
UNIT 1 MANGO (*Mangifera indica* L.)

Structure

- 1.0 Objectives
- 1.1 Introduction
- 1.2 Area and Production
- 1.3 Soil
- 1.4 Climate
- 1.5 Commercial Varieties
 - 1.5.1 Dashehari
 - 1.5.2 Langra
 - 1.5.3 Chausa
 - 1.5.4 Bombay Green
 - 1.5.5 Fazli
 - 1.5.6 Zardalu
 - 1.5.7 Gulabkhas
 - 1.5.8 Alphonso
 - 1.5.9 Kesar
 - 1.5.10 Bangalora
 - 1.5.11 Neelum
 - 1.5.12 Swarnarekha
 - 1.5.13 Banganpalli
 - 1.5.14 Mulgoa
- 1.6 Hybrids
- 1.7 Planting
- 1.8 Propagation
 - 1.8.1 Inarching
 - 1.8.2 Layering/Cutting/Budding
 - 1.8.3 Veneer Grafting and Side Grafting
 - 1.8.4 Stone Grafting and Epicotyl Grafting
 - 1.8.5 Preparation of Scion and Rootstock
- 1.9 Nutritional requirements
 - 1.9.1 Non-bearing trees
 - 1.9.2 Bearing trees
- 1.10 Cultural Practices
 - 1.10.1 Training and Pruning
 - 1.10.2 Top Working
 - 1.10.3 Interculture
 - 1.10.4 Irrigation
 - 1.10.5 Intercropping

Sub Tropical Fruits

1.11 Pests and Diseases

1.11.1 Insects-Pests

1.11.1.1 Mango Hopper

1.11.1.2 Mango Mealy Bug

1.11.1.3 Mango Stone Weevil

1.11.1.4 Fruit Fly

1.11.1.5 Stem Borer

1.11.1.6 Shoot Borer

1.11.2 Diseases

1.11.2.1 Powdery Mildew

1.11.2.2 Anthracnose

1.11.2.3 Bacterial Canker

1.12 Physiological Disorder

1.12.1 Alternate Bearing

1.12.2 Mango Malformation

1.12.3 Black Tip

1.12.4 Spongy Tissue

1.13 Harvesting

1.14 Storage

1.15 Packaging and Transportation

1.16 Processing

1.17 Let Us Sum Up

1.18 Key Words

1.19 Further References

1.20 Answers to Check Your Progress Exercises

1.0 OBJECTIVES

After going through this unit, you will be in a position to:

- explain the history, botany and uses of mango,
- discuss status of area and production of mango,
- describe the soil, climatic and nutritional requirements,
- identify the different varieties by their names and characteristics,
- describe the planting, propagation methods and other cultural practices,
- describe various pests-diseases and physiological disorders, and
- explain how and when the harvesting, storing, packaging and transportation to be done.

1.1 INTRODUCTION

The mango (*Mangifera indica* L.) because of its great utility, occupies an

eminent place amongst the fruit crops grown in India and is acknowledged as the “King of fruits”. It is one of the oldest cultivated fruit crop, having been grown in India for at least 4000 years. At present more than 100 countries produce mangoes. The fruit occupies an important socio-economic position in India and South-East Asian countries. The well known ‘Lakh bagh’, known to be stocked with 1,00,000 mango trees, was planted near Darbhanga in Bihar state by Akbar.



Mango Fruits

Mango belongs to the family Anacardiaceae and genus *Mangifera* and has been originated in South East Asia. The genus has 69 species, out of which only a few have edible fruits. In India, only three species are found i.e. *Mangifera indica*, *M. sylvatica* and *M. coloneura*. The species *Mangifera indica* bears edible fruits whereas other two species are wild and bears non-edible fruits. The tree is evergreen, medium in size and erect. Inflorescence of mango is branched panicle. Mango fruit is drupe and mesocarp is the edible portion. Fruit size, shape, colour, flavour and taste vary according to variety. The colour of the skin varies from green, yellow, red or any shade of the colour.



Mango Flower

Mangoes are consumed fresh as either green or mature ripe or processed into numerous products. Mango possesses unique nutritional and medicinal qualities apart from being a rich source of vitamin A and C. The green fruits are used for the preparation of chutneys and pickles. Ripe fruits are a delicacy for the table purpose while the unmarketable and inferior one's can be converted into delicious squash, juice, nectar, syrup, jam and jelly. Canned mango slices and pulp are also very popular.



Mango Products

1.2 AREA AND PRODUCTION

India is the largest mango producing country, accounting for 41.0 per cent of the world production. The total mango production of the country is 13792.1 thousand mt from an area of 2205.6 thousand ha. which covers 38.0 per cent of total area under fruits. The main mango growing states in the country are

1.3 SOIL

Soil requirement of mango is not very particular. It can grow well in all types of soil from alluvial to lateritic. For better performance, it requires deep (2 to 2.5 m) and well drained soils of loamy texture. Soils which lack proper drainage are not suitable for its cultivation. It grows successfully in soft rocky areas of the west coast. Likewise soils with a hard pan or a compact canker layer underneath or with a high water table or those liable to be flooded are also unsuitable. Before planting an orchard of mango, both soil and sub-soil should be got examined thoroughly. The pH of the most well known mango regions varies from 5.5 to 7.5. Soils with higher or lower values than the above optimum range should be avoided.

Table 1: Statewise area, production and productivity in total of Mango during 2017-18.

