CHAPTER

2

TEMPERATE FRUITS AND THEIR CULTIVATION

OBJECTIVES

After studying this chapter, students will be able to:

- Identify the temperate fruits and know their importance
- Explain the cultural requirements of temperate fruits
- Identify the problems of temperate fruits and their management
- Identify the major insect-pests and diseases of temperate fruits and their integrated control measures
- Start growing temperate fruits if they belong to hilly areas (temperate zone)
- Start agribusiness in temperate fruit plant nursery or development of value added products

INTRODUCTION

Whenever you go to fruit shop or a market, you might have seen several types of fruits in the shops. Have you ever thought about their areas of production, and specific climate in which they grow? I don't think you have ever thought about it. You may have several such queries in your mind. In this chapter, you will come to know about temperate fruits i.e. the fruits which are grown in cooler climate in hills or areas where the winter temperature is quite low. Most of these fruits require chilling temperature (below 7.2^{o}C) to break bud dormancy. If specific chilling requirement is not met, there will be low flowering in the spring, and hence the crop will also be low. The major temperate fruits grown in India are apple, pear, peach, plum, cherry, apricot and walnut. These fruits contain ample amount of carbohydrates, proteins, vitamins and minerals and thus protect our body from several ailments. In this chapter, we will discuss about the cultural requirements and production technology of important temperate fruits grown in India.

What are temperate fruits?

The fruits, which can be successfully cultivated under temperate climatic conditions i.e. areas where winter temperature is very low and summer temperature is not so high, are called as temperate fruits. Most of the world's temperate fruit production is confined to northern hemisphere, which has over 80 per cent terrestrial area unlike in southern hemisphere where major area is covered by oceans. In general, temperate fruits are grown in regions where winter temperatures are not so cold that would kill the plant but are low enough to provide the buds adequate chilling to break winter rest.

Most of these fruits require chilling temperature (below 7.2^{o}C) to break bud dormancy. If specific chilling requirement is not met, there will be low flowering in the spring, and hence the crop will also be low.

Most of the temperate fruits belong to the family Rosaceae, except the nuts (e.g. walnut, pecan nut, hazel nut) and other minor fruits like persimmon and gooseberries, etc. The temperate fruits can be broadly classified into three main groups, viz. i) pome fruits, ii) the drupes, and iii) nuts. The pome fruits are usually false fruits as the edible part develops from the extra ovarian tissues of thalamus. Apple and pears are major pome fruits. The drupe fruits are characterized by stony hard pit (e.g., plum, peach, almond etc.). Nuts have hard shell, and most of the temperate nuts (walnut, pecan nut, hazel nut) belong to the family Juglandaceae.

In India, temperate fruits are mostly confined to west Himalayan ranges i.e, Jammu and Kashmir, Himachal

Pradesh and Uttrakhand. Their cultivation has been extended to east Himalayan ranges in Sikkim, Nagaland and Arunachal Pradesh. Limited cultivation is also done in Nilgiri hills of south India. Although, the temperate fruit growing areas in India do not fall in typical temperate zone but the prevailing temperate climatic conditions due to the vicinity of snow covered Himalayas and high altitude has made their cultivation possible.

APPLE

Apple is the most important fruit among the temperate fruits grown throughout the world. It belongs to genus *Malus,* family Rosaceae with basic chromosome number of x = 17. Most of the cultivated apple varieties are diploid with chromosome number, 2n = 34. Some cultivars are triploids and tetraploids as well. For example, Suntan, Jupiter and Janagold are triploid and Alpha-68 is a tetraploid cultivar. The cultivated apple is usually referred as *Malus pumila* L., although, the exact name is *M. domestica* Borkh. The origin of apple is considered to be the Caucasus, Asia Minor and Soviet Central Asia. Ambri, a dessert apple variety, is considered indigenous to Kashmir. China, USA, Turkey, Poland, Russian Federation, France, Italy, Germany and Argentina are major apple producing countries. In India, apple is cultivated in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Nagaland and Sikkim. Some low chilling varieties are also cultivated in Nilgiri hills and eastern Himalayan ranges.

Soil and climatic requirements

Apple can grow on a wide range of soils. Well-drained, deep, fertile, slightly acidic, clay loam soils with pH 6.0-6.8 are considered ideal for apple cultivation. Sites with gentle slope are generally more suitable than too steep areas. Windy locations, ridge tops and skylines should be avoided for apple cultivation.

Apple requires about 1,000 to 1,500 hours of winter chilling for breaking the bud dormancy. Abundant sunshine is necessary for proper growth and colour development in fruits. Spring frost and hails are the major limiting factors in apple production. Therefore, areas experiencing frequent spring frosts and hails coinciding flowering and fruit set should be avoided. Well distributed annual rainfall of 100-125 cm is favourable for good productivity. Excessive rains and foggy conditions near fruit maturity result in poor fruit quality, poor colour and development of black fungal spots on the fruit surface.

Planting

The methods of planting apple in flat areas are square, rectangular, quincunx and hexagonal systems. However, in hilly areas, contour or terrace planting is convenient. The planting distance of apple depends on variety, rootstock, soil type and cultural practices, which influence the size of the canopy. However, in general, a planting distance of 8 x 8 m for vigorous and 5 x 5 m for dwarf cultivars is recommended in India. In general, pits of 1 x 1 x 1 m size are dug and filled at least one month before planting by mixing 40-50 kg FYM or compost, 500 g superphosphate and 50 g insecticidal dust like metacid dust or folidol dust at the time of filling. Early planting should be done preferably in December. Care should be taken that the graft union remains at least 25 cm above ground in order to avoid scion rooting and collar rot incidence.

Commercial varieties

Important commercial varieties of the world are Delicious, Golden Delicious, McIntosh, Rome, Beauty,

Top and Red Golden Delicious cultivars of apple

Jonathan, York Imperial, Golden Delicious, Stayman Winesap, Yellow Newton, Baldwin, Grimes Golden, Wealthy, Cox's Orange Pippin and Rhode Island Greening.

According to the time of harvesting, apple varieties can be categorized as early, mid season and late.

Early : Red June, Tydeman's EarlyWorcester, Kings Pippin, Summer Queen

Mid season : Starking Delicious, Red Delicious, Richared, Black Ben Davis, Red Gold, Mclntosh, Golden Delicious, Lord Lambourne

Late : Granny Smith, Ruspippin (yellow, winter banana)

Flowering, pollination and fruit set

Most of the apple cultivars especially of the Delicious group and its colour and spur mutants being self-infertile, require cross pollination for satisfactory fruit set. Therefore, pollinizing varieties, having overlapping flowering period should be planted with the main varieties. Tydeman's Early Worcester, Red Gold and Golden Delicious are good pollinzers. For the spur types, like Golden Spur, Wellspur, Top Red etc., can be inter-planted as pollinizers. Crab varieties such as *Malus floribunda*, Red Flesh, Crimson Gold, Yellow Drop, Manchurian, Snow Drift and Golden Hornet can also be introduced into the orchard apart from standard pollinizers to ensure pollination.

Attractive fruits of Red Delicious cultivar

Delicious group of apple varieties were introduced in India at Shimla (HP) by S.N. Stocks, which revolutionized apple cultivation in our country as well.. These varieties require polliniser variety in commercial orchards. Placement of 25-30% pollinisers has been recommended for Delicious group of apples.

Twenty five to 30 per cent pollinizer trees are adequate for Delicious varieties. In areas having poor set, the proportion of the pollinizer trees can be increased to 30 to 50 per cent. Since honeybees carry out cross pollination in apple, 4-5 bee hives per hectare should be placed in the orchard before flowering.

