CHAPTER

3

TROPICAL FRUITS AND THEIR CULTIVATION

OBJECTIVES

After studying this chapter, you will be able to:

- Identify tropical fruits, describe their importance and their main production sites
- Describe major cultural requirements of tropical fruits
- Identify major problems of tropical fruits describe their management
- Enlist major insect-pests and diseases of tropical fruits and their integrated management strategies
- Start growing these fruits after examining soil and climatic conditions of your locality
- Start business of import or export of these fruits

INTRODUCTION

In the previous chapter, you have learnt about temperate fruits, their production problems and management. In this chapter, you will come to know about tropical fruits i.e. the fruits which are grown in areas, which experience warmer climate throughout the year. This type of the climate prevails in the southern states of our country where there is no much variation in the winter or summer temperature. The major tropical fruits grown in India are mango, banana, papaya, pineapple, sapota, and guava. These fruits contain ample amount of carbohydrates, proteins, vitamins and minerals and thus protect our body from several ailments. Few fruits like sapota are very useful for patients and few (e.g., guava, papaya) are good for getting rid of constipation. Guava is a very rich source of vitamin C as well. In this chapter, we will discuss the cultural requirements of fruits, major production problems and their management.

Fruits of Mallika

What are tropical fruits?

The fruits, which are cultivated successfully in areas which experience high temperature during winter as well as summer are called as tropical fruits. Most of the world's tropical fruits are grown in southern hemisphere which has over 80 per cent terrestrial area near to oceans.

MANGO

Mango *(Mangifera indica* L.), the choicest fruit of India, is said to be the king of fruits. No other fruit is so intimately connected with the history, literature and life of Indians as mango. It is an outstanding source of vitamin A, a good source of vitamin C, apart from normal minerals and other vitamins. In India, it occupies the same position as apple does in temperate countries and grapes in certain regions.

Mango is indigenous to Indo Burman region. It belongs to family Anacardiaceae and genus *Mangifera* with basic chromosome number, X = 20. There are 41 species in genus *Mangifrea*, of which *M. indica, M. caseia, M. sylvatica* and *M. odorata* produce edible fruits.

Soil and climatic requirements

Mango can be grown in a variety of soils but clay-loam, well-drained soils with a pH range of 5.7 to 7.5 are considered to be the best for its cultivation. It has very deep tap root system and thus the presence of any hard pan or calcareous layer in the sub-soil is harmful. Similarly, black cotton soils are also considered unsuitable for commercial mango orcharding. A temperature range of 24-27°C throughout the growing season is the best for its cultivation. It is highly sensitive to frost especially at pre-bearing stage. Its cultivation is limited in areas located above 1,000 m mean sea level. Rainy and cloudy weather at flowering time is considered the limiting factors for its cultivation as these conditions may favour the incidence of many insect-pests and diseases.

Commercial varieties

Fruits of Pusa ArunimaIn India, there are several varieties of mango but only 10-12 are grown commercially. For example, Dashehari, Langra, Chausa and Bombay Green are grown commercially in north, Banganpalli/Baneshan, Neelum, Totapuri in south, Alphonso and Kesar in west and Langra, Himsagar, Zardalu, Kishenbhog, etc. in east. On the basis of embryos, mango varieties have been classified as monoembryonic (Most of the varieties) and polyembryonic (Bapakai,Vellary, Chandrakaran,Kurrukan, Goa, Olour, Carabao, Paho, Peach, Apricot, Strawberry etc.)

Fruits of Pusa Arunima

Some institutions have developed some interesting hybrids. For example Indian Agricultural Research Institute, New Delhi has developed Amrapali, Mallika, Pusa Surya and Pusa Arunima, Pusa Pratibha, Pusa Shresth, Pusa Pitambar, Pusa Lalima etc.. IIHR, Bangalore has developed Arka Puneet, Arka Anmol, Arka Neelkiran, RHRS, Vengurle has developed Ratna and Sindhu (Seedless) and CISH, Lucknow has developed Ambika. All these hybrids have one or the other special characteristics.

Plant propagation

Mango can be propagated both by sexual and asexual means. Rootstocks are propagated by seeds and stooling. Scion varieties are propagated by veneer grafting, stone grafting and soft-wood grafting in different parts of India.

Veneer grafting: The preparation of scion is the most important factor for getting high success by veneer grafting. For this, disease - free, healthy mother plant should be selected. Scion can be prepared from 4-6 months old round shoots. Defoliation of the selected shoots about a week before the grafting is essential for forcing of buds. One-year-old seedlings (pencil thickness) are considered most suitable for using as rootstock. For grafting purpose, 4-6 inch scion should be taken from mother plant and then a slanting cut is given both on the stock and the scion and then scion is fitted on the cut of stock and wrapped with 150 gauge alkathene tape of one inch width. When the scion begins to sprout, the upper part of stock is cut step-by-step. All the sprouts below the graft union should be removed regularly.


A view of side veneer grafting in mango

The best time for grafting under north Indian conditions is March-April. It can be done in May-June also but success is limited owing to high temperature during these months. The added advantage of this method over inarching is that one can prepare his own plants from the desired scion variety, obtained from anywhere, within the country or abroad. Moreover, the orchards established with inferior varieties or old seedling trees can be converted into superior varieties by top-working. In top-working, old/inferior plants are headed back up to secondary branch level during February. The new shoots arising from the beheaded branches are 'Veneer grafted' with a desired variety during June-July. Such plants will start bearing within two years of grafting.

Stone grafting: In addition to inarching (now hanging inarching) and veneer grafting, epicotyl (stone) grafting is the successful propagation method of mango in region with moderate temperature and high relative

humidity. In this method, germinating seeds of less than two-weeks-old are wedge or splice-grafted with a mature scion. A slanting cut of 2-3 cm length is given on 2-week-old epicotyl with a matching cut on the proximal portion of the scion and then these are tied firmly with a alkathene strip. In wedge grafting, the selected 2-weeks-old seedlings are headed back by retaining 6-8cm long stem with the stone. The longitudinal transverse cut running 4-6cm centrally down on the beheaded rootstock is made for fixing a wedge shaped scion prepared by giving a slanting cut from both sides on the lower side of scion stick. The scion stick is then inserted into the saddle-like cut made on the rootstock, pressed properly and tied with the help of 150 gauge - polyethylene strip so that cambium tissues of the rootstock and scion stick and overlap each other.

Mango trees are commercially propagated by stone grafting in Konkan region of India. In north, side - veneer grafting is best while in west, softwood grafting is better.

In some localities like south and western part of India, soft-wood grafting is followed for its commercial propagation.