Sl. No.	State	Area (000 ha.)	Production (000 mt.)	Productivity ha/mt
1	Uttar Pradesh	265.62	4551.83	17.14
2	Andhra Pradesh	363.00	4373.61	12.05
3	Bihar	149.28	2443.47	16.37
4	Karnataka	183.23	1760.60	9.61
5	Tamil Nadu	152.57	1234.00	8.09
6	Gujarat	162.77	1207.78	7.42
7	Telangana	115.99	1080.14	9.31
8	West Bengal	103.25	918.35	8.89
9	Odisha	199.08	805.77	4.05
10	Maharashtra	166.76	791.36	4.75
11	Kerala	83.12	439.20	5.28
12	Others	313.46	2216.22	7.10
	Total	2258.13	21822.32	110.06

1.4 CLIMATE

Although essentially it is a tropical fruit. The mango can grow from sea level to an altitude of about 1400 m provided there is no high humidity, rain or frost during the flowering period. In general, it does best in comparatively dry regions which receive good rainfall in hot weather from June to September, followed by a more or less dry spell in the subsequent period. A rainfall of about 125 cm falling mostly during the monsoon is considered very suitable, but much less of it will be sufficient if irrigation facilities are available. It does well within a temperature range from 24 to 27°C, although it can successfully grow even temperatures as high as 48°C, during the period of fruit development and maturity, if facilities for irrigation at regular intervals during this period are available. Higher temperatures during the period of fruit development hasten maturity and improve fruit size and quality. The

low temperature (freezing) and frosts during the period of flowering is harmful. Localities which experience bright sunny days and a relatively low humidity during flowering period are ideal for mango cultivation.

The frequency of winds, their intensity and speed, has also to be taken into account while selecting sites for mango orchards. Besides causing shedding of flowers and fruits, strong winds also cause mechanical injuries to the trees. The damage caused by the winds can however, be minimized by planting windbreaks of tall and hardy trees around mango orchard.

1.5 COMMERCIAL VARIETIES

About a thousand varieties of mango are known to exist in India. Most of them have originated as a superior chance seedlings, arising from natural crossing or gene mutation. These selections were later maintained true to type through asexual propagation. All the varieties are location specific and the commercial varieties of one region do not do so well when grown in other areas. Most popular commercial varieties of different regions are:

- Northern region : Dashehari, Langra, Chausa and Bombay Green
- Eastern region : Fazli, Zardalu and Gulabkhas
- Western region : Alphonso, Kesar
- Southern region : Bangalora, Neelum, Swarnarekha, Banganpalli, Mulgoa

1.5.1 Dashehari

This is the most popular cultivar of northern India because of its attractive appearance, excellent and pleasing flavour. It is a mid-season cultivar maturing towards the end of June. The fruits are medium in size (4 to 8 per kg), elliptical-oblong in shape, and have an attractive greenish yellow colour. It is good cropper, though biennial in bearing.

1.5.2 Langra

Some people in the north, rank it even higher than Dashehari. It is also a mid-season cultivar. The fruits are large in size (3 to 4 per kg), oblong-oval shape and have lime-green colour. It has excellent sugar/acid blend and a characteristically pleasant flavour. It is a heavy yielder, especially after the age of 15 years. However, this is also biennial in bearing.

1.5.3 Chausa

This is one of the sweetest mangoes lacking somewhat in acidity. It is late cultivar and matures towards the end of July or beginning of August. It starts bearing good crops only after 15 to 20 years. The fruits are large-sized (3 to 4 per kg). Almost oblong in shape and bright yellow in colour. Its major drawbacks, besides biennial bearing, are its high susceptibility to mango malformation, and very vigorous growth habit.

1.5.4 Bombay Green

This is the earliest cultivar of northern India, maturing during the first half of

Sub Tropical Fruits

June. The fruits are medium in size (4 to 6 per kg), ovate in shape and yellowish green in colour. The taste is good and yield moderate. However, this is also biennial in bearing and highly susceptible to mango malformation.

1.5.5 Fazli

This is a very late cultivar (matures late in August) with very large-sized fruits (2 fruits per kg). The tree is very vigorous and a medium to heavy cropper, with biennial bearing habit. The fruit quality is relatively poor and its importance lies in its lateness to mature.

1.5.6 Zardalu

This is considered to be a matchless fruit of Bhagalpur (Bihar). It matures towards the end of June. The fruits are medium in size (5 to 6 per kg), oblong-oval in shape and have attractive apricot-yellow colour. The fruit quality is good with a pleasant flavour. It is biennial in bearing.

1.5.7 Gulabkhas

The fruit is favored for its characteristic rose flavour and very sweet taste. The fruits mature in June and are of medium size (5 to 6 per kg), Oblong-oblique in shape. The fruits are amber yellow in colour, with reddish blush towards the base and the sides. This is heavy yielder, but biennial in bearing.

1.5.8 Alphonso

This is one of the finest of Indian mangoes and is rated to be the best by many in home and abroad. However, it is also biennial bearing. It is very specific in its requirements and does best only on the west coast of Maharashtra (Ratnagiri), although it is grown some extent in the south too. The fruits are very attractive, large-size (3 to 4 per kg) and oval in shape.



Alphonso Mango

The fruits have an attractive pinkish blush towards the basal end. The taste is superb, with excellent sugar/acid blend. The flavour is captivating. Besides being a table cultivar, much in demand, it is also a favored of the processing industry because it retains its characteristics flavour even during processing. It is medium bearer.