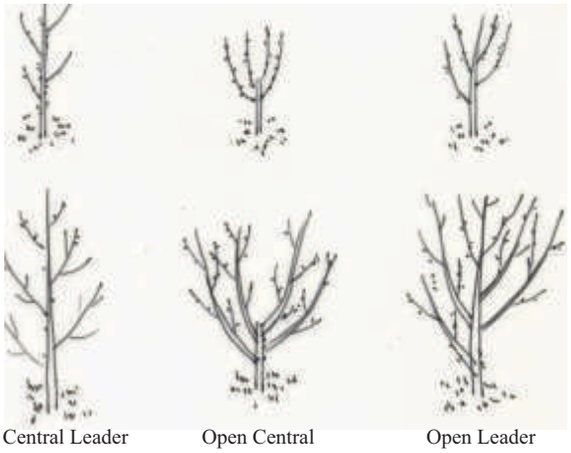
Rootstocks and propagation

Traditionally seedling rootstocks are used. These provide strong and well developed root system with good anchorage in shallow sloppy hilly conditions. In western countries, now standard clonal rootstocks such as Malling (M) series and Malling Merton (MM) series rootstocks developed at East Malling Research Station and John Inn's Research Institute, Merton, are used. MM series rootstocks are resistant to woolly apple aphid. EMLA series virus free rootstocks have also been developed by screening the M and MM series rootstocks. Based on their effect on the scion, clonal rootstocks of apple have been classified in four groups viz., dwarfing (e.g. M 9, M 26), semi-dwarfing (e.g. MM 106, M 7), semi-vigorous (e.g. MM 104, MM 111) and vigorous (e.g. M 16, M 25, MM 106).

Clonal rootstocks (e.g. M series) could not be successful in India because of low fertility status of soil, poor anchorage of stocks and bad suckering rate in such rootstocks.

Training and pruning

Modified central leader system of training is most suitable for developing framework of the tree in standard plantations on seedling rootstock. The proportional heading back and thinning out system of pruning is adopted to maintain the balance between the reproductive and vegetative growth. Apple requires regular moderate annual pruning. In the aged plantations, spur



Central Leader Open Central Open Leader

Some training systems in apple

pruning is advisable to encourage the vegetative growth and new spur development. In high density plantations on clonal rootstocks, the most suitable methods of training are spindle bush, dwarf pyramid or cordon. Espalier system induces *dwarfing effect* and improves spur development and fruit quality. All the size controlling training systems facilitate use of anti-hail nets in hail prone areas.

Manures and fertilizers

In general, 10 kg FYM, 70 g N, 35 g P_2O_5 and 70 g K_2O should be applied to one-year-old plants. The dose should be increased in the same proportion till the plant gains the age of 10 years when the doses are stabilized. A mature tree requires 100 kg FYM, 700 g N (2.8 kg CAN), 350 g P_2O_5 (2.0 kg single superphosphate) and 700 g K_2O (1170 g muriate of potash) in an 'on' year. In the 'off' year, the fertilizer doses should be reduced to 500 g N, 250 g P_2O_5 and 400 g K_2O.

NPK fertilizers should be broadcasted in the tree basin 30 cm away from trunk to tree dripline and mixed well in soil. FYM, P_2O_5 and K_2O should be applied during the winter before snowfall at the time of basin preparation whereas nitrogenous fertilizers should be applied one month before bud break. If irrigation facilities are available, nitrogen should be applied in two split doses, first half dose should be applied 2-3 weeks before flowering and the second half dose should be applied one month later. Apple trees also respond to foliar application of nitrogen in the form of urea (0.5 per cent), which can be sprayed twice after fruit set at one month's interval.

Orchard floor management

Mulching followed by herbicidal application has been the most effective for floor vegetation management and soil moisture conservation. Oak leaves and hay mulch has been found beneficial. Black polyethylene mulch in cooler conditions is the most effective in weed control, moisture conservation, reduction in fruit drop and improvement in size, colour and quality of fruits. However, in warmer conditions, black polyethylene mulch has adverse effect on root growth due to rise in soil temperature.

Gramaxone (1,000 ppm) or mixture of 2,4,5 T (100 ppm) and Gramaxone (500 ppm) is effective in controlling shrubby weeds. Diuron @ 2 kg/ha, Tok E-25 @ 4 litre/ha and Trafazine at 4 kg/ha can be used to check weed growth in apple nurseries.

Fruit thinning

The judicious thinning at proper stage of fruit development can regulate cropping and improve fruit size and quality. Hand thinning is cumbersome, hence chemical methods should be employed. Carbaryl (1,500 ppm) applied 3 weeks after petal fall induces 60 per cent thinning in Red Delicious. 2,4,5-T can induce 35-40 per cent thinning. In Golden Delicious, application of NAA (10 ppm) and Carbaryl (750-1000 ppm) at petal fall is effective for optimal fruit thinning.

Fruit drop and its control

Fruit drop is one of the most serious problems in apple. Most of the commercial varieties of apple have 3 waves of fruit drop : (i) early drop, (ii) June drop, and (iii) pre-harvest drop. Pre-harvest fruit drop results in serious economic losses as full grown marketable fruits abscise before harvest. This is caused due to hormonal imbalances, especially reduction in the levels of auxins. This drop is very high in early ripening cultivars like Tydeman's Early Worcester, Red Gold and Pippins and range from 40 to 60 per cent of crop load. Application of NAA (10 ppm) before the expected time of fruit drop or 20-25 days before harvest can check the fruit drop effectively.

Colour improvement and enhancement of ripening

In Delicious varieties of apple, colour development is generally poor in marginally warmer areas and thereby produce fetches poor price in the market. Application of 1,000 ppm 2-chloroethyl phosphonic acid (ethrel/ethephon), an ethylene releasing hormone, about 10 days before harvest improves fruit colour

substantially but impairs shelf life. Since this chemical accelerates fruit abscission, 10 ppm NAA is added to check drop.

Physiological disorders and their management

In apples, physiological disorders like cork spot, bitter pit, Jonathan spot, water core, internal breakdown, and storage scald can cause damage. Of these disorders, bitter pit is quite serious. Its symptoms appear as small, dry, brown pockets usually spherical in shape below the peel and also in the cortex. Delicious group is more prone to bitter pit. Early picked apples are more prone to bitter pit. In addition, unbalance or high nitrogen promotes its incidence. However, calcium deficiency is the primary cause of bitter pit in apples. Spraying calcium chloride (0.4%) or dipping harvested apples in calcium chloride (2%) is effective in reducing bitter pit. Similarly, boron and zinc sprays increase the Ca content of fruit and reduce the incidence of bitter pit effectively.

Maturity and harvesting

It is important to harvest the fruits at proper stage of maturity. Immature fruits are of poor flavour and quality and shrink during storage. Over mature fruits are also poor in quality and are more prone to storage disorders. The important picking indices for apple are, change of seed colour to brown, change of ground colour from green to pale or red, TSS of 11 to 14.5, firmness of flesh (16-18 lb/square inch), easy separation of fruit from the spurs and 90-180 days from full bloom to maturity, depending on variety. Now-a-days, starch-iodine index (SII) is being followed as a reliable maturity index.

Change of ground colour from green to pale or red, TSS of 11 to 14.5, firmness of flesh (16-18 lb/square inch), SII (4.5/10) and 90-180 days from full bloom (DFFB) to maturity depending on variety are major maturity indices for harvesting apples at a right stage of maturity.

The harvested fruits are graded according to size and colour. In India, apples are graded in seven size grades *viz.* super large (85 mm diameter), extra large (80 mm), large (75 mm), medium (70 mm), small (65 mm), extra small (60 mm) and *pittoo* (55 mm and below). The fruits can be packed in telescopic fibre board cartons or wooden boxes for transportation and storage. Apple fruits can be stored at -1.1 to 0 ^{0}C at 85-90 per cent relative humidity for 4-6 months. Controlled atmospheric (CA) storage is also becoming popular in advanced countries. Apples can be kept for about 9 months in CA storage. In India also, some CA storage facilities have been created by Adani group and Reliance Industries in Himachal Pradesh. Apple has the longest shelf life in cold storage than any other fruit and thus is available all the year round.