Planting distance and time

Planting distance varies from variety-to-variety and locality-to-locality. In general, a planting distance of 10-12m is recommended for commercial varieties like Dashehari, Langra, Chowsa, Alphonso, Banganpalli etc. However, for Amarpali, a planting distance of 2.5 x2.5 m is recommended with annual pruning after harvest. Usually, square system of planting is followed but, triangular system has been found useful for Amrapali. Pits of 1 x 1 x 1 m size are dug out and kept open during May, which are refilled by the end of the June with the mixture of top soil and Farm Yard Manure in the ratio of 1: 1. The best time for planting mango is the monsoon season. However, in areas of heavy rainfall, planting should be done at the end of raining season. The planting can be done throughout the year in areas having mild type of tropical climate.

Manures and fertilizers

The application of manures and fertilizers in mango depends on several factors like soil, climate of the area, variety, nutrient status of the soil, etc. It is always advisable to get the soil tested before application of fertilizers. In general, ammonium sulphate, super phosphate arid sulphate of potash should be mixed in the ratio of 1: 3: 1 with the following quantities of farm yard manure (FYM) should be applied as given in the table below:

Age of the plant (year)	Fertilizer mixture to be applied (kg)	Quality of Farm Yard Manure (kg)
One	½	10
Two	1	20
Three	1	30
Four	1.5	40
Four	1.5	50
Six year to 10 year	2 to 2.5	40
11 year to 15 year	3 to 5	60
Above 15	6 to 10	60

Farm yard manure (FYM) is generally applied in September-October every year. In pre-bearing young plants, manuring should be done in March and June in two split doses. However, for bearing plants, half quantity of fertilizers should be applied in July after harvesting and the rest during October along with FYM. A dose of nitrogen may be given a month before initiation of flowering i.e., in the first week of February.

Mango trees should not be irrigated between October-March because plants take rest in this period. During flowering, minimum water should be applied, as heavy irrigation may result in excessive flower drop .

Irrigation

Young plants should be irrigated at weekly intervals in summer and at fortnightly intervals in winter. However, the bearing plants should be irrigated at 10-15 days interval from fruit set stage to maturity. It is, however, advised to withheld irrigation during flowering as it may result in shedding of flowers.

Intercropping and interculture

During the early years of establishment (up to 10 years of age), the vacant space between trees can be profitably utilized by growing intercrops. Apart from giving good returns, intercropping prevents weed growth, reduces nutrient loss through leaching and surface run off, and keeps harmful diseases and pests under control. Vegetables like onion, tomato, radish, carrot, beans, cauliflower, cabbage, leafy vegetables and dwarf, short duration fruit crops like papaya, pineapple, *phalsa*, strawberry etc., can easily be grown in the vacant space of a mango orchard.

Problem of alternate bearing and its management

Most of the commercial varieties of mango bear heavily in one year with very low or no crop in the following year. This phenomenon is known as alternate or biennial bearing. The year of heavy or good crop is called as "on" year and the year of low or poor crop as "off' year. As a result of this habit, a mango orchardist gets less net returns as compared to other fruit crops. However, now farmers can take a regular crop of mango by adopting the following measures:

I. Grow regular bearing varieties like Amrapali, Mallika, Pusa Arunima, Pusa Surya, Ratna, Sindhu, Arka Puneet, Arka Anmol, Arka Neelkiran etc.

2. De-blossomimg in "on" year so as to get some flowers in "off"' year.

3. Drench paclobutrazol (3.5-4.5 a.i. per metre canopy diameter) around tree trunk every alternate year. It makes the plant dwarf and regulates the cropping pattern to a greater extent.

Plant Protection

Insect-pests	**Control measures**
Mango leaf hopper (*Amaritodus atkinsonii*)	Mango hoppers can be controlled by two sprays of carbaryl (0.1%) or Diazinon (0.2%) during January-February at fortnightly intervals.
Mango mealy bug (*Drosicha mangiferae*)	Kill nymphs and females by spraying metasystox (0.2%). Follow banding of tree trunks with 30 cm wide alkathene.
Stone weevil (*Stenochytes mangiferae)*	Difficult to control, however, bagging of fruits, destruction of affected fallen fruits and disposal of refuse debris etc., can bring reduction in the insect number
Fruit fly (*Dacus dorsalis*)	Collect and destroy the affected fruits. Use baits (malathion (0.05%) + jaggery+eugenol) at 4-5 places in open containers. It attracts the adult flies, and control them effectively. Raking of soil in May-June is equally useful as it helps in the killing of pupae.
Diseases	**Control measures**
Powdery mildew *(Oidium mangiferae)*	Two sprays of karathane (0.1%) at fortnightly interval completely control this disease. One preventive spray of karathane (0.1%) as soon as cloudy weather appears during flowering time.

Anthracnose (*Collectotrichum gloeosporioides)*	Spray zineb (0.2%). However, a preventive spray of Bordeaux mixture (4:4:50) is always useful in humid areas before panicle emergence.
Gummosis (*Botrypodiploidia theobromae)*	Remove affected parts and apply Bordeaux paste. Spray copper oxychloride (0.2%).

Physiological disorders

Malformation: It is most dreaded disorder of mango in northern parts of India, the causal agent of which is still unknown. Most of the commercial varieties in sub-tropical parts of India are affected by malformation and southern parts are virtually free from it. Plants both in nursery and field are affected by this malady. The symptoms of this malady are characterized by the transformation of inflorescence into compact mass with predominating male flowers. This disease is commonly related to the prevailing environmental temperature. Panicles emerging during late-December or early-January (when the environmental temperature is comparatively low) are worst affected by malformation. The following control measures reduce the incidence of malformation:

1. Remove and burn all the affected malformed panicles and branches as and when they emerge.
2. Follow up de-blossoming in January.
3. Application of methanol leaf extract of *Ruelia tuberosa* L. 12 g leaf per litre solution reduces malformation in cv. Dashehari. However, the concentration is variety specific, which needs to be standardized.
4. Spray NAA (200 ppm) in October.

Mango malformation is the most dreaded malady of mango in north India; its causes are not yet known, however, temperature plays a vital role. De-blossoming of malformed panicles during December-January is most useful solution.

Malformed mango panicle

Powdery mildew in mango panicle

Spongy tissue: Spongy tissue disorder accounts for more than 30 per cent loss in Alphonso mango. In this disorder, a non-edible, sour, yellowish and sponge like patch develops in one part of the fruit during ripening. The fruit pulp remains unripe but the fruits look normal in external appearance. On cutting, the fruits emit bad odour and are unfit for human consumption. The precise cause of this malady is still unknown. However, recent studies indicate that fruits low in Ca content are worst affected by spongy tissue disorder and the convecteric heat of the soil adds more to this disorder. Use of sod culture, green vegetation, leguminous crop cover or mulching at pre-harvest stage are some measures to reduce this disorder to some extent.