1.5.9 Kesar

The fruits are medium to large-sized (3 to 4 per kg), oblong in shape with an attractive light apricot-yellow colour. The taste is very good and sugar/acid blend is excellent. It is moderate cropper but biennial in bearing. It is famous cultivar of Gujarat.

1.5.10 Bangalora

This is one of the most widely cultivated, mid season cultivar of southern India. It is heavy yielder and one of the few regular bearing cultivar of mango.

The fruits are large-sized (2 to 3 per kg) and very typical in shape, i.e. oblong (bottle necked towards the base) with a prominent curve and beak. The fruits are attractive and have apricot yellow colour. The skin is thick and keeping quality very good. The fruit quality is relatively inferior but is preferred by the processing industry because of its dependable regular supply.

1.5.11 Neelum

This is yet another heavy yielding and highly regular bearing commercial cultivar of south and the fruit quality is relatively more acceptable than Bangalora. The fruits are medium in size (4 to 6 per kg) and the shape is ovate-oblique (roundish). The sinus is somewhat prominent and the beak distinct. The colour is orange-yellow and the taste is somewhat good, with an acidic blend. This cultivar has a wide adaptability and reaches the northern market late in season, i.e. end of August to beginning of September. Keeping quality is fairly good.



Neelum

1.5.12 Swarnarekha

This is one of the few table cultivars of commerce which have highly coloured fruits of attractive pinkish red. This appears early in the northern markets, i.e. about the last week of April. The fruit size is medium (4 to 6 per kg) and the shape is ovate-oblong. The flesh is somewhat fibrous and the taste is good with an acidic blend. The bearing is moderate but biennial.

1.5.13 Banganpalli

This is yet another of the most widely cultivated cultivars of the south which is sent to the northern markets very early in the season (i.e. towards the end of April), even when it has not attained proper maturity. It is good in taste if tasted towards the later half of May. This is also known as “Baneshan” in the south and “Safeda”



Banganpalli

in the north. The fruits are large size (2 to 3 per kg) and the colour is very attractive golden yellow, with a very smooth skin. The shape is obliquely oval. The bearing is moderate and fairly regular.


1.5.14 Mulgoa

This is an excellent late cultivar of the south but the bearing is rather light and biennial. The fruit size is large (2 to 3 per kg) and shape roundish oblique, with a sunken basal cavity. The taste is very sweet and flavour delightful. Two strains red and white are reported.

1.6 HYBRIDS

Besides the above varieties few promising hybrids have been released from different stations are given in the **Table -2**.

Table 2: Different mango hybrids and their parents.

Centre	Hybrids	Parents	Characteristics
IARI New Delhi	Amrapali	Dashehari x Neelum	Dwarf, regular bearer, medium size fruit, high β -carotene content
	Mallika	Neelum x Dashehari	Semi vigorous, regular bearer, fruit large, high β -carotene content, better keeping quality 
IIHR, Bangalore	Arka Aruna	Banganpalli x Alphonso	Dwarf, precocious, medium and regular bearer, fruits large, fibreless, good flavour, free from spongy tissue
	Arka Anmol	Alphonso x Janardan Pasand	Semi-vigorous, regular bearer, fruits medium, fibreless, good keeping quality, free from spongy tissue
	Arka Neelkiran	Alphonso x Neelum	Semi-vigorous, late, fruits medium, good colour, fit for export
	Arka Puneet	Alphonso x Banganpalli	Semi-vigorous, heavy and regular bearer, fruits medium, fibreless, good keeping quality, free from spongy tissue
RFRS, Kodur, Andhra Pradesh	Au-Rumani	Rumani x Mulgoa	Prolific, regular bearer, fruits similar to Rumani in appearance, fibreless, good flavour
	Neeleshan	Neelum x Baneshan	Fruits medium, fibreless, pleasant flavour, regular bearing, good for canning

	Neelgoa	Neelum x Pera Mulgoa	Regular bearer, fruits skin to Neelum in shape and colour but Mulgoa in size, fibreless, moderately juicy
	Neeluddin	Neelum x Himayuddin	Medium tree, regular bearer, fruit small to medium, fibreless, juicy with characteristic flavour
RFRS, Ananthapuram	Swarnajehangir	Chinnaswarna rekha x Jehangir	Prolific bearer, fruits medium, fibreless, juicy, sweet.
	No. 2/2	Neelum x Banganpalli	Regular bearer, good quality fruits
	No. 2/7	Chinnaswarna rekha x Neelum	Dwarf, regular bearer, good fruit quality
RFRS, Paria, Gujarat	Neelashan	Neelum x Baneshan	Dwarf, regular bearer, fruits medium to large, flavoured, good quality
	Neeleshwari	Neelum x Dashehari	Dwarf, regular bearer, good fruit quality
	Neelphanso	Neelum x Alphonso	Dwarf, fruits medium, not attractive, TSS and Vitamin C high
Periyakulam, Tamil Nadu	PKM-1	Chinnaswarna rekha x Neelum	Regular bearer, fruits medium
Sabour, Bihar	Mahmud Bahar	Bombai x Kalapadi	Strudy and medium tree, regular bearer, fruit small, fibreless, good quality.
	Sundar Langra	Langra x Sundar Pasand	Semi-vigorous, spreading tree, regular and moderate bearing, fruits large, shape like Langra, moderately flavored, fair keeping quality

