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# Production Technology of Peach, Plum and Apricot in India

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## Abstract

In this chapter production technology of peach, plum and apricot in India is elaborated in detail in relation to introduction, origin and distribution of crop, importance and uses, morphological features of tree, other related species involved, climate and soil requirement, varieties, propagation and raising of rootstocks, planting and planting densities, cropping systems, manure and fertilizers application, cultural practices, weed management, orchard floor management, after care training and pruning, pollination and pollinizers, flowering and crop regulation, use of growth regulators, fruiting in the crop, fruit thinning and drop, maturity and harvesting, post-harvest management, handling and storage, insects, pests and diseases, special production problems like low productivity, unfruitfulness and self-incompatibility, premature leaf fall, replant problem, alternate bearing and remedies and physiological disorders of the crop.

**Keywords:** peach, plum, apricot, production technology, India

## 1. Peach

Scientific name: *Prunus persica* Family: Rosaceae.

Peach has a good position among stone fruits and is rated as the third most important temperate fruit in India. With the introduction of chilling varieties, the crop is becoming popular in the subtropical plains of North India.

### 1.1 Origin and distribution

Early writers were of the opinion that peach is a native of Persia. The cultivated form of peach has come from China. The scientist from Spain introduced the Peach in America, and 50 years after Cortez, it was introduced in Mexico. Peach is grown as a commercial and home fruit in most of the temperate countries of the globe. The major peach-producing countries are Italy, the USA, Spain, China, France, Greece, Russia, Mexico, Japan and Argentina. In India, it is mainly cultivated in J&K, Himachal Pradesh, Uttaranchal, Punjab and Delhi.

### 1.2 Importance and uses

Peach is a delicious, juicy and highly palatable fruit. It is a rich source of vitamin A, iron and protein. The fruit is generally consumed fresh, but delicious products like squashed and dried products, frozen preserves, jam, nectar, juice, beverage, marmalade, etc. can be made from it. Peaches are also a good source of low-calorie diet.

### 1.3 Morphological characters of plant

Peach is a small- to medium-sized upright spreading, open topped deciduous tree. The trunk bark is dark brown and rough, and young shoots are smooth and pinkish in colour. The leaves are simple, large, oblong lanceolate, glabrous above and pubescent beneath. Vegetative and flower buds are borne in the axil of the leaves. Its flowers are numerous, sessile, white or pink appearing before the leaves. The flower is of perigynous type as the perianth surrounds the pistil but is not fused to it. The floral configuration is five sepals, five petals, thirty stamens and a single ovary. Fruits are fuzzy with free- or clingstone; however, the nectarines are fuzzless peaches. The stone is deep-pitted and very hard. There are two well marked horticultural forms [1]. These include:

Clingstones: *Persica vulgaris*, Risso.

Freestones: *Persica domestica*, Risso.

### 1.4 Ornamental forms of peach

a. *Prunus persica* var. *nucipersica*, Schneid: the nectarine.

Usually small, smooth-skinned fruit, and leaves strongly serrate but not always so.

b. *Prunus persica* var. *platycarpa*, Bailey: saucer peach.

Flattened, scarcely thick greenish fruit with a red cheek, medium in size with good flavour.

### 1.5 Other species

1. *Prunus davidiana*

Slender, willow-like tree.

Smaller than common peach.

2. *Prunus mira*.

Small, bushy tree.

Late blooming habit.

### 1.6 Flowering and fruiting

The flowers are perfect, solitary, sessile and pink coloured. Flowering starts in the first week of February and continues till the end of the month. Pollination is aided by insects, and the mode of pollination is homogamy. The pollen of peach is highly viable. Commercial peach varieties are self-fruitful and set good crops without cross-pollination. J.L. Hale is the only variety which is self-unfruitful and requires to be pollinated by other varieties. Fruit setting starts in the beginning of March. The fruits are borne after 1-year growth. A small proportion is borne on short-lived spurs also. The fruit is drupe, and the edible portion is the mesocarp [2].

### 1.7 Climate

In India, peaches are mainly grown in midhills at a height ranging from 1000 to 1600 m. They also do well in wet and humid climate with cold winter and

dry summer. It requires a chilling period below 7°C for breaking dormancy and flowering. The chilling requirement varies from 200 to 850 hours.

### 1.8 Soil

Peach thrives well on light sandy soils. Deep fertile loam or sandy loam with good drainage is considered to be the best. The pH ranges between 5.8 and 6.8. It cannot tolerate imperfect drainage. Fertile and heavy soils are hazardous.

### 1.9 Planting and aftercare

Peaches are planted in the end of January in 1 m<sup>3</sup> pits at a distance of 6.5 m apart. In hills, the spacing adopted is 5 × 4 m. A spacing of 3 × 3 m is practised under high-density orchards. Immediately after planting, staking is provided. The support should be firm, preferably of bamboo or other wooden logs. Young plants should be watered at frequent intervals. Stock sprouts should be removed carefully.

### 1.10 Propagation

The peach is commercially propagated by means of budding and grafting. T-budding is the common method, and the season of budding is from April to September. Tongue grafting and wedge grafting are also done. Grafting is done in December–January.

### 1.11 Raising of rootstocks

Rootstock for peaches is raised from seeds of desi peach trees. The seeds of commercial cultivars like Sharbati and Khurmani are also used. Peach plants can also be raised on peach-almond hybrid, apricot, almond seedling, plum and behmi (*Prunus mira*). Most commonly used rootstock are the seedlings of wild peach. Peach seeds need chilling in hours to germinate. The process of meeting the cold requirement is called stratification. The stratification of peach seeds can be done under natural conditions and cold storage conditions at 10°C or below.

