple



Early fruit drop

# Plant growth regulator

- Use of growth hormones is essential for good flowering and proper colouration in fruits.
- NAA @ 10-20 ppm at petal fall may be applied for the purpose.

# Training

- Timely pruning and training operation is essential for proper growth and good productivity.
- The plants are trained according to growth habit and vigour of the rootstocks.
- The standard trees are trained on modified central leader system so that plants receive proper light.
- This improves fruit colour and also minimizes the effect of heavy snowfall and hail.
- Spindle bush system is suitable for high density planting under mid hill conditions.

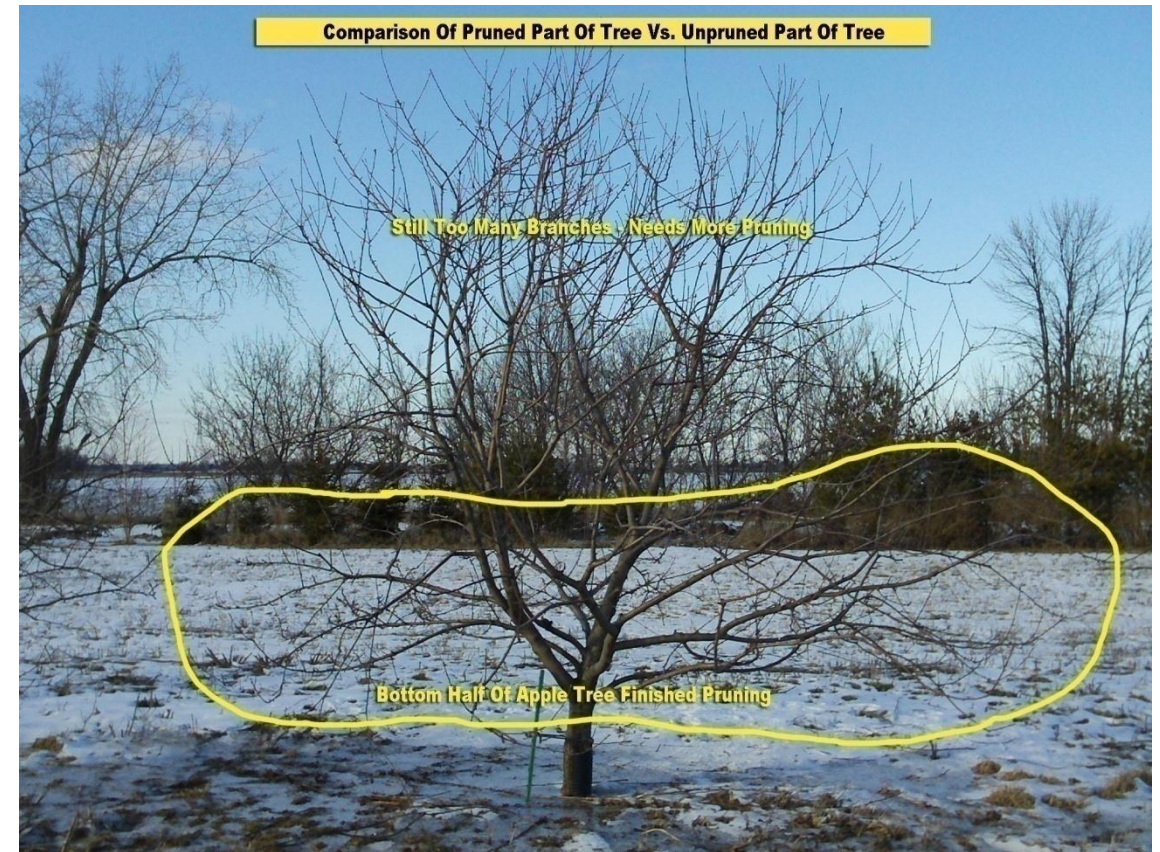
# Common Fruit Tree Training Systems



Fig:-Modified leader system training in apple

# Training

- Pruning is essential to maintain a proper balance between vegetative growth and spur development.
- Proper pruning of weak and undesirable branches/twigs is necessary after six years of plantation.