Plant protection

a. Insect pests and their control

Insect-pests	Control measures
San Jose Scale (*Quadraspidiotus perniciosus*)	Application of 2 per cent miscible oil or 5 per cent summer oil during February-March efficiently controls the pest. The summer oil formulations, e.g. Orchex 796, Caltex 1, POL Summer oil, etc. can be applied at the rate of 1 per cent at petal fall stage. *Coccinella septempunctata* and endoparasitoid, *Encarsia perniciosi* have been found to contain scale population effectively.
Woolly apple aphid (*Eriosoma lanigerum*)	Soil application of phorate or carbofuran granules during May and October-November checks its incidence and spread of this pest. The foliar spray of chlorpyriphos (0.02%), fenitrothion (0.05%),

	dimethoate (0.03%) or phosphamidon (0.03%) also controls the pest effectively. Rootstocks like MM 106, MM 109, and MM 111 are resistant to this pest. Endoparasite, *Aphelinus mali* is quite promising, and must be encouraged in apple orchards for the control of woolly aphid.
Root borers (*Doresthenes hugelii*)	Drenching tree basins with chlorpyriphos (0.04) or dusting with folidol dust at the rate of 25 kg/ha during September is quite effective for the control of root borers.
European red mite (*Tetranychus sp.*)	Spray of dicofol (0.05 per cent) followed by malathion (0.05 per cent) provide some control of red mites.
Blossom thrips (*Thrips flavus*)	Spray of chlorpyriphos (0.04%) or fenitrothion (0.05%) at pink bud stage is recommended for the control of thrips.

b. Diseases and their control

Apple scab: The disease is caused by *Venturia inaequalis* and it occurs throughout the apple growing belts of the world. The first severe epidemic of apple scab in India occurred in 1973 in Jammu and Kashmir. The disease was reported in Himachal Pradesh in 1977 and in 1982-83 severe epidemic occurred. In this disease, olive green spots appear on leaves and fruits, which causes severe losses to the growers.

Apple twig infested with woolly apple aphid

Symptoms of scab on apple leaves

The recommended spray schedule to control apple scab is given below:

Stage	Fungicide (per/100 litre water)
Green tip	Dodine (100 g), Captan (300 g) or Ziram (300 ml)
Pink bud	Benomyl (50 ml), Carbendazim (50 g) or Thiophanate methyl (50 g)
Petal fall	Fenarimol (40 ml), Hexaconazole (30 ml) or Penconazol (50 ml)
Pea stage	Mancozeb (300 g), Dodine (75 g) or Zineb (300 g)
Fruit development (20 days after pea stage)	Benomyl (250 g), Carbendazim/Thiophanate methyl [20 (50 g] + Mencozeb (250 g) or Dithianon (50 g)
Fruit development (after 20 days of previous)	Mancozeb (300 g), Captan (300 g), Carbendazim (50 g), Mancozeb (300 g), Zineb (300 g) or Propineb (300 g)

Pre-harvest (20-25 days before harvest)	Mancozeb (300 g), Captan (300 g) or Ziram (300 g)
Before leaf fall	Urea (5 kg)

Powdery mildew : In this disease, whitish powdery mass grows on leaves and other ariel parts. It can be kept under control by pruning and destroying affected terminals and spraying of wettable sulphur (0.2-0.3%), carbendazim (0.05%) or karathane (0.05%) during late dormancy, bud swell, petal fall and two weeks later. In nursery, spraying of fungicides at 7 days interval is recommended.


Powdery mildew affected apple branch

White root rot: White mass grows on roots, casing them to rot. Proper drainage, removal of infected roots and application of Chaubattia paste on cut ends of roots and soil drenching of the tree basins with carbendazim (0.1%) at 15 to 20 days interval during monsoon has shown recovery of the plants at an early stage of infection.

Collar rot: Rotting takes at the collar region of plant. The removal of soil around collar portion during November-December and exposure to sun, removal of affected bark and application of Chaubattia paste and soil drenching around trunk with mancozeb (0.3-0.4%), copper oxychloride (0.5%) or ridomil MZ (0.3%) has shown appreciable control. Clonal rootstocks like M 2, M 4, M 9 and MM 113 are resistant to collar rot, whereas, MM 106 is susceptible to the disease.

Cankers: A number of cankers like pink canker, European canker, smoky blight, nail head, stem black, silver leaf and stem brown cankers have been observed in apple plantations caused by various fungi. Scarification of cankered portion and application of Chaubattia paste or copper oxychloride controls the cankers effectively. Cow dung paste (1 part fresh cow dung + part clay soil + water) has also been found to give good healing of scarified portions. Spray of copper oxychloride (0.3%) or captan (0.2%) after harvest and at bud swell stage is recommended in severe canker prone areas.

PEAR

The cultivated pear, *Pyrus communis* L., belongs to the family Rosaceae with basic chromosome number, X= 17. The primary centre of origin of pear is the region including Asia Minor, Caucasus, Central Asia and Western Himalayas. Major pear producing countries are USA, Canada, Mexico, Argentina, Brazil, Chile, Italy, Russia, Germany, France, Switzerland, Spain, Austria, Poland, UK, Australia, New Zealand, Japan, China, Korea and South Africa. In India, pears are cultivated mainly in Jammu and Kashmir, Himachal Pradesh, Punjab, Arunachal Pradesh, Meghalaya, Mizoram, and Western Uttaranchal. Low chilling pears can be grown in Punjab and Nilgiri hills.

Soil and climatic requirements

Pears grow best in fertile, deep, medium textured and well drained clay loam soils. Pears are more tolerant to wet conditions but more susceptible to drought. Pears prefer neutral soil (pH 6.0 to 7.5). There should not be any hard rock or pan within two meters of soil depth, which may restrict proper root growth of the trees.

Conference pears

Pear is adaptable to a wide range of climatic conditions but European varieties require 1,000-1,200 chilling hours. The oriental pears require as low as 200-500 chilling hours below 7 ^{0}C during winters. A well distributed annual precipitation of 100 cm is desirable for successful pear cultivation in rainfed areas.

Commercial varieties

The leading pear varieties of the world are William Bartlett, Anjou Bose, Flemish Beauty, Conference, Hardy, Comice, Winter Nellis, Seckel, Kieffer and Clapp's Favourite. European varieties of pear are cultivated in high hills of India having cooler climate. These are categorized as early, mid - season and late as follows:

Early : Early China, Laxton's Superb, Fertility and Seckel

Mid - season : Bartlett, Conference, Starking Delicious, Max Red Bartlett, Dr July Guyot

Late : Doyenne Du Commice, Easter, Beurre Hardy, Winter Nellis, Clapp's Favourite and Flemish Beauty.

In lower hills and valley areas, which have warmer climate, the varieties belonging to oriental group are grown, which require low winter chilling. The important varieties for these areas are Sand Pear (*Pathar Nakh*), Kieffer, China, Gola, Le Conte and Smith. William Bartlett is the leading variety of pear in Indian conditions. The coloured strains of Bartlertt, viz. Max Red Bartlett, Red Bartlett and Starking Delicious are gaining popularity due to fancy red colour of fruits.

Fruits of Max Red Bartlett

Flowering and pollination

Most of the pear varieties are self-fruitful and do not require pollinizers. However, the provision of pollinizers increases productivity. Most of the varieties are cross-compatible. Bartlett, Burre Hardy, Winter Nellis, Flemish Beauty and Kieffer are pollinizers for other commercial pear varieties.

Plant propagation and rootstock

Pear varieties are propagated by budding or grafting on the seedling rootstocks. Tongue grafting and 'T' budding are most successful methods. Seedling rootstocks such as *P. communis* are compatible with all pear cultivars. The seedling rootstocks such as *P. pashia* (*Kainth*) and *P. serotina* (Shiara) are used in India. Quince (*Cydonia oblonga*) strains are used as size controlling rootstocks.

Planting and spacing

Pear plants are planted in winters when these are dormant. The standard plants on seedling rootstocks are planted at a spacing of 5 meters in normal soil conditions. The spacing can be reduced to 3 meters for plants on clonal rootstocks. In hills, pear is planted on terraces or contours in square or hexagonal system.

Training and pruning

Most of pear varieties are upright in growth habit and need a training system, which would induce spreading habit. Modified central leader system is most appropriate for training the standard trees. Usually, 2 to 3 scaffold branches are selected around the trunk every year for 3 to 4 years in a spiral stair case fashion. The central leader is headed back every year during winters and a terminal side branch is allowed to develop as modified central leader in order to check the upright growth and develop spreading habit.

Pear plants need regular but moderate pruning during winters. Both heading back and thinning out of branches are followed. All the shoots need to be headed back and about ¼ to ½ length should be removed to encourage spreading habit. Crowding branches should be selectively thinned out. Dead, broken or diseased branches should also be removed. Since pear is a spur bearer, renewal of spur is done after 8 to 10 years in order to encourage new healthy spurs.