### 1.12 Grafting operations

Peach seedlings from stratified seeds planted in the nursery beds during January become buddable in June. The grafting can be done when the seedlings are still in the nursery beds, or these can be uprooted and brought at one place for grafting.

### 1.13 Training

The peach is trained to the modified leader system. Plants should be headed back to a height of 90–100 cm at the time of planting. All the branches on the plants are also cut back to two buds. Three to five laterals which are well spaced are allowed to develop around the trunk. The lowest branch should not be below 40–50 cm from the ground level.

### 1.14 Open-centre system

After planting, the plant is cut back to 40–60 cm above the ground level. During the growing season, about three to six laterals, in addition to the central leader, are produced on the tree. In the first winter pruning, three to four scaffold branches

which are well located and have wide angle should be selected, and the remaining unwanted branches are removed. The central leader is also completely removed. The selected branches are headed back to  $\frac{1}{4}$  to  $\frac{1}{2}$  of the growth. During the second dormant pruning, two to three secondary branches are selected on the primary branches. The major consideration in selecting secondary branches should be their location so that after pruning, the tips of the primary and secondary leaders are about 30–40 cm apart from each other. The height of secondary branches is staggered in different years by pruning all branch leaders more severely. The vertical ones are pruned more severely. This will produce branch leaders at different heights and prevent overcrowding when the tree is mature. In the following years, the head should be fully formed, and selection of secondary branches is completed.

### **1.15 Tatura trellis system**

In high-density planting, this system of training of plants is very popular due to yield efficiency. Trees are planted at a spacing of  $5 \times 1$  m or  $6 \times 1$  m. At the time of planting, a 1-year-old plant is headed back to 20 cm above the ground level. In the next growing season, two limbs or branches are selected in opposite directions, and these branches are trained across the interrow space at an angle of  $60^\circ$  from the horizontal, forming a V-shaped canopy. The canopy is supported by a permanent trellis constructed of high-tensile galvanised steel fence posts. The secondary branches are developed along each primary branch forming a fruiting canopy.

### **1.16 Pruning**

The peach fruits are borne after 1-year growth. A small proportion is borne on short-lived spurs also. Pruning should be done so as to produce 50–100 cm of growth in young trees and 30–70 cm in old trees annually. About 40% of 1-year-old branches should be thinned out to ensure proper tree growth and improve fruit size and quality. The pruning of peaches is carried out in early January.

The main objective of pruning is to maintain balance between vegetative growth and fruiting. Bearing peach requires heavy and regular pruning because it bears fruits laterally on the previous season growth. It is known that once the tree bears fruits, it will never bear again throughout its life. Therefore, pruning is done to remove the unproductive parts which in turn will form new fruiting branches in the following season. In peach pruning, thinning and heading back of shoots are two basic components. Pruning should be done so as to produce 30–70 cm of growth under subtropical conditions and 25–30 cm under midhills, annually, which is sufficient for optimum fruit production. For good-quality fruit production, 40–50% of thinning out and 75% heading back of shoots are suggested under midhill conditions. At the time of pruning, dead, diseased and broken branches should be pruned off.

### **1.17 Orchard floor management**

In the initial years of plantation, the intercrops like peas, beans, tomato, cabbage, cauliflower and ginger are grown in the vacant area in between the trees but not in the basin area. Besides these, some green manuring crops like bean, peas and gram should be grown which helps in improving soil texture and nutrient status. In bearing orchard, the basin area of trees should be kept clean either by manual weeding or the use of weedicides. Sod grasses like white clover, red clover, orchard grass and rye grass are grown in the vacant area between the trees. Basins are mulched with 10-cm-thick dry grass mulch or black alkathene mulch. The mulching helps to conserve soil moisture and efficiently control the weeds in the basin area.

### 1.18 Thinning of fruits

Thinning is more desirable on mature trees making small annual growth than on young vigorous plants. Thinning may also be another resort when good-sized uniform fruits are needed for canning and fancy trade. Hand thinning and chemical thinning can be done. While doing hand thinning, first shake the branches in order to dislodge the fruits which are likely to drop off naturally. If there is still surplus fruit, then start thinning from top to bottom of the branches. The distance from fruit to fruit after thinning on the shoots should be between 10 and 15 cm, and the average number of leaves per fruit should be 20–25.

### 1.19 Manuring and fertiliser application

Particulars	Himachal Pradesh	Punjab	Uttaranchal
FYM (kg/tree)	60	25	10
N (g/tree)	500	500	300
P <sub>2</sub> O <sub>5</sub> (g/tree)	250	120	300
K <sub>2</sub> O (g/tree)	600	500	500

### 1.20 Harvesting

Peach fruits are harvested quickly when ready for harvest. Fruits are picked when they are still hard as they ripen in storage or transit.

### 1.21 Irrigation

Irrigation is very essential for harvesting the peaches of better size and quality. A sufficient moisture in the soil before the emergence of leaves and flowers is required for proper fruit set and growth. Frequent irrigations are needed during the fruit development. Lack of irrigation, particularly, during dry and hot summer, results in fruit drop and reduced fruit size and quality. In the hills, at least two to three irrigations and, in plains, weekly irrigation should be given during the fruit development period. In general, for quality fruit production, irrigation at 80% of field capacity is recommended. Orchard soil management and weed management are done during the initial 3–4 years after planting; the intercrops like peas, beans, tomato, cabbage, zinger and *Colocasia* are grown in between the peach trees; and basin area is mulched with hay or alkathene mulch. In fully grown trees, sod grasses are grown in vacant areas, and basin area is mulched with suitable mulch materials. Weedicides like simazine and atrazine at 2.0 kg/ha, terbacil at 0.8 kg/ha as pre-emergence and paraquat at 4.0 litre/ha and glyphosate 4.32 kg/ha as post-emergence herbicide proved to be most effective to control the weeds in peach orchards.