Spongy tissue is one of the most serious disorders of Alphonso mango, which hinders its export from India.

Maturity, harvesting and yield

Depending on variety and growing environment, mango fruits take 90-120 days to reach harvest maturity. Various indices have been suggested to determine the harvest maturity of mango, e.g., change of skin colour, natural falling of some fruits from the tree (*tapka*), formation of abscission layer at pedicel joint, specific gravity of fruits (1.01-1.02), etc. Harvesting is done manually. The most useful tool for this purpose is a long bamboo pole fitted with a cutting shear and a collecting net below it at the distil end of the pole.

Yield varies widely depending on cultivars, age of tree, climatic conditions, alternate bearing, general health of the orchard, etc. In general, grafted plants start bearing at the age of 4-5 years, while seedlings may take at least 8-10 years to come to bearing stage. Initially, the grafted plant (5 years old) may bear 15-20 fruits which will increase to 400-600 fruits by the 10th year; Normally, the yield will go on increasing up to 40 years (2,500 fruits) after which it may decline.

BANANA

Fully ripe banana fingers

Banana is one of the oldest and most popular fruits. The Indo-Malayan region is believed to be the place of origin. It is a good source of carbohydrates and minerals like potassium and sodium. It is widely used as a fresh fruit, but several value added products like chips, puree etc., can also be made from it. The central core of the pseudostem is used as a vegetable, and also for manufacturing paper and boards. India ranks second among the banana growing countries after Brazil. In India, Kerala, Maharashtra and Tamil Nadu account for major share in area and production of banana.

Banana belongs to family Musaceae and genus *Musa* with basic chromosome number, X = 11. *Musa* has been divided into five groups like Eumusa (x = 11), Rhodochlamys (x =11), Callimusa (x =10), Australimusa (x = 10) and Enserte Sedis (x =9). On the basis of genomic constitution, banana has two species, *Musa acuminata* and *M, balbisiana.* All edible bananas have been developed from these two species.

Soil and climatic requirements

Banana can be grown on a variety of soils ranging from clay to sandy clay-loam. However, the best soil is medium textured soil, uniform, reasonably deep and fertile, having good internal drainage and pH between 5.5 - 8.0. Banana is essentially a humid tropical plant, coming up well in regions with a temperature range of 10 ^{0}C to 40 ^{0}C with an average of 23 ^{0}C. In cooler climate, the duration is extended, sucker production is affected and bunches are smaller. Low temperatures (less than 10 ^{0}C) are unsuitable since they lead to a condition called 'choke' or impede inflorescence and bunch development. Banana comes up well from sea level upto an altitude of 1,800 m above sea level. Banana is well adapted to areas with temperature between 21-32 ^{0}C, and annual rainfall between 1,000-2,000 mm.

Commercial varieties/clones

Based on *Acuminata* and *Balbisiana* proportion, varieties of banana have been classified as AA, AAA, AB, AAB, ABB, AAAA or AAAB groups. However, only few varieties could become commercial. The major varieties are Poovan (AAB) , Monthan (ABB) , Harichal (AAA), Rasthali (AAB), Hill Banana (AAB), Nendran (AAB), Sevazhai (AAA) and Kunnan (AB).

Plant propagation

Bananas are propagated from offshoots (suckers or keikis) or corms (bullheads). If enough buds are present, large bullheads can be halved or quartered. Planting material should be treated for nematodes.

Planting system

Square, rectangle and triangle systems are recommended systems for banana planting. For mono-cultured

cropping system, the recommended planting distance is 3.0 x 1.5 m. When intercropped with other permanent crops, the recommended planting distance is 2.4 x 2.4 m. However, it can be modified to 1.9 x 1.9 m & 1.2 x 1.2 m for high - density planting of tall & dwarf varieties, respectively.

Cultural practices

Thinning of suckers: Thinning of suckers aims at maintaining of good of vigour of the plant, obtaining desired number of plant per clump and to enhance production of good quality fruits. Thinning involves removal of unwanted suckers; normally weak unhealthy, mainly water sucker using sharp knife at the ground level, leaving one bearer, one follower and one sucker per clump at any time.

Weeding: During early years of growth, weeds should be controlled manually or using a weedicide. Weeds between rows can be controlled by using contact herbicides or by planting cover crops. As banana roots are superficial, care is taken during weeding to ensure that root damage does not occur. Weeds in between rows are controlled with herbicides using sprayer with a protective cone to the spray nozzle.

Banana bunch covered with blue polythene bag

Fertilizer application: Banana requires high fertilization due to its rapid and vigorous growth and high fruit yield. It removes nearly 250-300 kg N, 25-40 kg P and 800-1200 kg K, 150-180 kg Ca, 40-60 kg Mg and 14-20 kg S per hectare. Usually, 300 Kg N, 40-50 Kg P and 250-300 K should be given per ha.

Water management: Banana plant should be irrigated to encourage development and healthy growth especially in the early years of growth. Micro-sprinkler or drip irrigation system is recommended. Areas with frequent flash floods, construction of in-field drainage is recommended.

Wrapping of fruit bunch: To have a good quality fruit, wrapping of fruit bunches is recommended. For wrapping, strong polyethylene bag with size 75 x 120 cm is used and should be done after the shooting of inflorescence has completed.

Panama wilt affected banana plants

Plant protection

Insect-pests	Symptoms	Control measures
Corm weevil (*Cosmopolites sordidus*)	Larvae feed and tunnel the corm of plant. Affected corm is riddled with tunnels. The leaves of infected plant are dull yellow - green and floppy. Young suckers often wither and fail to develop.	Use healthy material and treat with hot water for 5-10 minutes. Good sanitation. Drench with dieldrin.
Stem borer weevil (*Odoiporus longicollis*)	The weevil bores into the stem and the leaves of infected plant turn yellow and the plant becomes susceptible to wind damage.	Good sanitation. Spray with dieldrin.
Nematode (*Radopholus similis*) and Fruit fly (*Bactrocera musae*)	The infected root turns reddish-brown and later become black. The roots become short, blackened and reduce in number	Use hot water treatment. Provide sanitation. Drench with fenamiphos. Wrap fruits with polyethylene bags.

	and thus, susceptible to wind damage. Larva feeds on the fruit. Evidence of attack is indicated by black spot on the skin.	
Diseases	**Symptoms**	**Control measures**
Leaf spot (Sigatoka) (*Mycosphaerella musicola*)	Small pale yellow or greenish-yellow streak, parallel to the leaf veins. Later the streaks darken and expanded laterally to form elliptical brown spots. The centre of each spot eventually dries upto form light grey structure, like "eyespot" or scorching appearance.	Use resistant cultivar. Spray with benomyl (0.03%).
Panama disease (Fusarium wilt) (*Fusarium oxysporium*)	Soil-borne disease. The first symptom is yellowing of older leaves or collapse of the petiole while the leaves are still green. All leaves eventually collapse and die, hanging on the pseudostem. Later, pseudostem may split.	Use resistant variety. Good sanitation. Used diseases free material.
Bunchy top	It is a viral disease. Symptoms appear as prominent dark green streaks on petioles and along leaf veins. In badly diseased plants, leaves bunch together, margins of lamina become wavy and slightly roll upwards. Banana aphid (*Pentalonia nigronervosa)* acts as vector for its spread.	• Adoption of strict quarantine measures. • Destroy infected plant material. • Control aphid by spraying metasystox or dimecron (0.01%).