Sub Tropical Fruits

	Alfazli	Alphonso x Fazli	Tall tree, regular bearer, fruits large, fibreless, free from malformation and fruit fly
	Prabha Sankar	Bombai x Kalapadi	Tree medium, regular bearer, fruit resembles Bombai, but mature 15 days later than Bombai
	Sabori	Gulabkhas x Bombai	Tree semi-vigorous, regular bearer, fruits very sweet and fibreless
RFRS, Saharanpur (U.P.)	Hybrid-1	Dashehari x Totapari	High yield and good fruit quality
	Hybrid-2	Dashehari x Totapari	High yield and good fruit quality
	Hybrid-3	Dashehari x Fajarizafrani	High yield and good fruit quality
RFRS, Sangareddy (A.P.)	Au Rumani	Rumani x Mulgoa	Regular and heavy bearer, fruits round, sweet
	Manjira	Rumani x Neelum	Precocious, regular and prolific bearer, fruits medium, fibreless, sweet
RFRS, Vengurla, Maharashtra	Ratna	Neelum x Alphonso	Moderately vigorous tree, regular and precocious bearer, attractive fruit shape, size and colour, good quality, medium size, free from spongy tissue
	Sindhu	Ratna x Alphonso	High yielding, regular bearer, stone very thin and non viable, deep orange in colour, good quality, free from spongy tissue

1.7 PLANTING

After marking the places for the plants, pits of desired size are usually dug out during summer months. To keep the plants in the middle of the pit, planting board must be used, digging of pits is very essential. One metre deep and one

metre in diameter pits should be dug. Top 30 cm soil should be kept on one side and bottom 70 cm sub-soil should be kept on another side and the top soil is used for refilling the pits when mixed farmyard manure.

The distance of the planting in mango depends upon a number of factors such as locality, varieties to be grown and soil fertility. The square system is most commonly followed in the mango. Seedling mangoes which attain a much bigger size need more spacing than the grafted trees. Within grafted varieties certain varieties like Langra and Chausa being more spreading, require more space than Dashehari which has smaller size trees. For high density plantation few of released hybrids eg. Amrapali and Mallika etc. are planted which requires less spacing and accommodates more number of plants, however, Dashehari cultivars is also used in high density plantation. The increase in yield per hectare was 2.5 times more in high density plantation than that of the low density orchards.

Distance between plants (m)	Number of plants/10000 m ²
2.5 x 2.5 m	1600
3.0 x 2.5 m	1333
9 x 9 m	123
10 x 10 m	100

There are two planting seasons for mango i.e. spring (February - March) and monsoon (August - September). The later season gives better results, particularly in the dry and arid areas where intense summer heat of May - June results in heavy mortalities among the spring plantings.

Check Your Progress Exercise 1

Note: a) Space is given below for the answers.

b) Compare your answer with that given at the end of the unit.

1. Which hybrids were developed by IIHR, Bangalore ?

.....

2. What are the fruit characteristics of Alphonso and Amrapali varieties ?

.....

3. What are the main products of mango fruits ?

.....

-
4. Which species of mango bears non-edible and wild fruits ?
-
-
-

1.8 PROPAGATION

Almost all mango varieties are monoembryonic, except a few are polyembryonic. Seedling trees carry enormous variations, therefore, vegetative (Asexual) / propagation is a must. Sexual method of propagation only used to develop new hybrids in mango. Various methods of propagation were described one by one as below Asexual / Vegetative.

1.8.1 Inarching

It is still the most important commercial method of vegetative Asexual / propagation. In this method, the scion remains attached to the parent tree till the union is completed and the stock plant are raised in pots and placed on raised platforms are brought in contact with the scion shoots. The diameter of the rootstock and the scion should be the same. A slice of bark along with a thin piece of wood about 4 cm long is removed from matching portions of both the stock and scion. They are then brought together making sure that their cambium layers make contact at-least at one side. These grafts are then tied firmly with polythene strip. Both stock and scion plants are watered regularly to hasten the union. The union is complete in about 2 to 3 months. Then the scion is detached from the mother plant by giving a sharp cut. It is done in the July - August.

1.8.2 Layering/Cutting/Budding

Mango can also be successfully propagated by layering (air layering (goottee), pot layering and stooling), cuttings (easy to root when taken from seedlings not from mature mango tree) and budding (patch, shield and forkert methods). However, at present mango is not commonly propagated by these methods.

1.8.3 Veneer Grafting and Side Grafting

In this method scion-sticks are detached from the mother plant. The vertical flap of the rootstock bark is completely removed in veneer grafting, but in case of side grafting this flap is retained and tied over the scion. In the veneer grafting, the scion is sliced away one side in a sloping manner. The length of operation is about 5 to 6 cm or so. **In side grafting**, the lower most portion is sliced on both sides resembling to a wedge, it is properly fitted and tied with polythene strip. A very high success and further growth of grafts are achieved when scion shoots are defoliated at least 10 days before veneer grafting.

1.8.4 Stone Grafting and Epicotyl Grafting

It is an efficient, economic and rapid technique for mango propagation. The

method is being adopted on commercial scale. Mango stones are grown in polythene bags or pots containing light planting material. Very young seedlings of 10-12 days old are grafted by beheading them at 5 cm above the stone and placing the splice or wedge shaped defoliated scion in the vertical split. The graft is tied with polythene strip properly. The graft is kept under partial shade. They are watered regularly. One year old grafts are ready for planting. This technique is successfully adapted from August to September under sub tropical climatic conditions. Under moist tropical climate it is done before the start of heavy monsoon.