### 1.22 Crop regulation

Heavy flowering and fruiting are the characteristic features of peach trees resulting in small-sized, poor-quality fruits and reduction of flowering in the subsequent season. Hence for production of quality fruits, crop regulation through thinning is essential in peach. The criteria for fruit thinning in peach are based on leaf to fruit ratio and spacing between fruits per tree. Generally 30:40 leaves per

fruit is the appropriate ratio. Application of ethephon (300 ppm) at petal fall in July Elberta is recommended for optimum fruit thinning. However, in Redhaven peach, ethephon (600 ppm), 20–30 days after fruit set when the fruitlets are 20–25 cm in diameter, should be used for thinning. Hand thinning at 5–7.5 cm fruit spacing before pit hardening stage is equally effective.

### 1.23 Maturity, harvesting, storage and postharvest management

Harvesting of peaches at proper stage of maturity is essential as the post-harvest quality and storage life of fruits are controlled by maturity. Various indices used for judging fruit maturity used are the number of days from full bloom, calendar dates, fruit size, firmness, pit discoloration, freeness of pit and change of ground colour. Days required from flowering to maturity in different cultivars vary from 78 to 127. Early-season varieties like Flordasun takes 81 days, Alexander 86 days, mid-season July Elberta 101 days and late-season cv. Elberta takes 127 days from full bloom to harvest. Ground colour variation in conjunction with flesh firmness is one of the best maturity indices in peaches. Peach fruits do not mature uniformly, and hence several pickings are needed during harvesting. Hand picking is the standard method for harvesting fruits. The picking containers are lined with cushion materials to avoid cuts and bruises. Immediately after harvesting, fruits are stored at a cool place or marketed. Preharvest application of calcium nitrate at the rate of 1.5% increases storage life of peaches.

### 1.24 Storage

Peaches have a shorter storage life than most other temperate fruits. The recommended cold storage conditions are 0–0.3°C and 85–90% relative humidity. In these conditions, freestone peaches and nectarines can be kept for 2 weeks and clingstone for 4 weeks. Precooled peaches can be stored for 28–36 days. In controlled atmosphere storage containing 5% CO<sub>2</sub> and 1–2% O<sub>2</sub> at 0°C peaches can be stored up to 42 days. The peaches came into bearing after 2 years of planting in the field. The economic bearing life of peach plant is about 20–30 years. The yielding capacity increases with the age of the plant. The average yield of fully grown trees of different varieties varies from 50 to 125 kg in hills. In conventional plantation, 7–10 tones/ha and, under high density with Tatura trellis system of training, about 23 tones/ha yield have been obtained.

### 1.25 Pests

- Peach leaf curl aphid.
- Peach black aphid.
- Chafer beetle.
- Peach fruit fly.
- Flat-headed borer.

### 1.26 Peach leaf curl aphid (*Brachycaudus helichrysi*)

This is the most serious pest of peach. They also infest plum plants. The aphids suck sap from the buds and sprouting foliage causing curling, yellowing and thickening of leaves. The activity of aphid is seen with the emergence of new growth during March. Floral buds also become weak which results in poor setting.

## 1.27 Control

The pest is controlled by spraying of 0.025% methyl demeton (200 ml meta-systox 25 EC) or 0.03% dimethoate (200 ml Rogar 30 EC) in 200 litres of water 7–10 days before flowering. The spray should be repeated after 5 days.

## 1.28 Diseases

Shot hole.  
Peach leaf curl.  
Powdery mildew.  
Brown rot.  
Viruses.  
Crown gall.

## 1.29 Varieties

State	Early	Mid-season	Late
Himachal Pradesh	Alton, World's Earliest, Early White Giant, Redhaven, Stark	July Elberta, Kanto 5, Shimizu Hakuto,	J.H. Hale Parrot Delux, J.H.
Uttar Pradesh (midhills)	Red Gold	Sunhaven	Hale Peregrine
Jammu and Kashmir	Early Candour, Redhaven, Sunhaven	July Elberta, Alexander Crawford Early	
	Peshwari, Quetta, July Elberta, Saharanpur Prabhat	J.H. Hale, Alexander and CO Smith	

### 1.29.1 Candour

Early peach of the season.  
Yellow and medium-sized fruit.  
Fruit tends to produce split seeds, which limits this variety's usefulness in canning.

### 1.29.2 Redhaven

Early variety suited to midhills.  
Medium-sized round fruit.  
Yellow skin with red tinge.  
Firm, fine-textured, melting flesh.

### 1.29.3 Alexander

Excellent, early-season cultivar.  
Medium- to large-sized round fruit.  
Smooth, beetroot purple skin with green patches.  
Soft, greenish white, juicy, sweet, aromatic flesh.  
Freestone variety.

### 1.29.4 Elberta

Suitable for canning.  
Large, round fruit.

Pale yellow skin with red splash.  
Firm, juicy, sweet flesh.

#### 1.29.5 Stark Red Gold

Early variety.  
Medium-sized, moderately fuzzy fruit.  
Orange skin with a blush of red.  
Semi-clinging stone.  
High-yielding variety.

#### 1.29.6 Sunhaven

Medium-sized round fruit.  
Bright red skin.  
Yellow, firm, fine-textured flesh with good flavour.  
Freestone variety.

#### 1.29.7 Partap

Round, yellowish red fruit.  
Firm, yellow flesh.  
Freestone variety.  
12% TSS and 0.7% acidity.

#### 1.29.8 Sharbati

Spreading and vigorous tree.  
Large, greenish yellow fruit with rosy patches.  
Juicy, tasty, white flesh with excellent flavour.

#### 1.29.9 Khurmani

Red-coloured large fruit pointed at the base.  
Clingstone cultivar.  
White, soft, juicy flesh.