# Life cycle of apple fruit crop

Bud Swelling



Bud Opening



Flower Bud



Flowering



Fruit Set



Fruit Development



Maturation



Harvest



# Harvesting and Yield

- **The orchard start bearing from 4th and the economic life of an apple tree exceeds upto 30 years.**
- **The level of productivity varies form elevation to elevation. Production stage extends up to even forty years depending upon agro-climatic condition.**
- **Apple being a climacteric fruit, the maturity period does not coincide with ripening.**
- **The fruits are usually harvested before they are fully ripe.**
- **Maturity index:-.colour change, starch index should be 1-2.(starch iodine test)**
- **The average yield of different apple varieties in the state of Uttarakhand is very low (5-6 tonnes/ha.) as compared to that in Himachal Pradesh and Jammu & Kashmir which is around 11-13 tonnes/ha.**



# India's apple harvest season for major producing States

State	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Jammu & Kashmir								Early harvest	Peak harvest	Peak harvest	Late harvest	
Himachal Pradesh							Early harvest	Peak harvest	Peak harvest	Late harvest		
Uttaranchal						Early harvest	Peak harvest	Peak harvest	Peak harvest	Late harvest	Late harvest	



Source: National Horticulture Board, Ministry of Agriculture, Government of India.

## Harvesting method



Hand harvesting



Mechanical harvesting



Harvesting by ladder

Harvested fruits of  
apple



# Plant protection measure

**Woolly aphid**:- *Eriosoma lanigerum*

(most dangerous disease in world)

## Symptoms of damage

- Nymphs and adults suck the juice from bark of the trunk or fruits
- Weakening and death of the smaller plants

## Management

- Use resistant root stocks M 778, M 779, MM 14, MM 110, MM 112
- Spray dimethoate 30 EC 0.06% or methyl demeton 25 EC 0.025%
- Predator of aphid -*Aphilenus mali*



## **San Jose scale** : *Quadraspidiotus perniciosus*

### Symptoms of damage

- The infested region in bark becomes reddish pink
- Purple discolouration on fruits.

### Management

- Summer spray with phosalone 50 EC 0.05% or fenitrothion 50 EC 0.05%
- Winter spray with diesel oil emulsion at 8-12 l/ tree ( diesel oil 4.5 l, soap 1 kg, water 54 -72 l)



# Disease

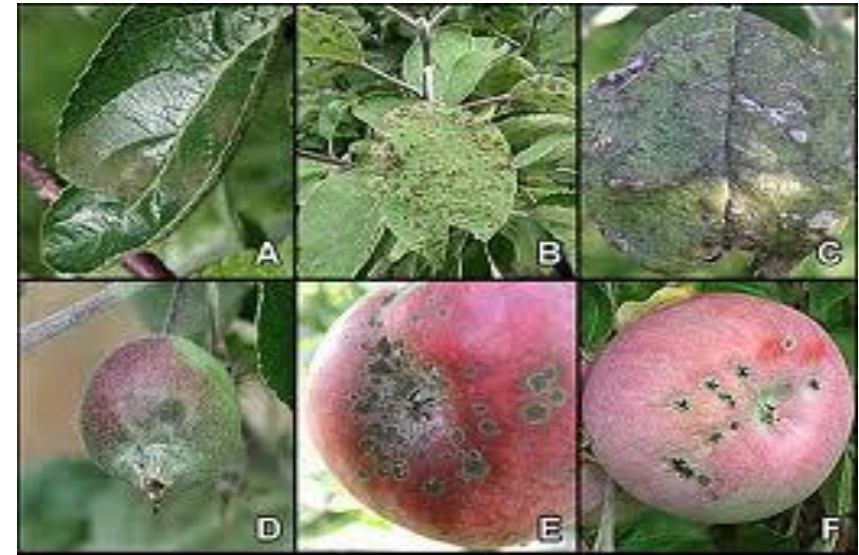
## Scab – *Venturia inaequalis*

### Symptoms

- Symptom appears on leaves and fruits.
- On lower side of the leaf lesion appear as olivaceous spots which turn dark brown to black and become velvety.
- On young foliage, the spots have a radiating appearance with a feathery edge.