Nutrition and manuring

Usually one-year-old plant requires 10 kg FYM, 70 g N, 35 g P_2O_5 and 70 g K_2O, which can be increased

annually till 10th year and the levels of fertilizers are maintained thereafter. Thus, a 10-year-old mature tree requires 60-100 kg FYM, 700 g N, 350 g P_2O_5 and 700 g K_2O. FYM, P_2O_5 and K_2O should be applied during December at the time of basin preparation. N is applied usually in February-March in single or in split doses. Pears are also sensitive to boron deficiency, and a single spray of borax (0.4%) during active growth period helps to correct B deficiency in plants.

Orchard floor management

Usually, the basins of pear plants should be kept weed-free. In the inter basin spaces, permanent sod may be allowed to develop. In areas where moisture conservation is important, plant basins can be mulched with hay, at least 10 cm in thickness, after spring rains and retained throughout the summers. The mulch should be removed before onset of monsoon in order to avoid excessive soil moisture and root suffocation. In cooler areas. black polyethylene mulch is better since it also helps in weed control.

Maturity, harvesting and storage

Pears are harvested when the seeds start to turn brown. For distant marketing and processing, fully mature, firm, green pear fruits are harvested as the ripe pears are delicate and do not withstand long transportation and have poor shelf life. However, for domestic or short distance markets, the picking can be delayed till green colour of peel starts turning pale. Pear fruits are graded as extra large (dia. 8 cm), large (dia. 7 cm), medium (dia. 6.5 cm) and small (5 cm). The fruits should be properly packed in 10 or 20 kg wooden boxes or corrugated fibre board cartons. Average yield of pears in proper management conditions is about 30-40 tons per hectare. Pears can be stored at –1 to 0 ^{0}C at 80-85 per cent relative humidity for 30 to 45 days. In controlled atmospheric storage, pears can be stored at 2 per cent O_2 and 1 per cent CO_2 level at –1 to 0 ^{0}C for 2-3 months.

Plant protection

Insect-pests	Control measures
Pear psylla (*Pyrylla pyricola*): Most serious pest of pear. It is known agent for spread of pear decline.	It can be controlled by restricting vegetative growth of the trees, summer pruning of water sprouts, use of overhead tree sprinklers to wash out the honeydew and spraying fenvelrate or fenoxycarb (0.05%) before flowering initiation.
Disease	**Control measures**
Fire blight (*Erwinia amylovora)*	Keep the orchard clean and destroy the affected plant parts. Spray, Bordeaux mixture (8:8:100) along with 2-3% oil at green tip stage and during dormant season or streptomycin (100 ppm) after rains, throughout the spring and early summer.
Blossom blight (*Pseudomonas syringae)*	Spray of Bordeaux mixture (4:4:50) at the onset of leaf fall and later at bud burst is quite effective in controlling it.

EXERCISES/ACTIVITIES

- Go to market and purchase several types of fruits from the vendors. Now identify those which areproduced in temperate regions. Also find the difference between their edible parts.
- Plan a visit to some hilly state during summer vacations (e.g. Himachal Pradesh, Uttrakhand, Jammu

and Kashmir), meet some fruit growers there. Make a list of fruit crops in different orchards and enquire about the different cultural practice used for different fruits.

CHECK YOUR PROGRESS

1) What are pome fruits? Name major temperate fruits grown in India. Write important varieties of apple.

2) Name major insect-pests of apple and pear. Write their control measures.

3) Name major diseases of apple and pear. Write their control measures.

4) Write short notes on grading, bitter pit, and colour development in apple.

FILL IN THE BLANKS

1. The basic chromosome number of apple is ……..
2. In commercial cultivation of Delicious apples varieties, about …… trees should be of polinizer variety.
3. For vigorous apples varieties, a planting distance of ……is recommended.
4. ……. is sprayed for enhancing colour improvement in apple.
5. ……is used for fruit thinning in apple.
6. ……is the major storage disorder of apple.
7. The smallest grade of apple is called as …….
8. Wooly apple aphid infests…… and ……. of apple trees.
9. Sand pear is grown in …… (lower/high hills).
10. Red Bartlett is a variety of …….. (apple/pear).
11. In India, ……rootstock is commonly used in pear propagation.
12. The best time for pruning apple and pear is…… (Dec-Jan, Feb-March, March April)

***

PLUM

Plums belong to family Rosaceae, and genus *Prunus* with basic chromosome number, X = 8. Most of the plum species belong to section Euprunus e.g., *P. domestica* (European plums), *P. insititia* (Damson plums), *P. cerasifera* (cherry plum) and *P. salicina* (Japanese plums). The fruit of plum is drupe, glabrous usually having bloom on the surface. The varieties of plums may be diploids, tetraploids and hexaploids with somatic chromosome number of 16, 32 and 48, respectively. The five different centres of origin for plums have been identified, which include Europe for European plums, Western Asia for Damson plums, Western and Central Asia for Cherry plum, China for Japanese plums and North America for American plums.

Santa Rosa plums

The USA, Germany, Romania, Russia, China, Bulgaria, Hungary, France, Poland, Italy, Austria, Turkey, Japan, Mexico, Argentina, Australia, New Zealand, Spain, Afghanistan, India and Pakistan are major plum producing countries. In India, the plums are grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Nilgiris, eastern Himalayan ranges and sub-mountainous parts of Punjab.

Soil and climatic requirements

Plums require deep, fertile and well-drained sandy loam soils for successful cultivation. However, European plums prefer heavy and rich clay-loam soils. Plums perform well in slightly acidic soils with pH 6.5 to 7. Alkaline or saline soils are undesirable for all types of plums.

Plum are successfully cultivated from temperate to subtropical zone. It can thrive well in areas with cold winters as well as hot summers. Plum can thrive in very high rainfall as well as in dry areas. Most of its varieties require 800 to 1,000 chilling hours to break winter rest. Plum tress bloom early in the season, and hence are prone to spring frost injury. About 50 to 100 cm well distributed annual rainfall is enough for quality production of plums.

Commercial varieties

European plum: European plum varieties are grouped in to following 5 sub-groups:

a) Prune: The popular varieties in this group are French, Sugar, Italian, German, Imperial and Stanley.

b) Reine Claude: This group is also called as Green Gage. Varieties like Reine Claude, Jefferson, Washington, Imperial Gage and Green Gage are included in this group.

c) Yellow Egg: It is comparatively a small and relatively unimportant group, suitable for canning purpose only. Yellow Egg and Golden Drop are important varieties of this group.

d) Imperatrice: Important varieties are Grand Duke, Diamond, Tragedy and President.

e) Lombard: Important varieties of this group are Lombard, Bradshaw and Pond.

Japanese plum: The Japanese plums require less winter chilling as compared to European plums. Under Indian conditions, the Japanese group varieties are predominantly cultivated. Important varieties of this group are Santa Rosa, Meriposa, Beauty, Methley, Burmosa, Red Ace (Florida), Formosa, Kelsey, Red Heart, Elephant's Heart, Burbank and Frontier. This group is suitable for both table as well as processing purposes.

American plums: This group is mainly used as rootstock or culinary purposes as the fruit quality is not good. The important species are *P. Americana* (cold resistant), *P. hortulana* (vigorous, resistant to brown rot, good for processing), *P. munsoniana* (resistant to spring frost and fruit brown rot).

Display of plums and peaches by shopkeepers

Important varieties of plums for different elevations are:

High hills:	Early	:	Sweet Early, Methley, Kelsey, Early Transparent, Gage
	Mid - season	:	Santa Rosa, Starking Delicious, Satsuma, Burbank, Elephant's Heart
	Late	:	Meriposa, Frontier, Prunes
Mid - hills :		:	Beauty, Santa Rosa, Meriposa, Frontier
Low hills and valley areas :			Alucha Purple, Titron, Alucha Black, *Alubukhara*, Kala Amritsari
Dry temperate zone		:	Prunes, Local Mansons

Flowering and pollination

In European plums, both self-fruitful and self-unfruitful varieties exist. In self-fruitful varieties, usually 30

per cent fruit set occurs, which is enough for a good crop. However, in self-unfruitful varieties, fruit set is less than 1.5 per cent without the provision of pollinizers. Thus, 10 to 20 per cent inter-plantation of pollinizers is required.

Important self-fruitful varieties are California Blue, French Damson, German Prune, Giant, Stanley, Prune, Victoria and Yellow Egg. The self-unfruitful varieties are Belgian Purple, Diamond, Grand Duke, Hall, Italian Prune, Jefferson, Imperial Gage, President, Reine Claude, River's Early, Sultan, Tragedy, Transparent and Washington.