#### 1.29.10 Nectarine

Fuzzless peach.  
Smooth skin.  
Smaller in size.  
Firm flesh.  
Stronger flavour and aroma.

## 2. Plum

Scientific name: *Prunus salicina*.  
Family: Rosaceae.

### 2.1 Introduction

It is a strong growing temperate tree. This fruit have found favour with orchard-ists because of their phenomenal yield potential and high economic returns. It

was introduced to India by Alexander Court in his orchard at Mashobra. The main producing countries are Russia, Romania, China, Germany, the USA, France, Italy and Spain. In India, it is grown in J&K, Himachal Pradesh, Uttaranchal and Punjab. It is also grown to some extent in Nilgiri hills of South India.

## 2.2 Importance and uses

Besides being palatable and delicious, the fruit has high nutritive value also. It is one of the richest sources of vitamin B1. Plum fruit is also rich in vitamin A and riboflavin. It is a good source of sugars, proteins, carbohydrates and minerals like calcium, phosphorous and iron. It is also known for its cooling effect, and it is considered best to overcome jaundice.

## 2.3 Morphological characters

Tree is medium- to large-sized, upright growing and deciduous. Leaves are alternate, serrate, sharp-pointed, medium-sized and glabrous. Flowers are produced three in a bud on a 1-year shoot or spur. Flowers are perfect, solitary or raceme, with five sepals; five petals, usually white; numerous perigynous stamens; one pistil with elongated style; and two ovules; and the fruit is drupe and usually single seeded. White flowers are seen clustered on the spurs and come to full bloom 7–10 days after the emergence of first flower. The fruit setting starts in the second week of March. Fruit is drupe, and the edible portion is the mesocarp.

## 2.4 Climate and soil

Plum requires varying types of climate and is grown from subtropical plains to the temperate high hills. The European-type plums require temperate climate and are grown in high hills at an elevation of 1300–2000 m amsl. It requires about 800–1000 h of chilling below 7°C during winter to break rest period. Japanese plum requires 100–800 h of chilling, and winch is met in midhill areas located at an elevation of 1000–1600 m amsl. Plums can be grown in areas where winters are cold and summers are hot. Cold, wet and windy weather during bloom is detrimental for good fruit set as spring frost injury causes damage to bloom. A northern slope is preferred particularly for Japanese plum, which tends to delay the bloom period and thus avoids early frost injury. Plum requires 90–110 cm well-distributed rainfall throughout the year. Prolonged drought during fruit growth and development and excessive rains during fruit maturity hamper fruit quality. Although plum can grow on a wide range of soils, deep, fertile and well-drained loamy soils with a pH of 5.5–6.5 are the most suitable. The soil should be free from hard pan, waterlogging and excessive salts. Very heavy or light soils are not suitable. The Japanese plums do well on average soils having high pH.

## 2.5 Species and varieties

The cultivated plums belong to two species:

1. *Prunus domestica* (European plum). It is a hybrid of diploid myrobalan plum (*Prunus cerasifera*) and tetraploid black thorn (*Prunus spinosa*). It is hexaploid in shape. Fruits are larger in size than Japanese plums. Fruit is oval or round having both yellow and green ground colour and also both red and blue skin colour. The cultivated varieties of European plum are classified into three main groups:

a. Prunes. Fruit is oval in shape with bulging ventral side and compressed bilaterally. It is blue or purple in colour, high in sugar content which makes itself suitable for drying without removal of pit. All prunes are plums but all plums are not prunes. Varieties are Italian prunes, Giant prune and President.

b. Reineclaude and green gage plum. This is a hybrid between *Prunus domestica* and *Prunus insititia*. Fruit is greenish yellow in colour and round in shape having yellow skin and flesh. Important varieties are Golden Drop, Green gage and Golden transparent.

c. Lombard plum. The colour of fruit is purplish red. Varieties are Lombard and Victoria.

2. *Prunus salicina* (Japanese plum). It originated in China but introduced in Japan from where it is disseminated around the world. Plant is more vigorous, productive, precocious and resistant to diseases than European plum. The fruits are large and heart shaped with pronounced apex. A few cultivars are oblate or round.

3. *Prunus insititia*. This is a small European plum which is hexaploid in shape and grows wild in Europe and Western Asia. Plums of this species are known as Damson and Mirabelles. Fruits are small and purple (Damson) and yellow (Mirabelles). Plants are small and compact and forms excellent hedge rows.

## 2.6 European plum cultivar

California Blue, Washington, French Prunes, Early Italian, Stanley, Grand Duke, Victoria, Damson.

## 2.7 Japanese plum cultivar

Beauty, Methley, Santa Rosa, Kelsey, Mariposa, Satsuma, Burbank Red Beaut, Fronteir.

## 2.8 Propagation and rootstocks

Plums are generally propagated through hardwood cuttings. In case rootstocks are to be used, budding and grafting methods are employed for its propagation. Plum is raised on seedling rootstock of wild apricot (Zardalu) and *Prunus cerasifera*.

## 2.9 Raising of rootstocks

The rootstocks can be raised either through seeds or through cuttings.

- a. Through seeds. Stones are extracted from ripe fruits and sown during November in rows. Light irrigation is provided after sowing.
- b. Stem cuttings. Stem cuttings are planted in beds in row at a distance of 15 cm in rows which are 30 cm apart. The rooted cuttings are budded in the following May–June or grafted in December–January.

