

MANGO CULTIVATION

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Mango

Botanical Name	-	<i>Mangifera indica</i>
Family	-	Anacardiaceae
Chromosome No.	-	$2n = 40$
Origin	-	Indo-Burma
Type of fruit	-	Drupe
Edible portion	-	Mesocarp

Basic Information-

- ❖ In India mango is known as king of fruits.
- ❖ The name *Mangifera* was given for the first time by Bontius in 1658, when he referred to this plant as arbor *Mangifera* (the tree producing mango).

Area and production

- India is largest producer of Mango and accounts about 56% of total mango production of world.
- Highest production and productivity of mango is A. P.
- U. P. Has highest area under mango cultivation.

Composition and uses

- Young and unripe fruits because of their acidic taste, utilized for preparing pickles, chutneys, amchur while ripe fruits are utilized in preparing squash, jam, mango leather and toffee.
- Mango is rich source of vitamin A(4800IU/100g).
- The bark has alkaloids like mangiferine and tannin(16-20%) which are useful against Diphtheria.

Botany

- The genus has 69 spp.
- Inflorescence- Panicle
- Flowers are small in the inflorescence & both side of male and female flowers are borne in the same flower i.e, hermaphrodite
- Fruit is drupe & mesocarp is the edible portion.



Fig.: Panicle of mango

- ❖ Linnaeus also referred to it as *Mangifera arbor* in 1747, prior to changing the name to its present from (*Mangifera indica*) in 1753.
- ❖ Mango is good source of vitamin A and B. Mango is also considered to have some medicinal properties.
- ❖ Besides table purpose, fruits of mango can be used for the preparation of pickles, preserves, jam, amchur (mango powder) and mango leather (ampapad).
- ❖ India shares about 56% of total mango production in the world.
- ❖ Andhra Pradesh tops in total production and area.
- ❖ Andhra Pradesh, Uttar Pradesh, Bihar, Karnataka, Maharashtra, West Bengal and Gujarat together contribute for about 82% of the total production in India.

Climate and Soil

- ❖ Mango can be grown on a wide variety of soils under varied climatic conditions.
- ❖ It can be grown from alluvial to lateritic soils except in black cotton soil having poor drainage.
- ❖ It grows well in soils with slightly acidic pH.
- ❖ It does not perform well in soils having pH beyond 7.5. Soils having good drainage are ideal for mango.
- ❖ Mango is a tropical fruit, but it can be grown up to 1,100m above mean sea level.
- ❖ There should not be high humidity, rain or frost during flowering.
- ❖ The temperature between 24 and 27°C is ideal for its cultivation.

- ❖ Higher temperature during fruit development and maturity gives better-quality fruits.
- ❖ It can be grown best in regions with a rainfall between 25cm to 250cm.
- ❖ Regions having bright sunny days and moderate humidity during flowering are ideal for mango growing.

Varieties

- India is the home of about 1,000 varieties.
- Most of them are the result of open pollination arisen as chance seedlings.
- However, only a few varieties are commercially cultivated throughout India.
- In India, mango is available from March to mid-August.
- The north Indian cultivars are alternate-bearer whereas south Indian ones are generally regular-bearer.
- About 20 varieties are grown commercially.

Commercial mango varieties grown in different states

Andhra Pradesh	Banganapalli, Suvarnarekha, Neelum and Totapuri
Bihar	Bombay green, Chausa, Dashehari, Fazli, Gulabkhas, Kishen Bhog, Himsagar, Zardalu and Langra
Gujarat	Kesar, Alphonso, Rajapuri, Jamadar, Totapuri, Neelum, Dashehari and Langra
Haryana	Chausa, Dashehari, Langra and Fazli
Himachal Pradesh	Chausa, Dashehari and Langra
Karnataka	Alphonso, Totapuri, Banganapalli, Pairi, Neelum and Mulgoa
Madhya Pradesh	Alphono, Bombay Green, Dashehari, Fazli, Langra and Neelum
Maharashtra	Alphonso, Kesar and Pairi
Punjab	Chausa, Dashehari and Malda
Rajasthan	Bombay Green, Chausa, Dashehari and Langra
Tamil Nadu	Alphonso, Totapuri, Banganapalli and Neelum
Uttar Pradesh	Bombay Green, Chausa, Dashehari and Langra
West Bengal	Fazli, Gulabkhas, Himsagar, Kishenbhog, Langra and Bombay Green

Mango varieteis and their most important characters

Alphonso	It is susceptible to spongy tissue.
Banganapalli	A widely cultivated, early-maturing mango of south India.
Bombay Green	It is one of the earliest varieties of north India.
Chausa	Late-maturing variety of north India, it matures during July or beginning of August.
Dashehari	One of the most popular variety of north India, it is a mid-season mango.
Fazli	This is indigenous to Bihar and West Bengal. Fazli is a late-maturing (August) mango.
Gulab Khas	It is indigenous to Bihar. Regular and heavy-bearer, it is mid-season mango.
Himsagar	Very popular in West Bengal, it is a regular-bearing mango.
Kesar	Popular in Saurashtra region of Gujarat, Kesar is an irregular-bearing mango.. It has good processing quality.