Most of the Japanese plum varieties are self-fruitful but provision of pollinizers can improve production. Red Roy, Red Rose, Santa Rosa, Climax, Beauty and Methley are self-fruitful varieties. Meriposa, Formosa, Kelsey, Burbank and Satsuma are self-unfruitful varieties. Wickson, Larodo, Santa Rosa and Beauty are good pollinizers for both self-fruitful and self-unfruitful varieties.

Planting

The plums are planted in winters when the plants are dormant. In flat areas, square, rectangle or hexagonal system of planting are followed. In hills, planting or terrace planting is most desirable. The plants on vigorous seedling stocks can be planted at 6 meter distance in well prepared pits. Size of the pit should be at least 1 x 1 x 1 m. For proper root development, any hard pan in subsoil or the rock should be removed while digging pits. The grafting point should be kept at least 15-20 cm above ground level at the time of planting.

Rootstocks and propagation

Seedlings of plums, apricots or peach can be used as rootstock for plum varieties. In Indian conditions, wild apricot and wild peach seedlings are considered good rootstock for plums. Some rootstocks selections from different species are Brompton, St. Julien A, Damson (*P. insititia*), Myrobalan (*P. cerasifera*) and Mariana (*P. cerasifera* x *P. munsoniana*).

The most common method of propagation is tongue grafting, which is done at bud break in spring. 'T' budding is also a good method of propagation, which should be done at the onset of rainy season. The grafting/budding success is more than 90 per cent in plums. The clonal rootstocks of plums are propagated by normal layering or hardwood cuttings.

Training and pruning

In general, modified central leader system of training is followed in plums as in case of apple. However, in mid-hills and valley areas, open centre system can also be followed. Burbank and spreading type Japanese plum varieties should be trained in open centre system, whereas, upright growing varieties like Santa Rosa, Stanley and Wickson can be trained in modified central leader system.

In general, plums require moderate pruning, relatively more than in apple but less than in peach. In plums, it is important to encourage 45 to 60 cm of average extension growth in young stage and 25 to 30 cm in bearing trees, which can be regulated by pruning. Heavy heading back encourages vigorous growth. Hence, the undesirable, diseased, broken limbs and water sprouts should be thinned out. The Japanese plum varieties have the tendency of over bearing, hence these should be pruned harder to improve fruit size and quality.

Manuring and fertilization

One-year-old plum plant requires about 50 g N, 25 g P_2O_5 and K_2O, which can be given in the form of calcium ammonium nitrate, single super phosphate and muriate of potash. These doses can be increased annually up to the age of 10 years when the plants are mature. The fully grown fruiting trees should be given 500 g N, 250 g P_2O_5 and 600 g K_2O along with about 60 kg well rotten farm yard manure (FYM). FYM should be applied during winter along with P_2O_5 and K_2O at the time of basin preparation. Half dose of N fertilizer should be applied in spring before flowering and the rest half dose a month later. Foliar application of nitrogen in the form of urea (1 per cent) is quite effective in plums and 2 to 3 sprays during fruit development stage can improve the fruit size as

well as the plant growth.

Weed control

The manual weed control in plum is quite laborious and expensive. Simazine or atrazine (6 kg/ha) at pre-emergence stage, followed by grammaxone (2 L/ha) at post emergence stage of weed growth can effectively control the weeds for 4 to 5 month in plum orchards. Care should be taken that foliage of the tree should not come in contact with the herbicides.

Maturity and harvesting

Plums develop best dessert quality on the tree but for long distance marketing, plums should be picked a few days in advance when the fruits are still hard but have attained proper colour in at least 50 per cent of fruit surface. Change in fruit surface colour is good maturity index. The fruits with 10-12 psi pressure at fruit maturity are fit for harvesting. Usually, Santa Rosa takes about 104 days after full bloom to maturity whereas Beauty requires only 84 days.

Packing of pulms

Plant protection

Main pests of plum are San Jose Scale, plum scale, tissue borers, plum fruit moth, European red mite, two spotted mite, plum saw flies and nematodes. The diseases infecting plums and causing economic losses are bacterial canker, oak root fungus, brown rot and collar rot. Some of viral diseases affecting plums are plum pox, plum line pattern, prune dwarf and plum decline. The integrated pesticides and fungicide spray schedule suggested for peach can effectively control most of plum pests and diseases.

PEACH

Peach [*Prunus persica* (L.) Batch.] belongs to family Rosaceae, with basic chromosome number, X = 8. Botanically, the fruit of peach is a drupe, and called as stone fruit. Peach originated in China and primarily grown in the temperate zone but has lower chilling requirements than pome fruits. Low chilling varieties are grown in subtropical and tropical zones as well. The peaches are commercially cultivated in USA, Italy, China, France, Spain, Greece, Japan, Argentina, Australia, Mexico, Korea, Russia, Germany, Portugal, New Zeeland, South Africa, Turkey, Canada, Chile, Austria and India. In India, peach is cultivated in Jammu and Kashmir, Himachal Pradesh, sub-mountainous tracts of Punjab and Western Uttar Pradesh hills. Limited cultivation of peach is also done in Nilgiri hills and to some extent in northern eastern states.

Soil and climatic requirements

Peach thrives on a wide range of soil types but does best on light, gravely clay loam soils, which are fairly fertile, deep and well drained. Peach does not do well on water-logged conditions. It is highly susceptible to logging condition among the temperate fruits. Very fertile and heavy clay soils are hazardous to peach because such conditions induce heavy vegetative growth, which is susceptible to winter injury. Well distributed rainfall of 80-100 cm per year or assured irrigation is desirable for a good peach crop. Dry climate with low humidity for 2-3 weeks before harvest is ideal for development of a good quality fruit.Peach requires the warmest climate amongst the temperate fruits. Peaches can be successfully grown in areas experiencing 750 to 800 chilling hours during winters. However, the low chilling peaches of Florida group require only 300 to 550 chilling hours to break winter rest. Peach is very sensitive to low temperature injury after bud break. The swelling buds are injured if the temperature falls below -6.5 ^{0}C for few hours.

Floridared peach

Commercial varieties

Peach varieties, in general, are classified into two groups: i). Flat peaches (*P. persica* var. *compress*) and ii). Nectarines (*P. persica* var. *nectarina*). Nectarines are identical to peach in tree and flower characteristics but differ in the absence of fuzz or pubescence on the fruits. Nectarines are usually small in size, having greater aroma, less melting flesh but are more susceptible to thrips attack than peaches. The peach varieties are divided in two groups based on separation of pit from flesh as under:

Nectarine is a mutant of peach. It is very difficult to differentiate peach and nectarine tree as they are identical in tree and flower characteristics but differ in the absence of fuzz or pubescence on the fruits.

Clingstone: The flesh adheres with the stone even at maturity and is not easily separated. Important varieties of this group are Sun Haven, Red Haven, Shimizu Hakuto and Kanto-5, Sharbati, Flordaquir.

Free stone: These are the varieties in which the stone freely separates from flesh at maturity. The varieties of this group are July Elberta, Rich Haven and Elberta, Flordasun.


Nectarine fruits

The peach varieties for the Indian hilly conditions are as follows:

Mid hills: Early ripening : Word's Earliest, Early White Giant, Red Haven, Sun Haven

Mid season : Alton, July Elberta, Kanto-5, Shimizu Hakuto

Late ripening : J.H. Hale, Elberta, Helberta Giant

Low hills and valley areas : Sharbati, Sun Red, Shan-e-Punjab, Totapari, Matchless, Sufeda, Honey, Sweet, Florida Red, Floidasun.

Low chilling varieties : Some of the low chilling varieties with low chilling requirement are Floridasun (300 hours), Sun Red (300 hours), Sun Gold (550 hours), 16-33 (300 hours), Florida Bell (200 hours) and Floridared (75 hours).

Rootstocks and propagation

Peach is easily grafted or budded on seedlings of peach, plum or apricots; however, peach varieties are usually propagated on wild peach or peach x almond hybrid seedling stocks. Peach scion varieties are usually grafted by tongue grafting during February-March with more than 90 per cent success. Peach x almond hybrid rootstocks like GF 556 and GF 677 are popular in Europe, which are suitable for alkaline soil conditions. Root-knot nematode resistant rootstocks are Nemagaurd, Nemared, Shalin, and Yunnan.