## 2.10 Rootstock

Plums are propagated vegetatively by budding and grafting on rootstocks. These can also be propagated by hardwood cutting and by leafy softwood cuttings

under intermittent misting. Cuttings taken from hardwood and semi hardwood are treated with IBA (2000–5000 ppm) for better rooting. For raising the seedlings, the seeds of wild apricot are stratified under alternate layers of moist sand for 45–50 days at temperature 3–5°C to break the rest. The stratified seeds are sown in nursery beds 6–10 cm deep in row 25–30 cm apart with a distance of 10–15 cm from seed to seed. The seedlings attain graftable size in a year. In Punjab, own-rooted plants of Kala Amritsari are generally used for planting. Clonal rootstocks of plum are multiplied commercially by layering. It has been observed that most of clonal rootstocks of plum are difficult to root. Application of 2500 ppm IBA to stool shoot helps to improve rooting. Clonal rootstocks are also propagated by hardwood cuttings. The hardwood cutting should be taken during dormant season and dipped in 2500 ppm IBA solution for 30 seconds. Then these cutting are planted in mist propagation chamber for rooting.

### **2.11 Propagation of scion**

Seedling as well as clonal rootstocks which are 0.8–1.2 cm in thickness are grafted in February with tongue and cleft method of grafting. The seedling which do not attain graftable size in February, they should be budded with T- and chip methods of budding in June–July. For grafting the scion, wood should be collected from healthy, disease-free, true to variety trees during January. The scion wood is collected from 1-year-old shoots. They are packed in moist sphagnum moss, which are properly labelled for variety. These bundles of scion wood are stored in cold storage or buried deep in the soil at shady place till grafting is done. The best time of grafting of these fruits is February in lower elevation and in March at higher elevations. Chip budding can also be done in March, July and September.

### **2.12 Vegetative propagation**

#### *2.12.1 Hardwood cuttings*

The rooted cuttings can be directly used without budding. The cuttings taken from subapical portions planted after dipping in IBA and callusing for about a month give higher percentage of success. The time of preparation of cutting is from the end of December to the end of January.

#### *2.12.2 Budding and grafting*

Budding by shield or T-method is performed in April and July–August. The plants budded becomes saleable after 1 and a half year. The propagation by cleft and tongue grafting is performed when the stock and scion are still dormant. Cleft grafting is generally performed when the stock is thicker than the scion.

#### *2.12.3 Planting operations*

They are planted in January in 1 m<sup>3</sup> pits. Fill the pits with top soil and well-rotten FYM before planting. Square system of planting is adopted with 6 m spacing. Provide irrigation soon after setting plants in pits and staking. Avoid water stagnation.

### **2.13 Planting and planting density**

Planting of plum is done in December–January when the plant is in dormant conditions. Before planting, the bushes and weeds on the site of an orchard should

be properly cleared off. It is advisable to plough the plantation area. In hilly area, terraces should be kept inwards to facilitate soil conservation. The orchard area should be properly laid out about 2 months before planting. In sloppy land, layout of an orchard should be done with contour or terrace system, while in a flat land, square system is followed.

### 2.14 Training and pruning

Plums are generally trained on the open-centre system or to modified central leader system depending upon the varietal growth habits. The varieties with spreading habits of growth as in Japanese plum should be trained to open-centre system. In HP open-centre system is followed irrespective of variety. However, in the plains, where plenty of sunlight is available, trees should be trained in the form of modified central leader system with four to five scaffold branches.

### 2.15 Open-centre system

After planting, the plant is cut back to 40–60 cm above the ground level. During the growing season, about three to six laterals, in addition to the central leader, are produced on the tree. In the first winter pruning, three to five scaffold branches which are well spaced and have wide angle should be selected, and the remaining branches are removed.

The central leader is also completely removed. The planting distance varies according to the varieties, rootstocks and fertility of soils. Plums are generally planted at a distance of 6 m × 6 m. In high-density plantation, the plum plants raised on semi-dwarfing clonal rootstocks should be planted at 4 m × 4m in distance. Pits of 1 m × 1 m × 1 m size are dug in October–November. Pits should be filled with fertile top soils mixed with 40 kg of well-rotten FYM and 1 kg of single super phosphate. To avoid any damage from insects, the pits are drenched with 10 litres of chlorpyrifos (4 ml/L) solution. The graft union should be kept 10–15 cm above the ground level at the time of planting to avoid any scion rooting. Young plants should be watered regularly, and basin area is mulched with 15-cm-thick dry grass.

The selected branches are headed back to  $\frac{1}{4}$  of the growth. During the second dormant pruning, two to three secondary branches are selected on the primary branches. The major consideration in selecting secondary branches should be their location so that after pruning, the tips of primary and secondary leaders are about 30–40 cm apart from each other. The height of secondary branches is staggered in different years by pruning all branch leaders more severely. The vertical ones are pruned more severely. This will produce branch leaders at different heights and prevent overcrowding when the tree is mature. In the following years, the head should be fully formed, and selection of secondary branches is completed.

### 2.16 Pruning

In plums, thinning and heading back of shoots are two basic components of pruning. Most of the plum varieties bear on spurs on 2-year-old woods. The life span of these spurs is 5–6 years. It is necessary to prune for some spur renewal each season. The extent of pruning is done such a way to induce an annual shoot growth of 25–50 cm. In bearing plum trees, 25–30% thinning of shoots and 50–75% heading back of shoots are suggested for proper fruiting. At the time of pruning, dead, diseased and broken branches should be pruned off.

## **2.17 Nutrition**

Plum requires adequate amount of nutrients for better growth and quality fruits. Application of manures and fertilisers depends upon soil fertility, type of soil, topography, age of tree, cultural practices and crop load. The requirement of fertilisers varies from region to region. The farmyard manure along with full dose of P and K should be applied during December and January. Half dose of N is applied in spring before flowering and the remaining half a month later.

## **2.18 Irrigation**

Plum is mostly grown under rainfed conditions. However, in order to produce fruits of good size and better quality, irrigation is essential. Various methods of irrigation are adopted to irrigate plum orchards, but in hill basin, drip irrigation methods are more popular and are widely used and recommended. After fruit setting, the plum trees are irrigated at weekly intervals and six to eight irrigations which are recommended for higher production of quality fruits in Santa Rosa plum.