Kishenbhog	Indigenous to West Bengal, it is a mid-season mango.
Langra	An important commercial mango variety of north India, it is biennial-bearer and a midseason variety, with good quality fruits.
Mankurad	It is a mid-season variety, popular in Goa.
Neelum	A heavy-yielding, late-season mango in south India, it has regular-bearing habit.
Pairi	A native to coastal Maharashtra including Goa, it is an early-maturing, heavy and regular-bearer mango.
Totapuri	Widely grown in south India, Totapuri is a regular and heavy-bearing mango.

Images of mango varieties



Alphonso



Bombay green



Chausa



Deshehari



Kesar



Langra

- A number of selections/hybrids of mango have been evolved.
- These include Clone C-51 from Dashehari selected at the CISH, Lucknow, and an off-season selection, Niranjana, selected at Parbhani.
- New clonal selections from Langra and Sunderja have been made at Varanasi and Rewa.
- A clonal selection, Paiyur 1, has been made from Neelum, in addition to few dwarf polyembryonic selections made in the north-eastern region.
- As a result of systematic hybridization, several hybrids have been released. However only a few have become commercially acceptable. Of these, Mallika, Ratna and Arka Puneet are becoming quite popular.

Mango hybrids and their characters

❖ Hybridization work on mango start in 1911 at Pune (Burns & Prayag)

Hybrid	Place of research	Parentage	Important characters
Mallika	IARI, New Delhi	Neelum x Dashehari	Regular-bearers, high TSS, good colour, uniform fruits, moderate keeping quality, in 1971.
Amrapali	IARI, New Delhi	Dashehari x Neelum	Dwarf, regular-bearers, cluster bearing, small-sized fruits, good keeping quality, in 1979.
Ratna	FRS, Vengurla	Neelum x Alphonso	Regular-bearers, free from spongy tissue and fibre, in 1981.
Sindhu	FRS, Vengurla	Ratna x Alphonso	Regular-bearer, stone thin, in 1992.
Arka Puneet	IIHR, Bangalore	Alphonso x Banganapalli	Regular-bearer, attractive skin colour, medium-sized, free from spongy tissue & fruit fly. Good keeping quality.

- Alfazli – Alphanso x Fazali (BAS, Sabour in 1981, free malformation)
- Arka Anmol – Alphanso x Janardan Pasand (free spongy tissue)
- Arka Aruna - Banganpalli x Alphanso (free spongy tissue)
- Arka Neelkiran – Alphanso x Neelum (free spongy tissue)
- AU Rumani – Rumani x Neelum (FRS, Sangareddy, fibreless)
- Jawahar – Gulabkhas x Mahmudbahar (BAS, Sabour in 1989)
- Manjeera – Rumani x Neelum (FRS, Sangareddy)
- Sunder Langra – Langra x Sunder Pasand (BAC, Sabour in 1981)
- PKM - Chinnasurarnarekha x Neelum (FRS, Periyakulam, TN in 1980)
- PKM – Neelum x Mulgoa

State wise availability of mango in India

Andhra Pradesh	March - mid August
Bihar	May end - mid August
Gujarat	April - July
Haryana	June - August
Himachal Pradesh	Mid June - mid August
Karnataka	May - July
Madhya Pradesh	Mid April - July
Maharashtra	April - July
Rajasthan	May - July
Tamil Nadu	April - August
Uttar Pradesh	Mid May - August
West Bengal	May - August

Propagation

- Mango is a highly heterozygous and cross-pollinated crop.
- There are 2 types of mango varieties.
- Most of the varieties in south are polyembryonic and thus give true-to-type seedlings. In north, the varieties grown are monoembryonic and need to be propagated vegetative.
- Mango is propagated on mango rootstock. For raising rootstock, the seeds of mango are sown within 4-5 weeks after extraction otherwise they lose their viability.
- For sowing the seeds, raised beds are prepared with a mixture farmyard manure, red soil and sand.
- In some places, seeds are sown directly in polythene bags.