Planting

The peach is planted in winters when the plants are dormant. In flat areas, square, rectangle or hexagonal system of planting can be followed. In hills, planting or terrace planting is most desirable. The plants on vigorous seedling stocks can be planted at 6 meter distance in well prepared pits. Size of the pit should be at least 1 x 1 x 1 m and for proper root development, any hard pan in subsoil or the rock should be removed while digging pits. The grafting point should be kept at least 15-20 cm above ground level at the time of planting. The planting distance depends on several factors, however, 5 x 5 m planting distance is ideal in any system of planting.

Flowering and pollination

Practically, all the commercial varieties of peach are self-pollinated. Thus, most peach plantations do not require elaborate cross-pollination provisions for assured crop. However, a few male sterile/self infertile varieties like J.H. Hale, June Elberta, Halberta and Chinese Cling etc., need male fertile varieties as pollinizers. For such varieties, every third row should be of a pollinizer (e.g. July Elberta). The pollination in peach is

accomplished by honeybees.

Training and pruning

Peach usually requires moderate to heavy pruning annually. The pruning in initial years of plantation is done to shape the framework of plants and is termed as training. Usually the modified central leader system or the open centre system of training is adopted in peach. Modified centre leader system can be followed in areas with plenty of sunshine or in areas of heavy snowfall where risk of limb breaking is more. Another method of training peaches is 'V' shaped *Tatura Trellis*, which is becoming popular because of high yield efficiency. Peach trees should be pruned every year to produce new growth for regular and good fruiting. All the shoots should be headed back to one-half to two-third to maintain the balance in fruiting and vegetative growth.

Manuring and fertilization

In general, the mature tree of over 6 years requires 60 kg FYM, 500 g N, 250 g P_2O_5 and 600 g K_2O annually. However, for the exact fertilizer scheduling, the leaf and soil analysis should be carried out. FYM, P and K fertilizers should be applied at the time of basin preparation in fall. Peach does not respond favourably to foliar nutrient sprays.

Maturity, harvesting and storage

The best time for harvesting peach is when ground colour of fruits starts changing from green to pale. The fruit should be firm at the time of harvesting in order to stand transportation. Peach should be graded according to size and quality. The fruits are packed in 5 or 10 kg wooden or corrugated fibre board (CFB) cartons for marketing. Firm and unripe peaches can be cold stored for 2-4 weeks at –1 to 0 ^{0}C at 85 per cent relative humidity.

Insect-pests	**Control measures**
Peach leaf curl aphid (*Brachycaudus helichrysi*)	Spray methyl demeton 25 EC (0.025%) or dimethoate 30 EC (0.03%) or monocrotophos 36 EC (0.04%) or fenitrothion 50% EC (0.05%) or formothion 25% EC (0.038%) 7-10 days before flowering (pink bud stage).
Peach fruit fly (*Dacus dorsalis*)	Spray neem oil/horticulture tree oil in April-May. Spray of bait consisting of malathion (0.1%) + sugar/gur (1%) is also very effective. Provision for bait station (25g gur + 10 ml malathion + water) can also be made to attract and kill the adult flies.
Nematodes like root knot (*Meloidogyne* sp.), and root lesion (*Pratylenchus sp.*)	Use resistant rootstocks (Nemagaurd, Shalil, Nemared). Use nematicides such as furadon, @ 100-300 g/tree or follow soil fumigation.
Diseases	**Control measures**
Peach leaf curl (*Taphrina deformans)*	Spray with Bordeaux mixture/ lime sulphur at leaf fall stage and bud swell stage. Spray insecticides to kill peach curl aphid, which are vectors for this disease.
Bacterial gummosis *(Pseudomonas syringae)*	Spray streptocycline @ 10g/100 L water before the onset of rainy season or alternatively spray copper oxychloride/Bordeaux mixture @ 0.3% after leaf fall
Brown rot (*Monilinia fructicola)*	Remove all rotten fruits after harvest. Apply fungicide sprays during bloom and as fruit ripens. In addition, hot water treatment (50^{o}C) for 3 minutes and refrigerated storage of the fruits should be done in time.

Leaf curl of peach

A view of gummosis in peach

Plant protection

ALMOND

Almonds are rich in vitamins and minerals and can be used for a wide variety of home remedies. Take care of your heart, brain, and digestive system with this superfood. It lowers our Cholesterol, regulates blood pressure and protects from diabetes

Almond is cultivated for its energy rich kernels. Almonds belong to family Rosaceae, and genus *Prunus*. The cultivated almond is *Prunus amygdalus* Batsch with basic chromosome number, X= 8. Most of the cultivars are diploids with somatic number, 2n = 16.

Almond is a native of western Asia and Mediterranean region, and is mainly cultivated in Italy, Iran, Morocco, China, Portugal, Turkey, France, Algeria, Greece, Afghanistan and Persia. In India, almonds are grown in Jammu and Kashmir and dry temperate zone of Himachal Pradesh (Kinnaur and Lahaul Valley). However, green almond cultivation is done in wet temperate zone of Himachal Pradesh (Shimla and Kullu districts), Uttarakhand and sub-mountainous areas of Punjab.

Almonds, a super food

Soil and climatic requirements

Usually, light sandy soils are suitable for almond cultivation but deep fertile, well-drained, light-loam soils are most suitable for commercial cultivation. It is more resistant to dry soils than most other temperate fruits, yet it shows good response to summer irrigation. Very heavy clay soils are not desirable. Commercial almond growing is limited to the areas having little or no frost hazard during flowering period. It is susceptible to injury by rainy weather in spring and summer. Almonds prefer dry and low humid conditions during fruit ripening

Planting

The planting of almond is done is winter as in case of other stone fruits. Usuallly, planting distance is 6 m in flat fertile soils, but it can be reduced to 4-5 m in less fertile and shallow soils, which restrict plant growth.

Commercial varieties

Prominent varieties grown worldover are Non Pareil, Mission, Ne Plus Ultra, Peerless, Eureka, Kapreil, Thompson, Ballico and Merced. The promising varieties for Indian conditions are:

Dry temperate zone	:	Ne Plus Ultra, Texas (Mission)
High and Mid - hills	:	Merced, Non Pareil, IXL, Nauni Selection, (wet temperate zone) Nikitskyi, White Brandis
Low hills and valley areas	:	Drake, Katha, Peerless, Ne Plus Ultra

Mid sub-tropical areas : Hybrid No. 15, NB 258, JK 39, JK 55, JK 57 and JK 75

Flowering and pollination

Most of the commercial cultivars of almond are self-incompatible and some combinations are even cross-incompatible. So it is necessary to interplant pollinizing varieties with the standard commercial varieties. Pollination is entirely dependent on honeybees activity. Unfavourable weather (e.g., very high or low temperature) for honeybees adversely affects normal fruit set. Provision of 4-6 bee colonies per hectare must be made for assured cross pollination.

Rootstocks and propagation

Almond seedlings, bitter almond and wild peach seedlings can be used as rootstock. Although, bitter almond is considered as a better rootstock than sweet almond. Almond trees on peach rootstock have short life especially in soils, which are high in lime and sodium. Other important rootstocks for almond are Behmi (suitable for cool high hills), Marianna 2624 (resistant to oak root fungus) and Nemaguard (suitable for nematode infested areas).

Training and pruning

Almond plants can be trained either by modified central leader system or by open centre system. The fruits are borne on short spurs or on one-year-old shoots. Since, the spurs remain productive for 5 years, it may be a good practice to prune one fifth of old bearing wood every year so as to encourage 20 to 30 cm annual extension growth. Almonds do not require heavy pruning. Hence, thinning of branches rather than heading back is recommended. Larger but fewer cuts are more desirable than numerous small cuts, which encourage the problem of gummosis. This practice is called bulk pruning.

Manuring and fertilization

Almond has high nitrogen requirement similar to peach, however, it can tolerate lower available potassium content of soil than apple and plum. A mature bearing tree of almond above the age of 7 years requires 40 kg FYM, 2.0 kg CAN, 1.5 kg single super phosphate and 1.2 kg muriate of potash annually. Almond is sensitive to boron deficiency, which affects flowering and fruit set and may cause stem gummosis. Spray of boric acid (0.1 per cent) before flowering and after petal fall is recommended to overcome boron deficiency.