Maturity, harvesting and yield

Depending on the variety, banana starts to bear fruit, 6-8 months after planting and is ready for harvesting in about 7-11 weeks later. The 'follower' plant will produce 3-4 months later, thus about four harvests from I clump per year is possible. The average yield per year for a 3 year-cycle is 12.0 tonnes per hectare for Rasthali. The general average yield is about 7 tonnes for the first year, 12 tonnes for the second year and 10 tonnes for the third year per hectare.


Papaya plant laden with fruits

PAPAYA

Papaya (*Carica papata* L.) is a widely cultivated tropical fruit of the world.

Papaya is one of the important quick growing fruit crops, which is a rich source of Vitamin A. It improves digestion and said to cure chronic constipation, piles and enlarged liver and spleen. Papain is a valuable enzyme prepared from the latex of papaya. The papaya is a native of tropical America and was introduced to India in the 16th century. It is now grown in almost all tropical and subtropical countries of the world like Australia, Sri Lanka, South Africa, Tropical America, Indonesia, Pakistan, India and Bangladesh. In India, it is largely grown in Bihar, Assam, Maharashtra, Madhya Pradesh, Tamil Nadu and Andhra Pradesh.

Papaya belfongs to family Caricaceae and genus *Carica* with somatic chromosome nunmber, 2n=24. The other important species of genus *Carica* are *C. monoica*, *C. candamarcensis, C. pentanda*.

Soil and climatic requirements

Papaya is adapted to practically any well drained soil. The plant is shallow rooted and will not tolerate excessive wetness or standing water. Well drained medium black to red loamy soils are suitable, and does not thrive well in calcareous and stony soils, which contain little organic matter.

Papaya thrives best under warm, humid conditions. It is generally intolerant to strong winds and cold weather. Temperatures just below freezing can kill small plants to the ground. Dry climate during flowering often causes sterility, while dry climate during fruit maturity adds to the sweetness of fruit. Plant can be grown from sea level to elevation of 1,000 m above mean sea level. It cannot withstand frost.

Pusa Nanha papaya

Commercial varieties

Papaya is polygamous, with three primary sex types: female, male and bisexual. Female flowers are borne along the trunk and can be identified by that location and the presence of a miniature papaya fruit inside the base of the flower petals. Male flowers are borne in long sprays that originate along the trunk. Varieties have been classified as Dioecious (produce male and female plants) and gynodioecious (produce female and hermaphrodite flowers. Honey Dew, Coorg Honey Dew, Washington, Solo, CO-1, CO-2, CO-3, CO-4, CO-5, CO-7, Pusa Dwarf, Pusa Delicious, Pusa Majesty, Pusa Nanha, Pant Papaya-1, Pink Lady, Red Lady, Sun Rise Solo etc., are important varietes of papaya.

Due to sex variations, about 40-60 per cent of the plant may turn to be male in the cases of dioecious varieties. Thus, in such case, 2-3 seedlings should be planted per the pit, and lastly population ratio of one male plant for every 8-10 female plants should be maintained. In the case of gynodioecious varieties (Pusa Delicious, Coorg Honey Dew, Pusa Majesty, Pink Lady, Red Lady, Sun Rise Solo) plant one seedling/pit. The ideal seasons for it planting are June to October and January to March as the other months are either too hot or rainy.

Male papaya plant

Female papaya plant

Plant propagation

Most papayas are grown from seed because of the impracticality of vegetative propagation methods. For this, seeds are extracted from fully ripe fruit, washed to remove gelatinous material and planted several per pot of soil or potting medium. Germination is accomplished in approximately two weeks under full sunlight. The plants can be set out as soon as they are large enough (about 1 foot tall) to survive with minimal care. The pots of plants should be spaced 8 to 10 feet apart. Papaya seedlings should begin flowering in five to six months, at which time they can be thinned to a single female or bisexual plant at each site. In the absence of bisexual plants, one male plant is needed for every eight to ten females.

Planting

Plough the land thoroughly and dig pits of 40 x 40 x 40 cm. size at about 1.8 -2.4 m apart either way depending on variety and fill them with topsoil and compost. Place the seedling in the centre of the pit and provide support. For Pusa Nanha a planting distance of 1.2 X 1.2 m is recommanded.

Manures and fertilizers

Application of 25 tonnes of FYM per ha and 250 g N, 250 g P and 500 g K/plant/year is recommended. Apply the entire quantity of N, P_2O_5 and K_2O in split application once in 2 months commencing from the 2nd month of planting. Fertilizer at the rate of one-quarter pound of ammonium sulfate (21-0-0) per plant should be applied a month after planting, increasing to one half pound six months after establishment.

Weed control

Weeds and grass control within 3 to 4 feet of the papaya is essential for optimum growth and fruiting. Cultivation for weed control should be quite shallow, as the papaya's roots are concentrated near the soil surface. The use of organic mulches is highly recommended.

Irrigation

Papaya responds well to copious irrigation in well-drained soils. Regular irrigation helps fruit development and induces the tree to bear larger sized fruits. Water stagnation should be avoided. In most parts of India, papaya is irrigated once in 8 to 10 days. Irrigation should be applied to thoroughly wet the soil periodically as needed through the year. A fluctuating irrigation regime may retard growth and cause poor fruit set. The ring system of irrigation is better than bed or basin system because the ring system prevents runoff water.

Anthracnose affected fruits of papaya

Plant protection

Diseases	Symptoms	Control measures
Foot rot (*Phytophthora sp*.)	The leaves turn yellow and drop off. The plant may collapse with a breakdown at the bottom.	Uproot and burn the affected plants. Avoid water logging. Spraying the stem and drenching the soil around the stem with Bordeaux mixture.
Powdery mildew (*Oidium caricae*)	Whitish patches appear on lower surface of leaves. Corresponding upper surface appears yellow. The affected leaves turn yellow and dry up.	Dusting sulphur 10 kg/acre or spraying of Karathane (0.05%) or any wettable sulphur (0.05%) is effective.