## **2.19 Orchard floor management and weed management**

In plum orchard, sod culture and mulching of tree basin area with hay mulch or black alkathene mulch are the most common methods of orchard floor management. During pre-bearing stage, intercropping with legumes and vegetables is also practiced in orchards planted in flat and less sloppy land. The weed removal manually is one of the practices employed in the orchards besides inter cultivation and cover crop growing. In rainy seasons, the weeds in plum orchard are controlled with the post-emergence sprays of glyphosate at the rate of 800 ml/hectare.

## **2.20 Crop regulation and quality improvement**

Generally plum tends to bear heavy crops and bear undersized fruits of low quality, and thinning, therefore, is necessary to increase the fruit size and uniformity in colour and to stimulate flower initiation for the regulation of next year's crop. Various methods such as manual, mechanical and use of chemicals are used, but chemical thinning has superiority with respect to thinning cost, fruit size and quality. NAA at 20 to 40 ppm sprayed after petal fall resulted in good fruit thinning.

## **2.21 Maturity, harvesting and yield**

It has been observed that plum usually ripen unevenly over the tree. Fruits, therefore, are harvested in two or three pickings, and it is very important to find out the exact stage of picking when they are mature. Among various indices of maturity, most commonly used are flesh firmness  $5.9 \pm 0.45$  kg, days from full bloom ( $94 \pm 3$ ), TSS 13.5–14.5 and TSS acidity ratio 1.2:1.5. The fruits are harvested with stalk intact avoiding any skin injury. Fruits are very delicate and perishable; therefore picking baskets should be lined with soft material on the inner surface. Immediately after plucking the fruits should be kept under the shade of the tree to remove field heat.

## 2.22 Grading and packing

To obtain high price in the market, the grading of the fruits is done to have uniform size and better quality. The packing and grading standards of the plum are:

## 2.23 Storage and marketing

Plums being perishable have very short shelf life. In India the work in HP has revealed that plum can be stored for 1 to 2 weeks at 0°C with 80–90% humidity. The CA storage has been practiced overseas by maintaining 2–3% oxygen and 2–8% CO<sub>2</sub>, and the fruits can be retained for a duration of 2–3 months.

## 2.24 Flowering and fruiting

Flowering starts in the second fortnight of February and last up to the first week of March. Growth pattern follows a double sigmoid curve. Specific gravity decreases from fruit set till maturity.

## 2.25 Manuring and fertilisation

State	FYM (kg/tree)	N (g/tree)	P <sub>2</sub> O <sub>5</sub> (g/tree)	K <sub>2</sub> O (g/tree)
Punjab	36	180	90	216
Himachal Pradesh	40	500	250	700

## 2.26 Training and pruning

### 2.26.1 Training

The tree is trained to modified leader system and headed back to a height of 90 cm from ground level. Select four to five well-spaced laterals to grow.

### 2.26.2 Pruning

Annual pruning is done in January. Remove thin and crowding twigs and branches. Thin out criss-crossed, lengthy, dried and diseased branches. After every 4–5 years of fruiting, heavy pruning should be done by heading back lengthy branches about half of their length.

### 2.26.3 Thinning

Hand thinning is commonly practised. First shake the branches to dislodge fruits which are likely to drop off naturally. If still surplus is there, then start thinning from top to bottom. Hold the stem of fruit to be removed between the thumb and the second finger, and pull it off gently. Foliar spray of 200 ppm ethephon and 100 ppm carbaryl at full bloom is very effective for blossom thinning.

### 2.26.4 Harvesting

It is a climacteric fruit. So it should be picked at proper stage of maturity. It starts yielding within 2–3 years of planting. Peak season is May.

## 2.27 Pests

San Jose scale.  
Plum twig borer.  
Plum fruit moth.  
Mites.  
Nematodes.

## 2.28 Diseases

Bacterial canker.  
Brown rot.  
Crown rot.  
*Cytospora* canker.

## 2.29 Varieties

### 2.29.1 *Santa Rosa*

Upright trees.  
Large purple crimson fruit.  
Amber coloured flesh.  
Prolific bearer.  
Very juicy fruit.

### 2.29.2 *Red Beauty*

Spreading tree.  
Medium-sized fruit; mix of red and yellow colour.  
Yellow-coloured flesh.  
Sterile pollens; require pollinizer.  
Early maturing variety.

### 2.29.3 *Mariposa*

Upright growing tree.  
Requires cross-pollination.  
Heart-shaped fruit.  
Skin: greenish yellow mottled with red.  
Red-coloured flesh.  
Good shelf life.

### 2.29.4 *Frontier*

Vigorous, upright, high yielding.  
Partially self-unfruitful.  
Red-purple-coloured large fruits.  
Red, firm, sweet flesh.  
Santa Rosa when used as pollinizer improves the yield.

### 2.29.5 *Satluj Purple*

Bright crimson fruit; thick-skinned.  
Sweet taste.

Yellow-orange firm flesh.  
13–14% TSS, 0.6–0.7% acidity.  
Self-unfruitful; requires Kala Amritsari as pollinizer.

#### 2.29.6 *Kala Amritsari*

Self-fruitful.  
Low spreading vigorous tree.  
Medium-sized, round fruits; dark brown coloured.  
Yellow flesh, moderately juicy.  
15% TSS, 1.2% acidity.  
Yield will improve if pollinated with Titron.

#### 2.29.7 *Titron*

Self-fruitful.  
Improved yield, if Alucha Early Round is used as pollinizer.  
Spreading tree.  
Small- and medium-sized fruit; deep purple colour, thin skin.  
Yellow flesh, moderately juicy.  
Excellent for jam making.