Maturity and harvesting

The mature well-filled nuts should be harvested. Harvesting starts when almond in shady portion of the tree show shriveling and cracking of the hulls. The harvested fruits should be stacked for few days for easy de-hulling. In wet temperate zone, mid and high hills, the green almonds are harvested before onset of rains. The kernels of green almonds are used for confectionery, healthy foods and fresh consumption as green almonds cannot be stored for long time.

Plant protection

Major diseases of almond are bacterial gummosis, almond rust, root rot, collar rot, crown gall, twig blight, shot hole, oak root fungus and almond rust. Important insect pests of almond are leaf curl aphid, twig borer, San Jose scale, root knot nematode and defoliating beetles. These can be controlled by following measures recommended for peach or plum.

Cherries, a high value fruit crop

CHERRY

The cherries belong to the family Rosaceae, and genus *Prunus*. The cultivated cherries are divided into three groups, *viz*. Sweet cherries (*Prunus avium* L.), Sour cherries (*Prunus cerasus* L.) and Duke cherries (*Prunus avium x Prunus cerasus*). The sweet cherries are mainly used for table purposes and most of the varieties are diploid (2n = 16). The sour cherries and duke cherries are

mainly used for processing purposes and are not popular commercially. Most of these are tetraploids (2n = 32) but few cultivars are diploids also. The cherries are native of south-east Europe, western Asia and Asia Minor. The major cherry producing countries are Italy, USA. Germany, France, Russia, Hungary, Spain, UK, Denmark, Poland, Turkey, Rumania, Bulgaria, Greece and Japan. In India, the sweet cherries are cultivated on a commercial scale in Jammu and Kashmir and to a limited extent in Himachal Pradesh.

Soil and climatic requirements

Sweet cherries are more exacting in climate and soil requirements as compared to other stone fruits. Cherries require fertile, well-drained, chalky or deep sandy-loam soils. Soil should not be waterlogged as cherries can't tolerate wet areas in root zone. The cherries are well adapted to cooler climates and require 1,000-1,500 chilling hours below 7 ^{0}C during winters. Cherry blossom is badly damaged by spring frosts. Cherries require about 100 cm of fairly well distributed rainfall throughout the year; however, the flowering and fruit ripening period should be dry.

Commercial varieties

Early Winkler, Black Heart, Red Heart, Early Purple, Coe, Ida, Lambert, Stella, Bing, Van Windsor, Schmidt, Napoleon, Emperor Francis, Ranier, Yellow Spanish and Lambert and Elton are important varieties of sweet cherries.

Flowering and pollination

Most of the sweet cherry varieties appear to be self-unfruitful as well as cross-incompatible. So, the cherry varieties must be inter-planted in proper combinations. Stella, Vista, Vega and Seneca are universal donors for cross-pollination. Most of the sour cherry varieties are self-fruitful and can be planted in solid blocks. Sour cherry varieties can't be used as pollinizers for sweet cherries as their flowering period does not overlap each other.

A branch full of cherries

Rootstocks and propagation

The most common seedling rootstocks for cherries are Mahaleb (*P. mahaleb*) and Mazzard (*P. avium*), and Paja (*P. cerasoides*). The Bird cherry (*P. padus*) seedlings are also used as rootstock but it results in delayed graft-incompatibility. F12/1 is a good clonal rootstock of cherry, which is resistant to bacterial canker and vigorous in growth. Colt is easy-to-root, semi-dwarfing rootstock suitable for high - density plantings but it is susceptible to bacterial crown gall. The clonal rootstocks are usually propagated by mound layering or hardwood cuttings. The scion varieties are propagated by 'Tongue' grafting or 'T' budding on seedling or clonal rootstocks.

Planting

Cherries are planted in winters when the plants are dormant. Pits of 1 x 1 x1 m are dug and filled one month prior to planting. In flat areas, the square or hexagonal system of planting should be followed, however, in hills the planting is done in terraces or contours. For standard plants on seedling rootstock, the plant-to-plant spacing should be 6 m, but in case of plants on dwarfing rootstocks or the compact cultivars (Compact Stella or Compact Lambert), the planting distance can be reduced to 3-4 m.

Cultural practices and manuring

Cherries are very responsive to nitrogen application and clean cultivation. Ten-year-old full grown tree requires 60 kg FYM, 2.0 kg calcium ammonium nitrate (CAN), 1.6 kg single super phosphate and 1.0 kg muriate of potash annually. The fertilizers should be broadcasted in tree basin, 30 cm away from trunk up to tree drop line. Clean basin with legumes or permanent sod between the basins is a good management practice. Mulching with 10-15 cm thick layer of dry grass after spring rains helps in soil moisture conservation, weed control and

improvement in soil structure and fertility.

Maturity and harvesting

There is no recognized maturity standard for picking cherries. Cherries are picked manually when mature, which is reflected by sweetness and change in fruit colour. The fruits are graded according to size and packed in corrugated cartons or baskets of 2 to 5 kg.

Plant protection

Cherries are attacked by bacterial canker, verticillium wilt, crown and root galls, leaf spot, brown rot and viral diseases. Amongst the insect pests, flat headed tree borer, black cherry aphid and San Jose Scale are serious pests. The control measures for these pests and diseases are the same as suggested for other temperate fruits.

APRICOT

Dried apricot, a product of high preference

Apricot is an attractive, delicious and nutritious temperate fruit rich in vitamin A, carbohydrates, proteins, phosphorus and niacin. Apricot belongs to family Rosaceae, and genus *Prunus.* The domesticated apricot is *Prunus armeniaca* L. with basic chromosome number, n= 8 and somatic number, 2n = 16. Apricots hybridize with plums to produce plumcots. *Prunus dasycarpa* is a plumcot resembling purple apricot produced by the cross of apricot and myrobalan plum (*P. cerasifera*).

The primary centre of origin of apricot is considered to be western China and secondary centre of origin is western Asia. Wild Indian apricots like *Zardalu* and *Chulli* are considered indigenous to western Himalayan ranges of India. Major apricot producing countries are Russia, USA, Spain, France, Turkey, Italy, Greece, Hungary, Australia, Morocco, Syria, Iran, Algeria, Afghanistan, Bulgaria, Rumania, China, Iraq, Pakistan, Israel and India. In India, apricots are grown in Jammu & Kashmir, Himachal Pradesh, Uttrakhand and to some extent in NE states.

Soil and climatic requirements

Apricots can establish well in deep fertile clay-loam and well-drained soils. It is a quite hardy plant and can withstand both drought and waterlogged conditions slightly. The climatic requirement of apricot is similar to peach but it needs slightly more winter chilling (800-1,000 chilling hours) than peach. Apricot flowers are as tolerant to spring frost as peach. The annual rainfall of 50-100 cm, long cool winters and uninterrupted warm springs are suitable for apricot fruiting.

Rootstocks and propagation

The common rootstocks used for commercial apricot plantation are seedlings of apricots, plums and peaches. However, the wild apricots such as *Zardalu* and *Chulli* seedlings are most suitable as they form the strong graft union with most of scion varieties and can withstand the adverse soil and climatic conditions. The apricot varieties are propagated by 'Tongue' or 'cleft grafting' and 'T' budding with more than 90 per cent success.

Commercial varieties

The most important varieties of apricot in the west are New Castle, Blenheim, Royal, Tilton, Early Montgamet and Moorpark. In India, varieties suitable for different agro-climatic conditions are:

Dry temperate zones	:	Charmagaz, Suffeda, Shakarpara, Kaisha
High hills	:	Nari, Kaisha, Nugget, Suffeda, Charmagaz, Shakarpara, Moorpark, Turkey, Royal and St. Ambroise
Mid hills	:	New Castle, Shipley Early, Zardalu

Planting

The planting of apricots is done is winter. Usual planting distance is 6 m in flat fertile soils, but it can be reduced to 4-5 m in less fertile and shallow soils, which restrict plant growth. The planting can be done on square or rectangular system of planting. In hills, contour system may be followed.

Training and pruning

Apricots tend to develop large and heavy branches. Therefore, modified leader system of training is advisable. However, open centre system is also satisfactory for most areas. Apricots require relatively less pruning than peaches but heavier pruning than apple. The fruits are borne on short one-year-old spurs largely towards the tip of last year's growth. Spurs bear fruits for three-to-four years. The objective of pruning in apricot is to induce new growth for quality fruit production. The young trees require light pruning, only sufficient for proper training, as the heavy pruning delays bearing.