Leaf curl	Severe curling, crinkling and deformation of the leaves. Other symptoms may be vein clearing, reduced leaf size inward rolling of the leaves and petioles are twisted	Spraying of metasystox (0.1%) at an interval of 10-15 days for controlling the vectors.
Papaya mosaic	The top young leaves of the diseased plants are much reduced in size and show blister patches of dark green tissue alternating with yellowish green and puckering. The leaf petiole is reduced in length and twisted	Removal of infected plants and destroying them. Control aphids and other vectors by periodical spraying of systemic insecticides.

Maturity, Harvesting and Yield

The change of colour from green-to-yellow and the consistency of the latex from milky to watery indicate that the fruit is ready for harvest. The fruits should be harvested individually by hand picking taking care to avoid all possible injuries.


Symptoms of leaf curl in papaya

Papaya fruits will be ready for harvest in about 9-10 months after planting. Fruits are borne throughout the year. Yield varies from 75 to 100 tonnes per hectare. The economic life of papaya plant is only 2½ to 3 years. A papaya plant with good management produces 25 to 40 fruits weighing 40 to 60 kg in the first 15 to 18 months.

Papain extraction

Papaya fruits, which are about 90-100 days old (fully grown but not mature) are selected for tapping. In the morning hours, four longitudinal incisions are given on the four sides of the selected fruits from the stalk end to the top of the fruit. The depth of the incision should be 3 mm. On incising, latex starts flowing, which is collected in a suitable container. (Areca nut spates, aluminum trays or glass vessels). Care should be taken not to use any other containers for papain collection since it will react with papain, rendering it unfit for any use. The latex that solidifies in the cuts should also be scrapped carefully and added to the liquid latex. This process of making four incisions in the untapped fruit surface at 3-4 days interval is repeated thrice or four times over a period of 12 to 16 days. The latex thus collected every time should be dried in the sun or in dryer at temperature ranging between 50 ^{0}C to 55 ^{0}C. Potassium metabisulphite (0.05 per cent) is added to the liquid latex in small quantities before it is dried since this helps to extend the storage life of papain. The drying is continued until it comes off in flakes having a porous structure. The dried papain is powdered, sieved in a 10 mesh sieve and stored in polyethylene bags or any other suitable container. After papain extraction, fruits can also be used for consumption.

SAPOTA

Sapota (*Achras zapota*), sapodilla or *Chiku* is another delicious tropical fruit of India, tropical America, south-east Mexico, Guatemala and other countries. Immature fruits are astringent, while ripe-fruits are sweet and used as desert. Now the crop has attained the status of major fruit industry in India. Sapota fruits are

nutritious, rich in minerals, carbohydrates and mostly eaten as fresh fruit. Sherbets, milk shakes and ice cream can be made from fresh pulp. In Chile, the latex obtained from the bark of the tree, was for many years, the principal ingredient of chewing gum. It is a very good fruit for patients suffering from fever and febrile attacks.

Bearing tree of sapota

It belongs to the family Sapotaceae and genus *Achras* with somatic chromosome number, 2n = 26. Sapota is believed to have originated in Mexico and Central America and being a tropical crop, grows throughout the tropics. In India, it is cultivated in Maharashtra, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu, Kerala, Uttar Pradesh, West Bengal, and some parts of Rajasthan, Punjab and Haryana.

Soil and climatic requirements

Sapota tree is well adapted to a wide range of soils but grows best in well-drained, light soils. Trees are especially well adapted to the rocky, and highly calcareous soils. It comes up well in alluvial soils of the riverbanks, sandy loams near coastal areas, red laterite soils of the heavy rainfall area and medium black soils.

Sapota prefers a warm and moist weather and grows in both dry and humid weather. Coastal climate is best suited. Sapodillas are adapted to tropical and warm sub-tropical climates. Young trees may be killed or injured at temperatures of 30 to 32 $^{\circ}$F (-1 to 0 $^{\circ}$C). Large trees can withstand temperatures as low as 26 $^{\circ}$F (-3 $^{\circ}$C) for a few hours with only minor damage. Optimum temperature is between 15 to 35 $^{\circ}$C and at higher temperature above 43 $^{\circ}$C during summer, the flower and fruitlets may drop. Areas with an annual rainfall of 125 to 250 cm are highly suitable.

Commercial varieties

Many varieties are popular among the growers. Most important being Cricket Ball, Baramasi, Badami, Thagarampudi, Dwarapudi, Kirtibharathi, Oval, Pala, Guthi and Culcutta Round. Some varieties produce fruits in winter and other in summer. Similarly some produce round fruits and others produce oval fruits.

Plant propagation

Although, seeds can be used for propagation and for selection of superior types, they should not be used for commercial plantings. Side veneer and cleft grafting on to seedling rootstock are the most common grafting methods. Chip budding can also be used. Inarching in sapota is the commercial method of propagation practice over forty years. One of the advancements in propagation of sapota has been the use of softwood grafting. For this, one year old rootstocks of pala (*Manilkara hexandra*) are selected and all side branches are removed. The stock is then cut down to a height of 20 cm above soil level. Scions should be 8 to 10 cm long and of pencil thickness with bulging tips. The colour of the scion should be turning from green to brown. For pre-curing, leaf blades are clipped off seven-to-ten days before grafting. When the petioles dry and drop off, the scions can be detached from the tree and used for grafting. Longitudinal cut of 3-4 cm is made and the scion wedge is inserted to the softwood portion of rootstock and tied with a polythene strip of 200 gauge thickness. The grafts are kept in shade or mist chamber for 15 days and later transfer the successful grafts to open place. Treating the scion with IAA (750 ppm) increase the percentage of success. Higher percentage of (more than 95) success can be obtained from this method.

Planting

Planting is done in July-August or February-March in well prepared field in a square or rectangular system of planting, The planting distance is usually 10 m x 10 m in light soils and 13 m x 13 m in heavy soils.

Manures and fertilizers

S. No.	Age of the tree (Yrs.)	Nitrogen	Phosporus	Potas
1.	1-3	50	20	75
2.	4-6	100	80	150
3.	7-10	200	40	300
4.	11 Years onwards	400	160	450

Irrigation

When plants are young, irrigation should be given throughout the year, depending upon the soil conditions, However, when plants grow, these should be irrigated once in a week during summer and at fortnightly interval during winter.

Weeding

Weeds compete for water and nutrients. Weeds may be controlled by herbicide applications of registered materials and/or by mulching. Weeds and lawn grass should be removed within a 2 to 4 ft (0.6-1.2 m) radius around the trunk and under the canopy. A 2 to 4 inches (5-10 cm) thick layer of mulch may be used to reduce soil drying and weeds. Keep mulch 8 to 12 inches (20-30 cm) away from the trunk.