### Management

- Clean cultivation, collection and destruction of fallen leaves and pruned materials in winter to prevent the sexual cycle.
- Spray Mancozeb 0.25 % at bearing stage
- **Note**:-sacb epidemic in J&K in 1972-73 and HP in 1978-79.



## **Fire blight- *Erwinia amylovora***

### **Symptom**




- The initial symptom usually occurs on leaves, which become water soaked, then shrivel turn brownish to black in colour and fall or remain hanging in tree.

### **Management**

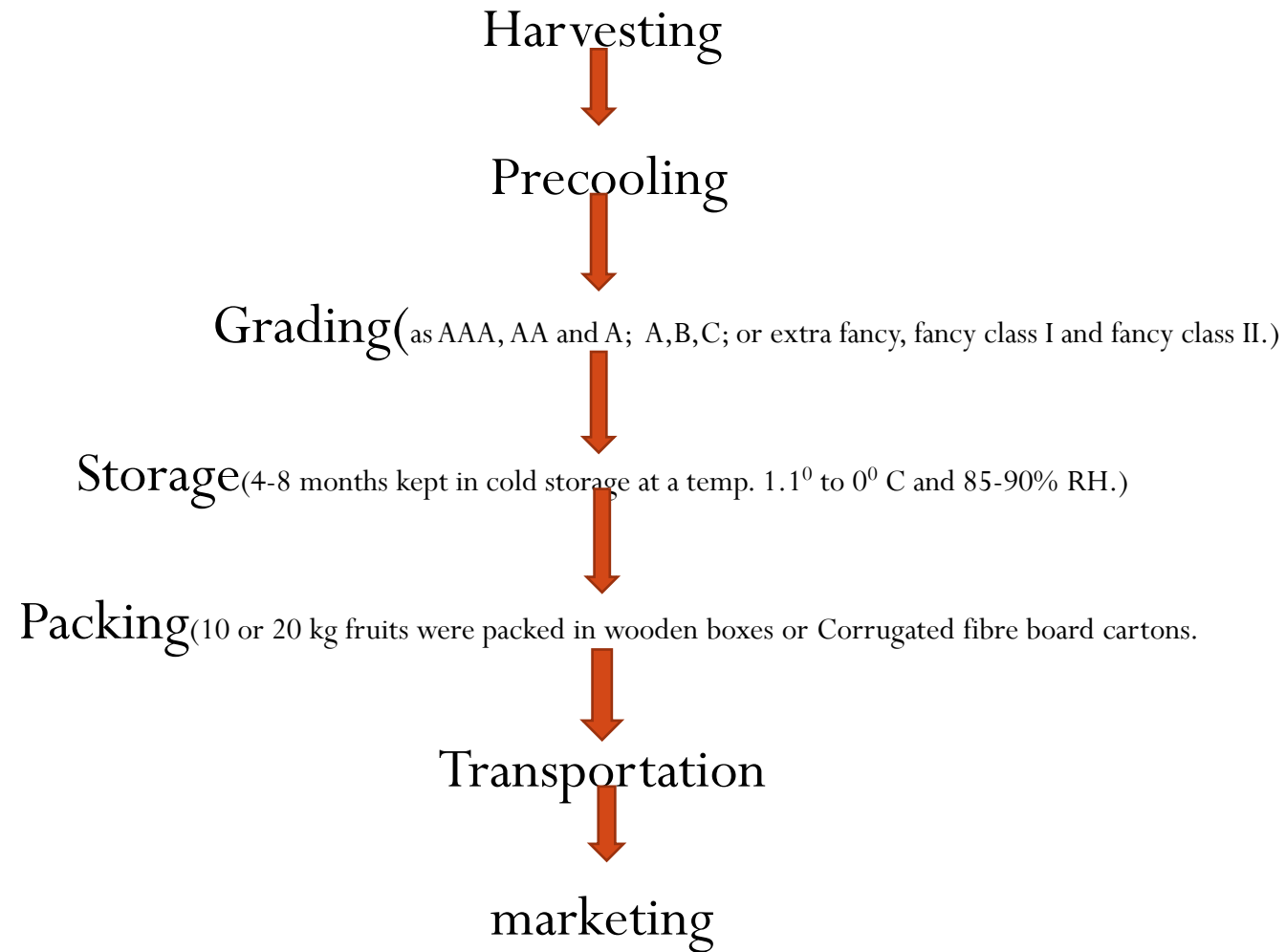
- Removal and destruction of affected parts.
- Spray with Streptomycin 500 ppm.