Manuring and cultural practices

Mature apricot plants above 10 years of age, require 60 kg FYM, 2.0 kg calcium ammonium nitrate, 1.6 kg single super phosphate and 1 kg muriate of potash annually. Apricots respond well to foliar nitrogen spraying in the form of urea (0.5 to 1.0 per cent). A pre-fall spray of 2.5 per cent urea improves fruits set and yield.

The tree basins should be kept weed free by manual weeding or herbicidal treatments. Atrazine or diurone (4 kg/ha) is effective for control of weeds for 4-5 months. Mulching of tree basins with 10-15 cm thick layer of grass is useful not only to conserve soil moisture but also to keep the weed growth in check.

Maturity and harvesting

A full grown apricot tree can yield about 50 to 80 kg fruits. The fruits are usually plucked at change of fruit colour from green-to-yellow or white and loose flesh firmness. Apricot fruits should be graded according to size and packed in 5 kg wooden boxes for transportation and marketing. The fruits are delicate and have poor shelf life. Apricots can be stored at 5 ^{0}C at 85 per cent relative humidity for a week.

Plant protection

Major diseases of apricot are leaf spot, stigmina blight, collar rot, root rot and shot hole. Major insect pests affecting the apricots are blossom thrips, peach fruit-fly, plum fruit moth, tissue borers and defoliating beetles. The control measures for these pests and diseases are the same as suggested for other temperate fruits.

WALNUT

Walnut belongs to family Juglandaceae and genus *Juglans,* having basic chromosome number, n = 16 and somatic chromosome number, 2n=32. Genus *Juglans* includes 20 species. All the *Juglans* species are edible but English walnut or Persian walnut, *Juglans regia* L. is the most important.

The walnuts are considered to be the native of North America, South America and south east Europe to East Asia. Major walnut producing countries are France, Italy, USA, Romania, China, Portugal and Germany. In India, walnut remained confined to Kashmir and spread to Himachal Pradesh and Uttarakhand during the last century only and is yet to gain popularity in east Himalayan ranges and hills of south India.

Soil and climatic requirements

Walnut prefers well-drained, silt loam soils rich in organic matter. Coarse and sandy soils with hard pan should be avoided for walnut plantation. Fluctuating water table is also not suitable for walnut cultivation. Walnuts are most sensitive to alkaline soils.

Main climatic limitations of walnut cultivation are spring frost, extreme summer heat and insufficient winter chilling. Walnut requires more than 1,000 chilling hours during winters. An annual rainfall of 80 cm is

considered sufficient for the cultivation of walnut. High temperatures in spring or summers above 40 ^{0}C accompanied by humidity may cause sunburn of exposed tissues. Such conditions early in the season may cause blank nuts, but if occurs later, kernels may be shriveled. In warm areas, walnuts do not receive adequate chilling, causing delayed bud break and flowering, which result in poor fruit set.

Thin shelled walnuts

Rootstocks and propagation

Generally, walnut seedlings are used as rootstocks. The seedling stocks are vigorous in growth and susceptible to oak root fungus but make smooth graft union, free from constriction with scion varieties. Some of the important rootstocks suitable for walnut are Manregian seedlings, *J. hindsii* and Paradox. Side-veneer grafting, patch budding, annular budding and chip budding are the recommended methods of propagation.

Planting

Planting of walnut is done any time from December to March during dormancy but an early planting is advisable for successful field establishment of plants. In warmer areas without irrigation facilities, walnuts should be planted during rainy season with earth ball or seedlings raised in polythene bags to ensure better establishment of the plants. For *in situ* grafting, 3 to 4 seeds are sown 10 to 15 cm deep during winters at one location and the desirable scion is grafted on the selected seedling during July-August. Since the walnut plants on seedling rootstock are vigorous in growth, plant-to-plant spacing of 8 m is suitable.

Commercial varieties

Eureka, Placentia, Wilson Wonder, Prolific, Franquette, Howard, Pedro, Chandler, Hartley, Payne and Serr are important varieties of walnuts grown worldover. The promising varieties of walnut in India are Govind, Kashmir Budded, Eureka, Pratap, Placentia, Wilson and Franquette.

Flowering and pollination

Walnuts are monoecious plants having male and female catkins separately on the same tree. The male catkins are borne on lateral buds of last year growth whereas the female catkins are borne terminally on current season's growth. Some of the varieties are lateral fruiting as well having high yield potential like Sunland, Chico, Howard and Tehma. Walnut is a wind pollinated fruit and most of the varieties are self-compatible. But the plantation of different varieties is useful as the anthesis of male and female catkins may not synchronize in one tree due to dichogamy (maturation of male and female parts at different times of the day). Pedro is a good pollinizing variety.

Training and pruning

Modified central leader system of training is followed in walnuts with 5 to 6 laterals developed around the stem. After the initial frame of the tree is developed, walnut plants require minimal pruning. Some thinning out of branches is desirable in heavy bearing varieties.

Manures and fertilizers

Annual application of nitrogenous and phosphatic fertilizers is required for regular fruiting. In practice, the walnut plantations are scattered and seldom manured resulting in alternate bearing habit. The fertilizer doses depend on age, yield, size and the fertility of soil. Usually 60 kg/ha each of N, P and K is sufficient for fully grown up trees. Walnut trees are sensitive to zinc deficiency, which can be corrected by foliar application of 0.4 per cent zinc shulphate.

Maturity and harvesting

Walnuts are harvested when 10-15 per cent fruits have dropped themselves, indicating fruit maturity. The

harvested nuts are de-hulled by keeping in a heap under wet leaves. Bleaching of nuts is a practice to give attractive appearance by dipping nuts for 5-10 seconds in a mixture of 8 kg each of Salsoda (sodium carbonate) and lime dissolved in 227 litre of water. Yield of walnut trees varies with the variety, age and size, however, the average yield is about 40 kg/tree.

Plant protection

Main diseases of walnut are leaf blotch, dieback and powdery mildew. Walnut weevil and stem borer are the main pests.

EXERCISES/ACTIVITIES

- Go to fruit market. Purchase several types of temperate fruits available there and classify them into pome, stone fruits and nuts. Among stone fruits, write about their edible parts and differentiate between stone fruits and nuts.

CHECK YOUR PROGRESS

1) What are stone fruits? Name major stone fruits grown in temperate region in India. Write important varieties of peach grown in India.
2) What are major insect-pests of stone fruits?. Write their control measures.
3) What is the importance of rootstock? Write the rootstocks used for peach, plum and apricot.

FILL IN THE BLANKS

1. J.H. Hale is a variety of …….
2. Leaf curl is a major problem in……..
3. Nectarine is a mutant of ……
4. Walnut belongs to family ……
5. Which one is a monoecious fruit plant? (apple, peach, walnut)
6. Charmagaz variety of apricot is grown in …….(dry temperate zone / mid hills/ low hills / plains)
7. Sand pears are mainly grown in …… (dry temperate zone / mid hills / low hills / plains)
8. Fruit cracking is a serious problem in ……..(apple / cherry / peach/almond)
9. Dichogamy is found in …… (apple / peach / walnut / cherry)
10. Sweet cherries are used for table purpose, whereas ……. and …….cherries are used for processing purposes.

SUGGESTED FURTHER READINGS

- Chadha, K.L. and Awasthi, R.P. (2005). Apple. Malhotra Publishing House, New Delhi.
- Chadha, T.R. (2000). Textbook of temperate fruits. ICAR, New Delhi.

- Bose, T.K., Mitra, S.K. and Rathore, D.S (1991). Temperate fruits. Naya Prokash Publishers, Kolkata, India.
- Bal, J.S. (2007). Fruit growing. Kalyani Publishers, Ludhiana, India.
- Chattopadhyay, T.K. (2006) A textbook on Pomology, Vol. 4 (Temperate fruits), Kalyani publishers, Ludhiana, India.,
- Sharma, R.R. (2006). Fruit production: Problems and Solutions. Intl. Book Distributing Co., Lucknow, India.
- Sharma, R.R. (2009). *Adhunik phalotpadan*. Kalyani Publishers, Ludhiana, India.

***