1.8.5 Preparation of Scion and Rootstock

Mother trees from where the scion is to be taken should be healthy vigorous and have sufficient record of good bearing. Before the actual grafting is done, the scion should be prepared carefully. For this, the healthy shoots of the last mature flush having plump terminal buds are selected. These shoots are defoliated 7 to 10 days before they are detached from the mother tree for grafting. For raising the rootstocks the stones are extracted from the full ripe fruits. As the mango seeds (stones) lose their viability in a short period, so they are sown quickly. They are sown in flat beds which are mixed with compost or farmyard manure. One year old seedlings are used for grafting.



Scion preparation

1.9 NUTRITIONAL REQUIREMENTS

Mango grows well even in poor soils because of its deep root system. Nutritional requirements of the mango falls two categories *viz.* non-bearing stage and bearing stage which may also varies with the type of soil and age of the tree.

1.9.1 Non-bearing Trees

This stage extends from the planting of the tree in the orchard until it begins to yield fruits. The young trees need to be given liberal doses of nitrogen, calcium, phosphorus, and potassium. During this period, nitrogen is particularly needed in rather heavy quantities to support healthy and fast growth. These needs can be met roughly if N, P and K are applied at the rate of 50-100 g, 40-80 g and 100-200 g each year to plant with 40 to 80 per cent derived from organic source.

1.9.2 Bearing Trees

To maintain optimum vegetative growth from year to year and to ensure regular cropping with superior quality fruit proper manuring for nutritional requirement at this stage is required. For sufficient fruit bud differentiation

and for getting proper flowering every year, proper nutrition should be provided to the bearing trees. Manuring of mango is therefore a quite complex problem. Following fertilizer schedule is recommended for mango trees.

Table 3: Fertilizer schedule for mango trees.

Tree age (years)	FYM (kg)	Nutrients (g)		
		Nitrogen	Phosphorous	Potassium
1 – 3	5 – 20	50 – 100	40 – 80	100 – 200
4 – 6	25 – 50	100 – 200	80 – 100	200 – 400
7 – 9	60 – 90	200 – 250	120 – 160	400 – 600
10 & above	100	250	160	600

The above doses are for the “Off” year of crop. During the “On” year apply one additional kg of CAN in June. Apply the whole quantity of farmyard manure and phosphatic fertilizers in December. Apply all nitrogen and potash in February. During “On” year, split the nitrogen dose into two parts, first part is given at the time of flowering and the remaining half in the month of June.

1.10 CULTURAL PRACTICES

Different cultural operation in mango has been described below one by one:

1.10.1 Training and Pruning

The training of mango plants in the initial stages is very essential to give them proper shape. At least 75 cm of the main stem should be kept free from branching and the first leader of main branch should be allowed after that. During first four years of orchard life, the mango plants need not to be given any pruning except the removal of dead or diseased branches. After the trees are well grown up, the criss-crossed or too close branches underneath the main limbs which remain under perpetual shade should be removed.

1.10.2 Top Working

The old unproductive and inferior seedling trees which are found in large number everywhere can be rejuvenated and improved by the process of top working. Conversion of inferior trees into superior varieties of good performance, not only improves orchard performance but increase the growth of mango trees in the shortest time.



Crop

1.10.3 Interculture

Interculture of mango orchards is necessary not only to remove the weeds which compete for water and nutrients but also to ensure aeration. It is so essential for the proper development of roots and shoots. Interculture may help in reducing the insect-pest population by killing them physically. Frequency and the time of intercultural operations will vary with the age of the orchard. Hoeing should be done before onset of rains, after the rainy season and in the first week of December to check run off losses and facilitate maximum intake of water into the soil. It will also suppress the weed growth and to check the population of mango mealy bug, respectively.

1.10.4 Irrigation

Irrigation should be given depending upon the type of the soil, climatic condition, especially rainfall, and its distribution and age of the trees. Irrigation requirements of young and non-bearing trees are different from those of the bearing trees. The newly planted young mango trees were irrigated twice a week in hot weather for its rapid growth. The young non-bearing trees must be irrigated at regular intervals.

During the period of two or three months preceding flowering season, profuse irrigation is advisable for bearing trees. A mango tree should receive irrigation according to its needs which in turn would depend upon several factors such as soil structure, climatic conditions, variety, rootstock, and age of the tree.

1.10.5 Intercropping

Intercropping should always be done in the initially few years of non-bearing period in between the vacant land of mango orchards. The cultivation of harmless intercrops like fodders, farm crops, vegetables and pulses preferably of leguminous type are beneficial. Instead of intercropping, temporary quick growing fruit trees can be grown as fillers which are removed when the mango trees assume big size. Papaya, peach, plum, phalsa are grown as fillers.

1.11 INSECT-PESTS AND DISEASES

1.11.1 Insect-pests

The list of pests attacking mango is long which make serious attacks during one season or the other. A description of major insect-pests along with their control is given below:

1.11.1.1 Mango Hopper (*Amritodus atkinsoni*)

This is the most damaging insect during the flowering season. Until February, the hoppers remain in hiding under the bark crevices and become active during flowering period. The nymphs and adults both are damaging, they suck the sap from tender shoots and panicles. The panicles wither away and the fruit set is adversely affected. The young fruits and dried inflorescence fall to the ground as the summer winds blow. Its incidence is very high in overcrowded and neglected orchards.