Images of mango varieties



Alphonso



Bombay green



Chausa



Deshehari



Kesar



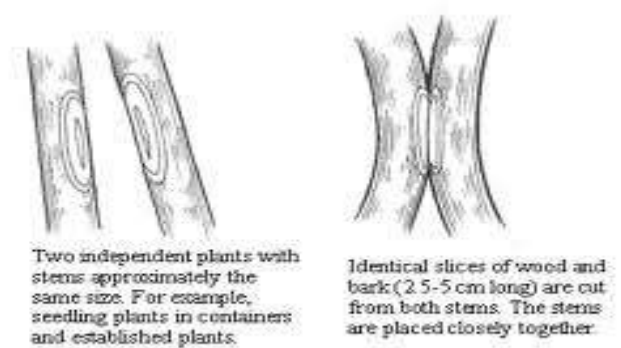
Langra

Propagation

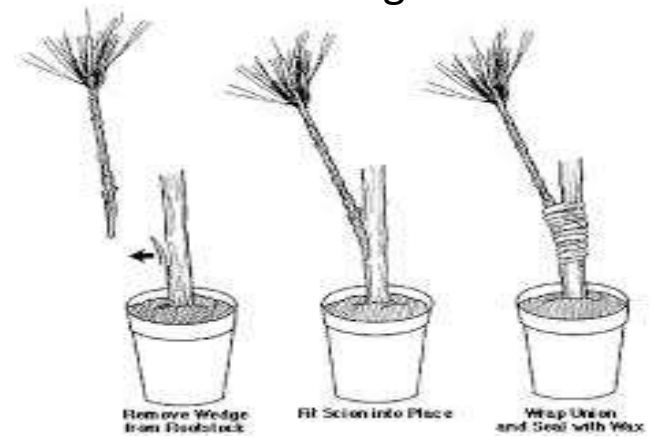
- Polyembryonic var. propagated through seeds while monoembryonic var. propagated by vegetative methods.
- Rootstock is prepared from seeds for veg. propagation.

Grafting:-

- Inarching:- Most popular method of propagation of mango cultivar.
- Veneer grafting:- It is commercial method of mango propagation in north India.
- Epicotyle/Stone grafting



Inarching



Veneer grafting



Epicotyl grafting

- After germination, the leaves turn green in 2-4 weeks.
- These seedlings are transplanted to polythene covers containing red soil, sand and farmyard manure.
- Addition of nitrogenous fertilizer to polythene covers after the establishment of plants helps in quick growth of seedlings.
- The seedlings thus raised should be used for grafting at different ages.
- Several methods of grafting are practiced. They are:

Inarching:

It is one of the most widely practiced methods of grafting. One can get a big-sized plant material for planting with over 95% success rate.

Veneer and side grafting:

These can be utilized for preparing a grafted plant material or for *insitu* grafting, i.e. for the rootstocks which are already planted.

Epicotyl /stone grafting:

This method is widely practiced in the Konkan region of Maharashtra. The germinated seedlings of 8-15 days old are used for grafting.

CULTIVATION

Planting

- Different systems of planting like square, rectangular and hexagonal are followed at different places. However, square and rectangular systems are also popular.
- The spacing depends on the vigour of the variety and the cropping system between 10 and 12 metres.
- The planting season varies from Jun to Sep.
- The main field is brought to fine tilth.
- Pits of 1m x 1m x 1m size are dug. These are exposed to sun for about 30 days. Before planting, pits are filled with well-rotten farmyard manure and mix aldrin dust in the pit mixture @ 150 g/pit.

- The top and sub-soil are taken out separately while digging the pits.
- The grafts should be planted during rainy season.
- In the in-situ grafting, rootstocks are planted in the main field.
- Then they are raised for 6 months to 1 year. Then the scions of the variety that need to be grown are taken and grafted.
- This is usually done when humidity is high. After grafting the scions are covered with polythene covers.

High-density planting

- High-density planting helps increase the yield/unit area.
- In north India, mango Amrapali is found enable for high-density planting with a spacing of 2.5m x 2.5m.
- Soil drenching with paclobutrazol (2 ml/tree) induces flowering during off year. It has become a commercial practice in Konkan region of Maharashtra.
- The polyembryonic mango Vellaikolumban when used as rootstock imparts dwarfing in Alphonso.

AFTER CARE AND MANAGEMENT

Training and pruning

Training is an important practice during the first few years after planting. It is essential to space the branches properly to facilitate intercultural operations.

Manuring and fertilization

The nutritional requirement of mango varies with the region, soil type and age. A dose of 73g N, 18g P₂O₅ and 68g K₂O / year of age from first year and increase same doses to tenth year and thereafter a dose of 730g N, 180g P₂O₅ and 680g K₂O should be applied in 2 split doses during June-July and September- October respectively.

- Spraying of zinc sulphate (0.3%) during February, March and May is recommended to correct the zinc deficiency.
- Spraying of Borax (0.5%) after fruit set twice at monthly intervals and 0.5% manganese sulphate after blooming corrects boron and manganese deficiencies.
- Organic manures and phosphate fertilizers should be applied immediately after harvest, whereas ammonium sulphate should be given before flowering.