Plant protection

Insect-pests	Damage	Control measures
Leaf webber (*Nephopteryx eugraphella*)	Feeds on buds, leaf and young fruits	Spray phosalone 35 EC (2 ml/l)
Hairy caterpillars	Flowers and flower buds are damaged	Spray chlorpyrifos 30 EC or endosufan 35 EC (2ml/l)
Diseases	**Symptoms**	**Control measures**
Sooty mould (*Capnodium* sp.)	Photosynthetic functions of the leaves get affected and fruits get disfigured	Spray starch or maida (1 kg boiled in 5 liters of water and diluted to 20 liters)
Leaf spot (*Phaeophleospora indica*)	Pinkish to reddish brown spots are seen, resulting in drying and shelding of leaves.	Spray mancozeb (0.2%) if defoliation occurs.

Maturity, harvesting and yield

Indicators of maturity are fruit size, loss of peel scruffiness and a change in peel color from brown - to - amber. Another test is to lightly scratch the peel; if it is tan,fruit can be picked, but if it is green or oozes latex, the fruit is not fully mature.

Fruits can be harvested by hand, using a pole with a basket, or using machines or platforms that place the picker close to the fruit. Removing the fruit with a hook is not advisable as many of them hit the ground before they can be caught in the air. Fruit should be handled carefully during harvesting, packing and shipping.

Sapota starts bearing from 4th year onwards and economical yields can be obtained from 7th year onwards. Plants flower almost throughout the year. It takes 4-6 months from flowering to fruit maturity. March-to-May and September-to- October are the two distinct seasons of harvest. A full bearing tree may produce about 2,500-3,000 fruits/season.

GUAVA

Guava (*Psidium guajava* L.) is also known as the 'apple of tropics' and 'poor man's fruit' in India. Guava has wide adaptability to varied types of soils, climatic and cultural conditions. It is a rich source of vitamin C and pectin, and good source of other vitamins like thiamine and riboflavin, and minerals like calcium and phosphorus. Being rich in pectin, excellent jelly is made from guavas. The fruits can also be utilized for making nectar and ready-to-serve (RTS) drinks.


Allahabad Safeda guavas

Guava is native of tropical America. It is commercially cultivated in India, Pakistan, Bangladesh, Philippines, Hawaiian Islands, Myanmar and Cuba. In India, it is mainly grown in Uttar Pradesh, Madhya Pradesh, Bihar and Maharashtra. In Uttar Pradesh, Allahabad region has the reputation of growing the best quality guavas in the world.

Guava belongs to family Myrtaceae and genus *Psidium* with basic chromosome number (n) = 11. Other species of *Psidium* are the mountain guava (*P. montanum*), *P. friedrichsthalianum* (Chinese guava) and *P. cateinum* (Cattley guava).

Soil and climatic requirements

Guava is a hardy fruit plant and can thrive on all types of soils ranging from heavy clay to light soils. However, the clay loam, deep, friable and well drained soils are best. It can be grown in soils having pH up to 9.0, though the optimum range is 4.5 to 7.5. Under highly waterlogged, saline and alkaline conditions, its cultivation is adversely affected.

Guava grows successfully in tropical and sub-tropical regions and even under adverse climatic conditions. However, both yield and fruit quality are better in areas with distinct winter. It grows well even at an altitude of 5,000 feet. The areas receiving a rainfall of 40 inch between June-to-September, are considered ideal for its cultivation. The young plants are susceptible to drought and frost. Dry atmosphere at the time of flowering and fruiting are favourable but high temperature during fruit development may cause excessive fruit drop.

Commercial varieties

Important varieties of guava are Allahabad Safeda, Sardar (Lucknow-49), Behat Coconut, Seedless, Apple Colour, Banarasi Surkha, Chittidar, Harijha and Red Fleshed. Some hybrids/ varieties such as Safed Jam, Kohir Safeda, Hisar Lalit, Hisar Surkha, Hisar Safeda, Arka Amulya, Arka Mridula etc., have also been developed by different institutes.

Plant propagation

Guava can be propagated both by seed and asexual means. Most important methods of vegetative propagation are air layering/gootee, stooling and budding. Now-a-days, stooling is preferred. In this method, the plants are headed back during December-January and allowed to grow new shoots. These shoots (stools) are ringed, treated with IBA (2,500 ppm) made in lanolin paste and earthed up to induce rooting. Profuse rooting occurs within a month. The rooted stools are separated from the mother plant and planted in the nursery during July-August. Rooting is better if the soil in the stool bed is kept moist all the time. 40-50 plants can be prepared from one mother plant per year by performing stooling twice a year.


Vegetatively propagated plants of guava

Planting

Before planting, the field should be thoroughly ploughed and leveled. The pits of 1 x 1 x 1 m size should be dug out at appropriate distance in a square system before monsoon. The pits are refilled with 25-30 kg well decomposed farm yard manure, mixed with top soil and irrigated. The best planting time is onset of monsoon. However, planting can be done during March-April also. The planting density depends on factors like variety, rootstock and climatic and soil conditions. Guava is usually planted at a distance of 7 to 8 m.

Irrigation

Guava is a hardy fruit plant and requires very less water. However, in the early stages of orchard establishment, plants require frequent irrigation. Later, more frequent irrigation (fortnightly interval) is required from April-to-June, for good growth and fruit yield. Irrigation during winter is beneficial to obtain quality crop. Usually, no irrigation is given during winter. Due to regular growth, flowering and fruiting in south India, guava requires irrigation throughout the year.

Manuring and fertilization

The amount of manure and fertilizers to be given, depends upon the variety, age of plant, soil and climatic conditions and type of the fertilizer to be applied. Although, it is difficult to give one general fertilizer schedule, but a ten-year-old guava tree should be given about 80 kg of FYM, 1 kg of ammonium sulphate or 800 g of calcium ammonium nitrate, 3kg of super-phosphate and 2 kg of potassium sulphate.

The fertilizers should be applied in two split doses (June and October) when there is sufficient moisture in the soil. 50 per cent of nitrogen and full dose of potash should be applied in June and the remaining the N and entire phosphorus in October. Foliar application of nitrogen in the form of urea (4-6%) has been found to be very effective in increasing growth, flowering, yield and quality of guava. The best time for foliar application is January and July. A fertilizer schedule is given below:

Age (Yrs)	FYM (kg)	Nitrogen (g)	Phosporus (g)	Potash (g)
1-2	10-15	60	30	30
3	20	120	60	60
4	30	180	90	90
5	40	240	120	120
6	50	300	150	150
7 and above	60	360	190	190

Flowering and crop regulation

Guava flowers twice a year in north India. First flowering takes place in April-May, which gives fruits in rainy season. The second flowering takes place in August-September to give fruiting in winter season. The rainy season crop is generally avoided as most of the fruits are infested by fruitfly and the fruits are insipid and of very poor quality. The winter crop is virtually free from fruitfly and the fruits are of high quality. Winter crop is therefore, preferred as it gives very high returns to the farmers. In central-southern India, guava flowers thrice a year, with flowers appearing in October also. In West Bengal, flowering once in April-May and again in September-October has been reported.