Sub Tropical Fruits

The insect can be controlled by spraying the trees at the time of panicle emergence and again at the fruit set stage with Carbaryl (0.15 %) or Malathion 50 EC (0.15 %) or 350 ml of Thiodan in 250 lt. of water.

1.11.1.2 Mango mealy bug (*Drosicha mangiferae*)

This pest does a lot of damage during the flowering and fruiting stage. The female lays eggs during May under soil clods, around the tree trunk, upto a depth of 5-15 cm. The nymphs emerge in December-January and starts climbing up the tree where they congregate together and suck juice from young shoots, panicles and flower pedicels. The affected parts dry up and yield is reduced substantially.

Once the pest manages to reach the top of the plant, its control becomes rather difficult. Damage from the mealy bugs can be avoided if the eggs are destroyed by digging around the trunk during hot months. Stick bands (grease and coal tar in the ratio bands of 1:2, rosin and castor oil in the ratio 4:5) or slippery bands of alkathene, 30 to 45 cm wide should be applied around the tree trunk about 30-45 cm above the ground level during December. However, before applying these bands, care should be taken to plaster all the bark crevices with mud so that the nymphs may not climb up from underneath such bands. Alkathane bands need to be wiped clean at least once a week and the nymphs on the lower edges may be collected and destroyed in kerosene oil or in any strong insecticide. In the case of nymphs have climbed up the tree, these should be controlled at the earliest by spraying carbaryl (0.2 %).

1.11.1.3 Mango stone weevil (*Cryptorhynchus mangiferae*)

This is most prevalent in the southern parts of the country and is reported to be specific to sweet cultivar of mango. Grub of this insect damage both the pulp and the cotyledons of the stone. The eggs are laid in partly developed fruits. The grubs travel through the pulp and enter the seeds where they pupate and the adults come out piercing through the stone and the pulp.

General cleanliness in the orchard and destroying the adults in the bark crevices and holes, during August has been reported to be helpful. Infested bark should be washed with kerosene emulsion.

1.11.1.4 Fruit fly (*Dacus dorsalis*)

This a serious pest as the affected fruits becomes unfit for consumption through the feeding of the maggots in the flesh. The fly lays its eggs in clusters of 150-200 under the skin of the fruit juice before ripening. The affected fruits begin to rot and drop down.

The control lies in prompt collection and destruction of the damaged fruits in hot water or by burying them deep in the soil. Poisoned baits placed in wide mouthed containers @ 10 per hectare are helpful in checking the incidence of fruit fly. The formulations containing



Fruit Fly

100 ml emulsion of Methyl euginol 0.1 per cent and Malathion 0.1 per cent are also effective.

1.11.1.5 Stem Borer

This pest tunnels through the main trunk or its branches, weakens the plant and in extreme cases the plant may die. Its presence can be identified by dry hard balls of excreta, emerging from the tunneled portion.

The control lies in cleaning the tunnels with a hard wire, pouring kerosene oil, petrol or formalin and subsequently, closing the entrance of the tunnel with mud after plugging it with cotton wool soaked in any of the above substances.

1.11.1.6 Shoot Borer

The damage is caused by caterpillars which enter the young shoots from the terminal end and bore down to a depth of 8-10 cm. The affected shoots wilt and dry up.

It can be controlled by 1 or 2 sprays of Carbaryl (0.2 %) during the emergence period of vegetative flush.

Other insect-pest which causes damage to mango crop is red ants, bark-eating caterpillar, leaf-cutting weevil, shoot-gall maker and leaf-gall maker.

1.11.2 Diseases

Major diseases which can cause damage to mango are powdery mildew and anthracnose. Other diseases which cause damage are sooty mould, pink disease, stem end rot and bacterial spot in certain areas.

1.11.2.1 Powdery Mildew (*Oidium mangiferae*)

This fungal disease is widely prevalent in all mango growing regions and can even destroy the crop completely. Its incidence is favoured by humidity accompanied by cloudy weather and low night temperatures during the period between panicle development and fruit set. It is characterized by the appearance of grayish white powdery bloom on the flower buds and fruitlets. Quite often the entire panicle may be affected. Such panicles get dried and turn black, resulting in total failure of the crop. In serious cases, even young leaves and shoots may be affected.

The disease can be kept under control by spraying 0.1 per cent karathane or 0.25 per cent wettable sulphur once before flowering, again during flowering and then after fruit set. If need be arises one more spray should be given after 10-15 days. The timing of the first spray is very important which must be given as soon as the growers observe the very young inflorescence stalks emergence out from the flowering buds. Quantity of spray suspension will depend upon the age and size of the tree.

1.11.2.2 Anthracnose (*Colletotrichum gloeosporioides*)

This fungal disease is also of wide occurrence, more especially in humid and high rainfall areas. The leaves, shoots, inflorescence and the fruits are all

affected by it. The characteristic symptoms are the appearance of black necrotic areas on the affected parts. The affected young shoots finally show die back symptoms. The diseased young fruitlets drop down and if the fungus attacks the fruits at maturity the disease is enhanced by the storage.

As the fungus survives on the dead or dried twigs, these should be pruned and burnt at the earliest. The disease can also be controlled by spraying Bordeaux mixture (3:3:50), Blitox (0.3 %) or Bavistin (0.1 %) thrice a year i.e. February, April and September.