#### 2.29.8 *Alu Bhokra*

Upright, tall, vigorous tree.  
Self-unfruitful.  
'Howe' is a good pollinizer.  
Large fruit, red coloured.  
Sweet and juicy pulp.

### 3. Apricot

Scientific name: *Prunus armeniaca*.  
Family: Rosaceae.

#### 3.1 Origin and history

The apricot ranks second next to plum among the stone fruits in India in area, production and popularity. It is a drought-resistant, salt-tolerant, hardy plant being rather less susceptible to pests and diseases. The word 'Armeniaca' indicates its introduction to Italy and Greece by Armenian traders. The major producing countries are China, Russia, Turkey, Italy, Spain, France, Greece, the USA, Morocco, Syria and Romania. In India it is grown in Jammu & Kashmir, Himachal Pradesh, Uttaranchal and limited extent to Amritsar and Patiala in Punjab.

#### 3.2 Botany

It is a small tree growing up to 6–9 m in height. The bark is reddish with glabrous twigs. The leaves are ovate, glabrous above and pubescent beneath. Pinkish to white flowers are produced before the leaves. Fruit is velvety when young and peach-like in colour and shape, and flesh is yellowish orange. Stone is smooth and flattened [3].

### **3.3 Climate**

Apricot can be successfully grown at an altitude between 900 and 2000 m amsl. The white-fleshed sweet kernelled apricots require cooler climate and are grown in dry temperate regions up to 3000 m amsl. The long cool winter (300–900 chilling hours), frost free and warm spring are favourable for fruiting. Average summer temperature between 16.6 and 32.2°C is suitable for growth and quality fruit production. In general, the sites located on the northeastern aspect at lower elevation and southwestern at higher elevation are suitable for its cultivation. Spring frost causes extensive damage to the blossoms, which are killed when temperature falls below 4°C. An annual rainfall of about 100 mm, well distributed throughout the season, is good for normal growth and fruiting spur favours fruiting. An annual rainfall of 100 cm is sufficient for obtaining a good apricot crop.

### **3.4 Soil**

Apricots are quite hardy and can be grown in most of the soils. Deep well-drained soil is the best. The soil should be about 3 m deep. In Kinnaur region of Himachal Pradesh, where apricots are grown in large wild stands, the soils are sandy and well-drained but not very fertile. If the drainage is good, high lime content of the soil does not depress the growth of tree.

### **3.5 Propagation**

Apricots can be commercially raised by vegetative methods of propagation like budding and grafting. Seed propagation can also be practised.

#### *3.5.1 Seed propagation*

Apricot seeds require stratification for 72 days at 4°C. The germination of seeds can be hastened by the removal of kernel from the shell, scarification and gibberellic acid or kinetin treatment. Seeds are soaked in 500 ppm GA3 or 5 ppm kinetin solution for 24 hours before planting. Seeds are sown in nursery beds 30 cm apart. Frequent watering and mulching should be given.

#### *3.5.2 Vegetative propagation*

Apricot seedlings are generally propagated on wild apricot, wild plum and peach. Apricot seedlings are the best for graft union and for producing vigorous trees. In rainfed orchards, where drought conditions prevail, apricot on peach makes better growth than on apricot seedlings. T-budding and tongue grafting are adopted.

### **3.6 Planting**

The apricot plants are planted during the dormant season, i.e. end of December to February, but early planting gives better establishment of plants. Undesirable trees and shrubs should be removed from the land during its initial preparations by digging and ploughing. On the flat land, a regular planting layout system such as square and triangular is followed, while on the hill slopes, contour system is generally practiced. The spacing of plants varies with the soil, climate and vigour of variety and rootstocks. The plants are generally planted at a spacing of 6 m × 6 m. The pits of 1 × 1 × 1 m dimension are dug about a month before planting and are filled with a mixture of soil and 50–60 kg well-decomposed FYM. About 1 kg SSP

and 10 L of chlorpyrifos (4 ml/1 litre of water) is also added to each pit. In comparison to other temperate fruits, high-density planting in apricot has begun rather late as there are very less dwarfing rootstocks. A density of 7200 trees/ha has been reported in cv. Canino.

### 3.7 Flowering and fruiting

In apricot, usually three flower buds develop in the axil of a leaf at each node on a shoot and a spur. The central one is vegetative and side ones are floral. In Himachal Pradesh, flowering occurs in March. High temperature, low humidity and wind shorten flowering duration by increasing respiration.

### 3.8 Irrigation

Tree has shallow roots; so good soil moisture is beneficial. The roots are confined to 2 m from the surface, so wet the land up to a depth of 2 m. In rainfed conditions, mulching and water harvesting technique can be practised.

### 3.9 Manuring and fertilisation

Parameter	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
General	100–200 kg/ha	80 kg/ha	100 kg/ha
Kashmir	450 g/tree	150 g/tree	750 g/tree

### 3.10 Training

Apricot is trained to modified leader system. The main branch is cut 50–75 cm above the ground. Four to six well-spaced branches are retained.

### 3.11 Pruning

#### 3.11.1 Pruning of young trees

The main central axis is cut off 50–75 cm above the ground, and all laterals are cut off if these are not properly spaced along the central axis.

Pruning at the end of first growing season in winter consists in selection of five to six well-spaced laterals around the trunk. The lower branch should be about 40–45 cm, and all other laterals should be completely thinned out. All the selected laterals should be headed back to get secondary branches on them.

During the second year growth, only five to seven secondary scaffolds about breast height are retained, and others are removed.

At the end of the third year, pruning is confined to thinning of the branches which are either crossing or crowding each other for proper development of the framework and to admit sunlight in the tree centre to promote growth of the spurs.