Under certain climatic conditions, guava plants may flower twice or thrice a year. Under these conditions, regulation of flowering is required, to get fruits of desirable quality in a desired *bahar*. Regulation of flowering can be achieved by exposure of roots, root pruning and with chemicals, which is called as bahar treatment.

In areas where guava flowers twice or thrice a year, we need to regulate guava crop in such a way that only quality crop is harvested. In this process, rainy season crop is avoided. This can be done by forcing the plants to

take rest in the undesired season by stopping irrigation, and then applying fertilizers and manures in the desired season. De-blossoming can be done by spraying NAA (100 ppm) or 2,4-D (30 ppm) in summer.

Plant protection

Insect pests	Damage	Control measures
Fruit fly (*Chaetodacus* sp.)	Most serious pest of rainy season crop, renders whole crop unfit for consumption. Adult flies lay eggs on fruit, maggots on hatching, enter the fruits, and feed inside.	Soil raking, destruction of infected fruits, use of baits (sugar + malathion) and spraying plants with malathion (0.05%) or dimecron (0.03%) during oviposition period are some useful measures.
Mealy bug (*Cryptolemus* spp.)	Causes damage by sucking cell sap from tender leaves, shoots, flowers and fruits. The affected leaves dry up and the fruits drop off, resulting in poor yield.	The banding of the tree trunk with polyethylene film or Ostico-sticky bands is the best method to prevent them climbing up the tree. Further, treatment of soil with malathion is also effective.
Bark eating caterpillar (*Indarbela* spp.)	Feeds on bark under silken galleries. The infested trees are visible from a distance as the winding silken galleries full of frass faecal matter are seen on the trunk.	Remove the silken galleries, plug the holes with cotton soaked in diesel/petrol or monocrotophos.
Diseases	**Symptoms**	**Control measures**
Wilt: Several fungi like *Fusarium solani, F. oxysporum, Marophomina phaseoli* are associated.	This disease is characterized by yellowing of leaves, followed by drying of the leaves. The twigs start drying from tip downwards. The plant may collapse slowly in several or within 15-20 days.	Remove and burn the infected plants, maintain proper drainage, grow wilt resistant varieties (L-49, Banarasi), avoid planting in highly alkaline soils, disinfect soil with 2 per cent formaldehyde solution before planting, and drench soil with brassicol or spray bavistin (0.1%) at an interval of 15 days at early stages of disease infection.
Anthracnose (*Gloesporium psidii*)	Die-back starts from top of the branch. Other plant parts, like shoots, leaves and fruits are readily affected. High humidity and frequent rains favour the spread and intensity of disease.	Spray dithane-Z-78 or phytolan (0.2%) at fortnightly interval.

Maturity, harvesting and yield

Seedling guava plants have 5-6 years juvenile phase whereas the grafted or layered plants start bearing after 2-3 years. Change in fruit colour is usually taken as harvesting index. As soon as colour starts turning from

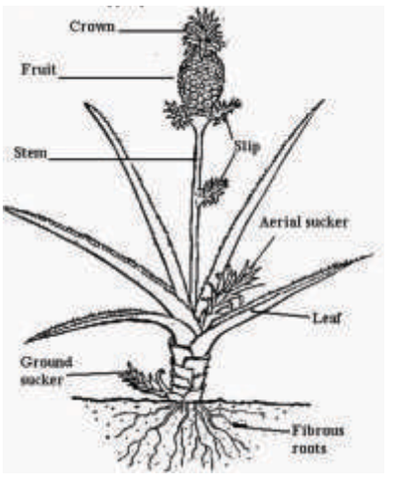
greenish-to-yellowish, the fruits should be harvested. Hand picking of fruits at regular intervals is preferred. Harvesting by shaking of tree may cause severe damage to fruits and the tree. Guava starts giving economic yields after 8-10 years of planting. In general, grafted plant of 8-10 years age can yield 400 to 800 fruits weighing 80 to 100 kg. Guavas are highly perishable and must be marketed immediately after harvest. It is possible to keep ripe but firm fruit in good condition for about 4 weeks at 8.3 to 10 ^{0}C and 80-90 per cent relative humidity.


Wilt affected guava tree

PINEAPPLE

Pineapple (*Ananos comosus*) is a tropical fruit plant known for its juicy and fragrant fruit. It probably received its name because the fruit looks like a large pinecone. Many people enjoy drinking the juice of the pineapple and eating the fruit as a dessert or in salads. Thailand grows more pineapples than any other country of the world. It belongs to family Bromeliaceae and genus *Ananas* with somatic chromosome number, 2n = 50. Many scientists believe that pineapples originated in Brazil. Today the world's chief pineapple producing countries are Brazil, China, Indonesia, Malaysia, Mexico, Philippines, South Africa, Thailand, and the United States. In India, it is mainly grown in NE states, West Bengal, Assam, Kerala, Karnataka, Bihar, Jharkhand etc.

It is a very good source of vitamin A and B_1. It is mainly consumed as fresh fruit but processed products like jelly, jam, juice, snack food, canned fruits, wine, and vinegar also made from it. In addition, several parts of the plant are used to make cattle feed, meat tenderizers and medicines. In the Philippines, people weave the fibers of the plant into a cloth called *ping*.



Parts of a pineapple plant

Soil and climatic requirements

Medium-to-heavy loams, rich in humus and having slightly acidic reaction are more suitable. Plant prefers soil pH of 5.0-6.0. Soils with a higher pH are unsuitable owing to the development of lime induced iron chlorosis. Too much water can harm it , but irrigation is necessary in some dry regions but plant is particularly sensitive to waterlogged conditions.

Pineapple needs a warm climate. Extremes of climates such as occurrence of frost and intense solar radiations associated with very low humidity are not favourable for pineapple cultivation. The optimum temperature range for successful pineapple cultivation is between 15.6 ^{0}C and 32.2 ^{0}C. High temperature over 35 ^{0}C is unfavourable for the development of fruits, especially if the relative humidity is low. In general, pineapple needs a sunny climate, though there are no exact figures on hours of sunshine or of solar radiations required for flowering and higher productivity.

Commercial varieties

Varieties of pineapple are divided into 3 main groups-I) Cayenne, 2) Queen and 3) Spanish. The first group is by and large, is the most important group. Most of the varieties in India may be accommodated into anyone of these three groups. For example, Kew or Gaint Kew, synonymous with Smooth Cayenne, grown most extensively in India, represents Cayenne group, and Queen another popular variety belongs to Queen group.