1.11.2.3 Bacterial Canker

The earliest symptoms of this disease, on the leaves and the fruits are the appearance of small dark green water soaked spots which finally assume the shape of raised black spots. These areas on the fruits develop longitudinal cracks and gum starts oozing out from the splits. Seriously affected fruits drop down and the yield may adversely be affected. Affected fruits are unattractive and unmarketable.

This disease is widely prevalent and the infection increases with recurrent rainy weather. However, all the cultivars are not affected equally. In dry seasons, the incidence is not noticed. Although no satisfactory control measure is available as yet, Bordeaux mixture (4:4:50) may be applied at fortnightly interval from the first appearance of the diseases on the leaves.

1.12 PHYSIOLOGICAL DISORDER

1.12.1 Alternate Bearing

It refers to heavy fruiting in one year “On year” followed by less or no fruiting in the following year “Off year”. It is a very serious and old problem in mango especially in the North Indian varieties. Various causes like varietal differences, growth habit, crop load, cultural practices, sex-ratio, insect-pests and diseases etc. have been attributed to the occurrence of biennial bearing in mango. Besides, there endogenous level of growth hormones, reserve metabolites and nutrient status has also been considered responsibility for the bienniality in mango. Biennial bearing is a characteristic of a variety and some workers emphasized that this is due to the genomic constitution of the particular variety. Most of the commercial varieties of North India eg. Dashehari, Langra and Chausa are prone to biennial bearing but varieties of South India like Totapari, Neelum and Bangalora are regular bearer.

Application of deblossoming, pruning, better cultural practices and exogenous plant regulators treatments have shown good results in the recent years. A highly regular bearing variety “Amrapali” has been evolved by crossing “Dashehari x Neelum” by the Scientists at IARI, New Delhi. The concentration of ethephon 200 ppm coupled with 0.1 per cent urea was found effective in inducing regular flowering over the year.

1.12.2 Mango Malformation

You might have observed a bunchy look at the tips of the branches of mango. These are called mango malformation. It is a disorder. This disorder was first

observed in 1891 in Bihar, India. It is also prevalent in other mango producing countries like Pakistan and Egypt. It affects both the vegetative and floral parts of a mango tree. Malformed vegetative shoots, assume the appearance of bunchy top. Of these two types, floral malformation causes heaviest losses. The malformed panicles mostly produce sterile male flowers and hence no fruit set on these panicles. The disorder is wide spread in the mango orchards of northern and western India. It is not observed in the Southern India. Varieties like “Bahaduran”, “Alib” and “Illaichi” are resistant to mango malformation. Up till now, exact causal agents of this disorder are unknown. This disorder is caused perhaps due to environmental factors, insects (mites), viruses, fungus, mangiferin, malformins or physiological (hormonal imbalances). Several management measures recommended by various workers include use of anti-malformins (glutathione and ascorbic acid), deblossoming or spray of naphthalene acetic acid. Spray of NAA @ 200 ppm at the time of fruit bud differentiation (October – November in Northern India) is found beneficial. Pruning of the malformed panicle and shoots is only other control measure.

1.12.3 Black Tip

It is purely a non pathogenic physiological disorder. There is development of a small etiolated area at the distal end of the fruit, which gradually spreads and turns nearly black and covers the tips completely. Black tipped fruits fetch very low price in the market. This disorder is quite common if the fruiting orchards fall in the direction of wind from the brick kiln side.

This disorder can be avoided by allowing brick kilns only at a distance of at least 1.6 km in the east and west and 0.8 km in the north and south of the orchard taking into consideration the usual wind direction during the fruiting season. Spray of sodium hydroxide and washing soda solution which does not contain boron is beneficial in controlling brick tip.

1.12.4 Spongy tissue

This is a serious disorder affecting mango production, particularly of Alphonso variety, which is a prized variety for export. This disorder accounts for about 30 per cent loss in Alphonso production annually. In this disorder a non-edible, sour, yellowish and sponge like patch with or without air pocket develop in the mesocarp of the fruit during ripening. Its intensity varies from a small patch to the whole fruit pulp. This malady has become more complicated since the affected fruit presents healthy external appearance. Affected tissue is visible only when the ripe fruit is cut and the affected fruit have a bad odour and become unpalatable. The intensity of disorder varies with variety, size of fruit, soil moisture, geographical location, tree aspect, rootstock and time of harvest. The incidence is more in large size fruit and when the harvesting is delayed.

Mulching, cover cropping and fruit harvesting at 3/4th size are recommended practices to escape from this problem.

1.13 HARVESTING

As mango is highly perishable fruit. Its harvesting at proper stage of maturity

Sub Tropical Fruits

is of fundamental importance. The criteria for judging mango maturity are slight yellow colour development on the shoulders, when one or two ripe fruits fall from the plant naturally (tapka) and when the specific gravity of fruits ranges between 1.01 and 1.02. The fruits are usually harvested when slightly yellow in colour, fully mature but unripe. The fruits are not harvested by shaking the branches which results in internal breakdown of the flesh on falling and spoils the appearance also. A bamboo hand tool called mango picker is always used for harvesting of mango.

The grafted plants which are relatively short lived and less vigorous, bear fruits of highly uniform size and good quality. These start bearing at the age of 5 years (15-20 fruits) and the optimum crop starts from the 10th year when each year yields about 400 to 600 fruits per plant. During an “On year”, a well looked after mango tree of 20 to 40 years bears a crop of about 1000 to 3000 fruits per plant. Seedling trees usually take about eight years to come into bearing, but their productive life is much longer.