# Physiological disorder

disorder	causes	Symptom	management
Water core	Bo deficiency		Borax apply
Bitter pit	Ca deficiency		Caco3 apply.
Rosset leaf	Zn deficiency		ZnSO4 apply

# Post harvest technology





# Common Mistakes-Avoided!

- Appropriately packed in crates
- Segregation of apples
- Stored at controlled temperature (18°C)
- Trained staff to handle fruits
- Effective Supply chain

# Prepared product from apple





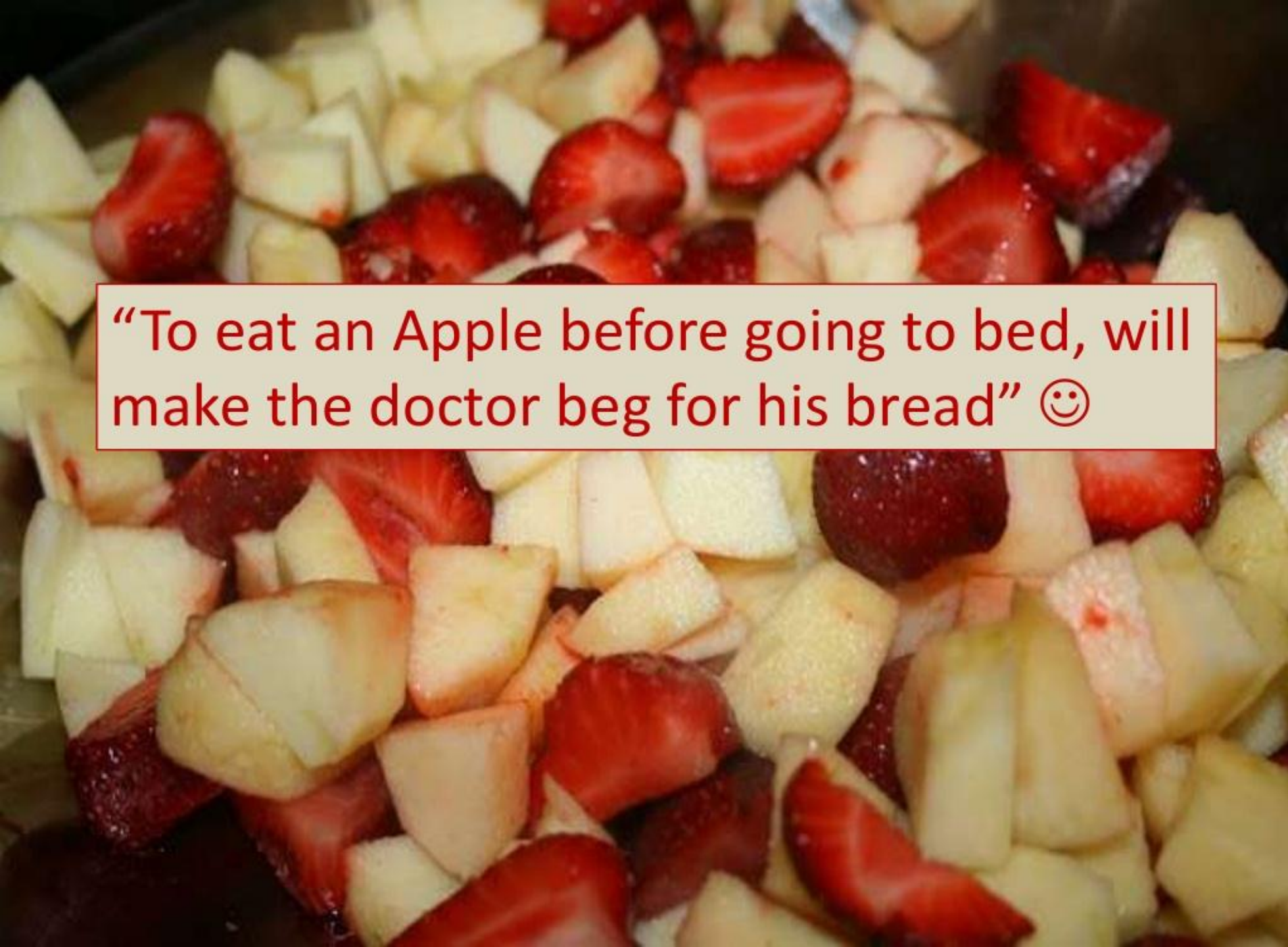
# Constraint in apple cultivation

- Large number of **old orchards** (more than 30 years old) are showing decline in terms of growth and fruit yield.
- choice of **wrong pollinizers** and their inadequacy in number often result to low productivity.
- The need for injecting new blood into the apple industry through **spread of new cultivars** (spur types, color mutants, Red Fuji; scab resistant cultivars, bud sport selections of Royal Delicious, and some of the promising hybrids) **is urgently felt**.
- The **low chilling cultivars** and promising cultivars **identified need further spread**.
- Technologies like **use of clonal rootstocks, introduction of renewal pruning techniques and micro nutrient applications** have not been transferred and adopted at a satisfactory level.
- The **water and fertilizer use efficiency is generally poor**. Also, spring frost and hailstorms are adverse weather parameters leading to low productivity
- **Apple scab disease** has been the major plant protection problem in apple

- **For checking entries of diseased material in the free areas of Uttarakhand and North-Eastern Hills, strict quarantine and selection of elite disease-free mother plants are very essential. Often it is not followed strictly**
- **Biological and serological indexing/detection procedures have been developed.**
- **Limited quantity of virus-free budwood is also being supplied.**
- **Extreme care is now required to be taken to multiply quality planting material (in apple alone approximately 2 million plants/year) for establishing new plantations**
- **Most of the orchardists still sell their crop at flowering to contractors as there is no well organized marketing system**
- **Transportation in the hills itself is problematic**
- **Post-harvest management problems originating from poor harvesting (strip picking) and improper packing system (non CFB boxes) and lack of proper pre-cooling and cold storage facilities result in huge (25-30%) loss of fruits**
- **Capacity of the processing sector is also inadequate.**
- **The existing processing units are quite old and they require modernization for which substantial investment is required.**

# Future thrust in apple

- Both **North-West and North-Eastern regions of India** offer large areas ideally suitable for cultivation of apple.
- Scientific water management and practicing proper training and pruning of trees including introduction of renewal pruning techniques, will make significant impact on increased production .
- There is **immense scope for increasing various processed products** of apple.
- For rapid multiplication of germplasm **tissue culture** method can be adopted



“To eat an Apple before going to bed, will make the doctor beg for his bread” 😊