Varieties of Cayenne group are - Smooth Cayenne or Cayenne, Hilo, Kew, Giant Kew, Charlotte, Rothschild.

Varieties of Queen group are - Mauritius, Ripley Queen, Alexandra, Mac Gregor, Queen.

Varieties of Spanish group are - Red Spanish, Singapore Spanish, and Masmerah.

Other varieties : Abacaxi and Cabezona.

Plant propagation

Propagation of pineapple is exclusively done by vegetative means. In case of hybrids, progenies evolved through seeds are also vegetatively propagated. Propagation can be done from any four parts of a pineapple plant: (1) *shoots,* (2) *slips*, (3) *crowns* and (4) *suckers*. Shoots grow from the main stem. Slips grow from the flower stalk just below the fruit. Crowns are the groups of leaves at the top of the pineapple. Suckers arise from the roots below ground. Among the types and sizes of propagules tried, slips and suckers weighing around 350 g and 450 g are best in terms of yield and quality.

Planting and after care

The planting system depends on the topography of land and rainfall. There are four planting system in vogue, viz. flat-bed planting, furrow planting, trench planting and contour planting. Workers insert the shoots, slips, crowns, or suckers through the plastic strips by hand. They punch holes in the plastic with a planting tool. After planting, pineapple plants require careful cultivation.


A view of high density plantation of pineapple

Plant spacing or density of pineapple depends on the growth of the plant and system of planting. Adoption of low planting densities has been the major constraint in India, contributing towards high cost of production per tonn of pineapple. One of the ways to reduce cost of production is to increase yield per unit area by following high density planting.

Spacing followed for 63,758 plants per ha was 22.5 cm from plant to plant, 60 cm from row to row and 75 cm between beds. This planting density did not adversely affect fruit size, quality and canning ratio. The following is the spacing required for different plant populations per hectare.

Plant population/ha	Distance (cm)		
	Plant to plant with in row	Row to row	Trench to trench
43,500	30	60	90
53,300	25	60	90
63,700	22.5	60	75

Manures and fertilizers

The following fertilizer schedule should be followed for fruitful production:

Time	Type of fertilizer	Fertilizer rate/ha
Before planting	Lime	2.5 Tonnes
At time of planing	CIRP	200 Kg
3 months	NPK 12:12:17:2	200 Kg
6 months	NPK 12:6:22:3	500 Kg
9 months		

Weeding

The major factor, which contributed to the high cost of production of pineapple, is the manual weeding, which accounts for 40 per cent of the total cost of production. Six months after planting , weeding has to be done every 3 months. This can be done manually or by the use of weedicide like paraquat. Pre-emergence application of bromacil (4 kg/ha) and diuron (2 kg/ha) could effectively reduce both dicot and monocot weed population.

Irrigation

Pineapple is grown mostly as a rainfed crop in heavy rainfall areas. Optimum range of rain needed for pineapple is 1,000 to 1,500 mm. However, some of the pineapple growing areas come under high rain fall zone, where rainfall is to an extent of 3,000 and nearing 2,000 mm. Although pineapple is grown in India in rainfed areas, where sufficient rainfall is received, but it can also be grown successfully with a few irrigations during summer in the semi-arid tropics.

Regulation of flowering

In pineapple, flowering is erratic, and sometimes it is difficult to get good crop. For this, growers may use hormones and chemicals to make the plants flower and produce fruit faster than they would naturally. To induce uniform flowering, the following treatments are recommended.

1. At 40 leaf stage, 50 ml solution containing NAA at 10 ppm + 2% urea is poured into the crown.
2. 50 ml solution containing 2% urea + 0.04% sodium carbonate + 20 ppm ethrel is poured into the crown.

Sometimes flowering is erratic in pineapple. Hence, regulation of flowering is mandatory. It can be achieved by pouring NAA (10 ppm) or ethrel (20 ppm) in to crown during night.

Maturity, harvesting and yield

Pineapple flowers 10-12 months after planting and attains harvesting stage in about 15-18 months after planting, depending upon the variety, time of planting, type and size of planting material used and prevailing temperature during the fruit development. A pineapple plant bears one fruit for the first harvest and may bear two fruits for the second or third harvest. Most planters replant fields after every two or three harvests. In most countries, pineapples are harvested by hand. The pineapple pickers grab the fruit by the crown and twist it from the stalk. The average yield for the first year is between 40-65 tonnes per hectare, which depends on cultivar used.

Plant protection

Disease/pest	Control measures
Bacterial heart rot (*Erwinia chrysanthemi*)	Remove and destroy the affected plants. Refrain from planting in flood prone areas. Spray with the insecticide chlorpyrifos (Dursban) to prevent disease and control ants.
Deep eye (*Penicillium uniculosum*)	Chemical control has not been successful. Do not apply fertilizer while the plant is flowering and during the rainy period.
Fruit collapse (*Erwinia chrysanthemi*)	Destroy the affected plants and fruits. Spray with heptachlor just before flowering to control ants.
Mealy bug (*Dysmicoccus brevipes*)	Spray with the insecticide diazinon (0.05%) to control mealy bugs and ants.

ACTIVITIES/EXERCISES

- Plan a visit to some mango orchard. With the help of supervisor or gardener (*Mali*) make a list of important varieties grown in it. Also try to differentiate the varieties grown in the orchard. Also find some insect or disease infected plant parts. Observe the nature of damage and note down the symptoms of damage caused by an insect or disease.
- Go to some guava orchard. Note down the wilt affected plants and symptoms of disease. Also see if fruitfly attack is there. Cut such fruits into 2 halves and note down the extent of damage caused by the fly.

- Note the symptoms of guava wilt and panama wilt after visiting orchards of guava and banana, respectively.
- Plan a visit to pineapple plantations and observe the different plant parts and density of plantation.
- Attempt to give incisions to immature papaya fruits and collect latex and prepare papain from it after following all precautions.

CHECK YOUR PROGRESS

1) Name major varieties of mango. Name some hybrids developed by research institutes.
2) List major physiological disorders of mango.
3) List major insect-pests of mango and write their control measures.
4) Name major diseases of mango, banana and papaya. Write their control measures.
5) What is papain? Write procedure for making it.
6) Write briefly about regulation of flowering in guava and pineapple.

FILL IN THE BLANKS

1. ……is a serious disorder of Alphonso mango.
2. Dashehari is a famous variety of mango in ……India (North, South, West)
3. Epicotyl method of mango propagation is commercially followed in ……region.
4. Amrapali, a mango hybrid is a cross between …….. and ……..
5. Panama wilt is caused by……
6. ……..acts as vector for bunchy top of banana.
7. Pineapple is commercially propagated by……
8. Papain is obtained from immature ……. fruits
9. Pusa Delicious is a variety of……
10. Papaya is commercially propagated by …….

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