The leader of the tree is modified after the fourth year of its age by cutting it back very close to a lateral branch.

#### 3.11.2 Pruning of bearing trees

To produce new spurs annually and to replace the older and unproductive ones, light to moderate thinning of branches and heading back of new laterals are

essential annually. In old trees when the growth becomes less, the heavier pruning is done by way of cutting back the main primary limbs and thinning of undesirable secondary laterals.

### **3.12 Thinning of fruits**

The apricot tends to set heavily. So to produce fruits of marketable size, it must be thinned. Fruit-to-fruit spacing should be kept 4–8 cm when crop is heavy, and when crop is light, spacing may be done to 4–5 cm. Two to three fruits may be retained on each spur. Thinning should be done within 40 days after full bloom.

### **3.13 Flowering**

In apricot, usually three buds develop in the axil of a leaf at each node on a shoot and spur. The central one is a vegetative bud, and the two side buds are floral. Time of flowering and its duration vary with the variety and the prevailing weather conditions. Under midhill condition, the flowering in apricot occurs in the month of March and higher hills at the end of March and April.

### **3.14 Pollination and fruit set**

Most of the commercial cultivars of the Apricot are self fruitful and set fruits without pollinizer. However, varieties like Charmagz and Perfection have been reported self-incompatible. There is generally a good fruit set in the apricot cultivars growing in appropriate climatic conditions. There is 40–60% fruit set in the cultivars commercially grown in midhills, but fruit drop is to the extent of 79% in these cultivars, which occurs mostly in the second week after fruit set. A spray of 10 ppm NAA at the beginning of pit hardening reduced the preharvest drop.

### **3.15 Manuring and fertilisers**

Apricot trees remove large amount of nutrients from the soil and require organic manures as well as chemical fertilisers for normal growth and fruit production. The manurial requirements depend upon age of tree, type of soil, climate conditions and cultural practices, which vary from region to region. FYM is applied during December–January along with full dose of P and K by broadcasting method. Nitrogen is applied in two doses via first half dose of N in spring 2–3 weeks before flowering and the remaining half N a month later, if irrigation facilities are available. Under rainfed conditions the second half dose of N should be applied at the onset of monsoon rains or through one or two foliar sprays of 0.05% urea after fruit set. Fertilisers should be broadcast on the soil surface under the spread of the trees and mixed with the soil. It should not be applied in too wet or too dry soil. In high rainfall areas with steep slopes, the band application of nitrogenous fertilisers should be preferred over broadcasting. During the initial 3–4 years of orchards' life, when the plants are young, intercropping with leguminous crops like pea, bean, soya bean, cowpea and also tomato and strawberry is recommended as they enrich the soil and also give economic returns.

### **3.16 Irrigation**

Though apricot is tolerant to dry atmosphere yet requires irrigation water especially during critical periods of fruit growth and development. Water requirement varies with the soil, tree age, climatic conditions and irrigation method. The

peak water use period is from the end of April to mid of June, which coincides with fruit development period. Irrigation at 20% depletion of soil moisture from field capacity improves fruit size and yield. Irrigation interval should be 10 days during May and 6–8 days during June. All in all, eight irrigations in a season are sufficient for apricot in midhill of Himachal Pradesh.

### 3.17 Maturity indices, harvesting and yield

Change of surface colour, days from full bloom to harvest and fruit TSS are considered to be the best indices of maturity. For fresh market, the fruits are plucked when surface colour turns green to yellow. Fully ripe fruits are, however, harvested for freezing, canning and drying. In Himachal Pradesh, days from full bloom to harvest and fruit TSS have been standardised for different varieties to judge the optimum time of harvest. Since apricot fruits are very perishable, so due care is required during harvesting, packing and transportation. The fruits should be harvested in the morning hours, and direct exposure of fruits to the sun is avoided during grading and packing. Apricot trees start fruiting at the age of 5 years and give economic yield up to 30–35 years. Apricot attains full bearing age at about 8–10 years and yield about 50–80 kg fruits per trees.

### 3.18 Thinning

Fruit set in apricot is rather heavy which results into undersized fruits and also increases the tendency of biennial bearing. Fruit thinning improves fruit size, promotes regular bearing, decreases limb breakage due to heavy crop load and maintains the tree vigour. Fruit thinning should be done within 40 days after full bloom, i.e. during the last week of April or first week of May, because this is the effective period influencing fruit bud formation. Both hand and chemical thinning method are employed. Depending upon the crop load, the fruit may be thinned till the fruit are 6–10 cm apart. A spur should have not more than two fruits. Foliar spray of 25–50 ppm NAA 20 days after fruit set is best for thinning.

### 3.19 Orchard soil management and weed management

Sod culture plus mulching of basin with dry grass or black polythene is the common orchard floor management practice followed in apricot orchards. In apricot orchards atrazine or diuron at 4.0 kg/ha as pre-emergence and gramoxone at 2 kg/L or glyphosate at 800 ml/ha as post-emergence has been found effective and economical in controlling weeds. Mulching of trees basin with 10–15-cm-thick dry grass also checks the weed growth.

### 3.20 Maturity indices

- Fruit and flesh colour.
- Size, firmness.
- TSS, acidity.
- Dry matter content.

### 3.21 Pests

- Indian gypsy moth (*Lymantria obfuscata*).
- Leaf roller (*Archips micaceana*).
- Peach stem borer (*Sphenoptera lafertei*).
- Peach fruit fly (*Bactrocera dorsalis*).

### 3.22 Diseases

Bacterial canker and gummosis (*Pseudomonas syringae*).  
Powdery mildew (*Sphaerotheca pannosa*).  
Brown rot (*Monilinia laxa*, *M. fructigena*, *Sclerotinia*).  
Wilt (*Verticillium albo-atrum*).

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