1.14 STORAGE

The mango is climacteric fruit and to avoid the glut in the market, proper storage is absolutely essential. The processing units cannot utilize the entire produce at a time and proper storage conditions become vital. Storage at optimum low temperature has effective in increasing storage life. The fruits treated with 4 per cent wax emulsion can be kept at room temperature for 12 days and 35 days in cold storage ($13^{\circ}\text{C} \pm 1$ and 85-90 % humidity) after packing in perforated polythene bags.

1.15 PACKAGING AND TRANSPORTATION

The harvested fruits should first be graded according to size and appearance. Proper packaging is an essential pre-requisite for maintaining good appearance and quality of the produce on reaching the marketing centre. The fruits are packed in bamboo baskets of 50 to 100 fruits capacity, sometimes straw is utilized as a cushioning material to avoid bruising injury to the fruits.

For local markets the fruits are packed in simple manner whereas, for distant markets the fully mature but unripe fruits are packed in CFB boxes of 5-10 kg filling capacity of proper size. For this purpose individual fruits are wrapped in tissue paper and cushioning is provided by paper shavings.

1.16 PROCESSING

Raw mango fruits are utilized for products like chutney, pickles, amchoor, green mango beverage, etc. whereas, the ripe ones are used in making pulp, juice, nectar, squash, leather, slices, etc.

Check Your Progress Exercise 2

Note: a) Space is given below for the answers.

b) Compare your answer with that given at the end of the unit.

1. Which is the commercial method of propagation of mango ?

.....
.....
.....

2. What are the maturity indices of mango ?

.....
.....
.....

3. What are the main causes of mango malformation ?

.....
.....
.....

4. Write a short note on Mango hopper and Spongy tissue.

.....
.....
.....

1.17 LET US SUM UP

In this unit, we have studied about the history, botany, nutritive value, area and production, soil, climatic and nutritional requirements, planting and propagation methods, cultural practices, pests, diseases and physiological disorders, harvesting, storing, packaging and transportation of mango fruits. You have also study about the different varieties of mango and the commercial varieties of one region do not do so well when grown in other areas. Mango has 1st Position in production and area than other fruit crops and it has titled “King of Fruits”. You have also study the popular products of mango such as Squashes, juices, nectars, syrup, jam, jellies, canned mango, slices and pulp from mango fruits under this unit.

1.18 KEY WORDS

- Physiological disorder** : Disorder is due to abnormal environmental conditions, improper nutrition and without involvement of primary parasite.
- Spongy tissue** : Development of bad odour with sponge like mesocarpic tissue having air pocket due to inactivation of hydrolytic enzyme by convective heat.

- Climateric fruit** : Fruits in which the respiration rate is higher at maturity and peaks suddenly after harvest.
- Inflorescence** : The branch system of the floral region bearing the group of flowers i.e. arrangement of flowers on the stalk.

1.19 FURTHER REFERENCES

1. Singh, L.B. (1960). **The Mango - Botany, Cultivation and Utilization**, Leonard Hill, London.
2. Singh, R.N. (1978). **Mango**, ICAR, New Delhi.
3. Singh, S., Krishnamurthy, S. and Katyal, S.L. (1967). **Fruit Culture in India**, ICAR, New Delhi.

1.20 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

1. The hybrids developed by the IIHR, Bangalore are “Arka Aruna”, “Arka Anmol”, “Arka Neelkiran” and “Arka Puneet”.
2. The raw fruits are used for the preparation of chutneys and pickles, whereas the ripe fruits are used in making delicious squash, juice, nectar, syrup, jam and jelly. Canned mango slices, and pulp are the other popular products.
3. The species which bears wild and non-edible fruits are *M. sylvatica* and *M. coloneura*.

Check Your Progress Exercise 2

1. Inarching and Veneer grafting are the commercial methods of propagating a mango.
2. Development of slight colour on the shoulders, naturally fallen of one or two ripe fruits (tapka) and when the specific gravity of fruits ranges between 1.01 and 1.02 are the few maturity indices for the mango harvesting.
3. The main cause of mango malformation is environmental factors, insects (mites), viruses, fungus, mangiferin, malformins or physiological (hormonal imbalances).
4. Mango hopper is the most damaging insect which attacks during the flowering season. The nymphs and adults suck the sap from tender shoots and panicles. The panicles wither away and the fruit set is adversely affected. The young fruits and dried inflorescence fall to the ground as the summer winds blow. More prevalent in overcrowded and neglected orchards. It can be controlled by spraying the trees at the time of panicle

emergence and again at the fruit set stage with Carbaryl (0.15 %) or Malathion 50 EC (0.15 %) or 350 ml of Thiodan in 250 litre of water.

Spongy tissue affects particularly Alphonso variety, which is a prized variety for export whose loss ranges upto 30 per cent. A non-edible, sour, yellowish and sponge like patch with or without air pocket develop in the mesocarp of the fruit during ripening. Its intensity varies from a small patch to the whole fruit pulp, however sometimes the affected fruit presents healthy external appearance. Affected tissue is visible only when the ripe fruit is cut and the affected fruit have a bad odour and become unpalatable. The intensity of disorder varies with variety, size of fruit, soil moisture, geographical location, tree aspect, rootstock and time of harvest. The incidence is more in large size fruit and when the harvesting is delayed. Mulching, with polythene or dry grass etc. cover cropping and fruit harvesting at 3/4th size are recommended practices to escape from this problem.