Intercropping

In mango, intercropping helps check weed growth and reduces nutrient losses. Intercropping blackgram-wheat-mango and brinjal-onion-mango gives better monetary benefits. Besides, taking up cover crops like sunhemp, cowpea, pea help to prevent soil erosion.

Irrigation

The young plants upto 2 year old should be watered regularly. The newly-planted grafts need about 30 liters of water every week. Irrigation during pre-flowering phase increases flowering. Irrigating grown-up trees after fruit set at 10-day interval increases the yield.

Biennial Bearing :

The term biennial, alternate or irregular bearing generally signifies the tendency of mango trees to bear a heavy crop in one year (On year) and very little or no crop in the succeeding year (Off year). Most of the commercial varieties of north India, namely, Dashehari, Langra and Chausa are biennial bearers, while south Indian varieties like Totapuri Red Small, Bangalora, and Neelum are known to be regular bearers. When a tree produces heavy crop in one season, it gets exhausted nutritionally and is unable to put forth new flush thereby failing to yield in the following season. The problem has been attributed to the causes like genetical, physiological, environmental and nutritional factors.

Control :

For overcoming biennial bearing, deblossoming is recommended to reduce the crop load in the 'On' year so that it is balanced in the 'Off' year. Proper maintenance of orchard by way of effective control of pests and diseases and regular cultural operations may also result in better performance of the tree every year.

Soil application of Paclobutrazol (PP) or Cultare @ 4 g/tree in the month of September resulted in early flowering with higher fruit set and yield. It may be applied every year for regular fruiting, particularly in young trees.

Diseases of mango

Powdery Mildew (*Oidium mangiferae*) :

Powdery mildew is one of the most serious diseases of mango affecting almost all the varieties. The characteristic symptom of the disease is the white superficial powdery fungal growth on leaves, stalk of panicles, flowers and young fruits. The affected flowers and fruits drop pre-maturely reducing the crop load considerably.

Control :

Alternate spraying of Wettable sulphur 0.2 per cent (2 g Sulfex/litre), Tridemorph 0.1 per cent (1 ml Calixin/litre) and Bavistin @ 0.1 % at 15 days interval are recommended for effective control of the disease. The first spray is to be given at panicle emergence stage.



Symptoms of powdery mildew (*Oidium mangiferae*) in mango

Anthracnose (*Colletotrichum gloeosporioides*) :

It is of widespread occurrence in the field and in storage. Favorable climatic conditions (high humidity, frequent rains and the temperature range of 24- 32°C). The disease produces leaf spot, blossom blight, withered tip, twig blight and fruit rot symptoms. Black spots develop on panicles. Severe infection destroys the entire inflorescence resulting in failure of fruit setting. Young infected fruits develop black spots, shrivel and drop off. Fruits infected at mature stage carry the fungus into storage and cause considerable loss during storage, transit and marketing.



Symptoms of Anthracnose (*Colletotrichum gloeosporioides*) in mango

Control :

- The diseased twigs should be pruned and burnt along with fallen leaves.
- Spraying twice with Carbendazirn (Bavistin 0.1%) at 15 days interval during flowering controls blossom infection.
- Spraying of copper fungicides (0.3%) is recommended for the control of foliar infection.
- Postharvest disease of mango caused by anthracnose could be controlled by dip treatment of fruits in Carbendazim (0.1%) in hot water at 52°C for 15 minutes.

Physiological disorders

Black tip

Symptoms

- Found in orchards in the vicinity of brick kilns.
- Coal fumes from brick kiln releasing gases like carbon monoxide and sulphur dioxide are responsible for black tip.
- Characteristic spots leading to yellowing tissues of the distal end of the fruit that turn black finally.

Management practices

- Planting of mango orchards away from the brick kilns may reduce incidence.
- Spray 1% borax at the time of fruit set, followed by two more sprays at 10 days.

➤ Sprays of washing soda (0.5%) and caustic soda (0.8%) are good in minimizing the disorder.



Leaf scorch

Particularly old mango leaves show scorching at the tips and margins. Affected leaves fall down and the tree vigour and yield are reduced. The main cause of this malady is reported due to an excess of chloride ions which render potash available. Leaf scorch is common in saline soils or where brackish water is used for irrigation or where muriate of potash is used for potassium.

Control measures

- Collect and destroy fallen leaves.
- Apply potassium sulphate.
- Avoid planting on saline soil.
- Avoid brackish water for irrigation.

- Spongy tissue:- Due to conductive heat.

Alphonso is susceptible.

- Mango malformation:- 2 types

1. Vegetative 2. Floral

- Also known as Bunchy top.

- Control: Paclobutrazol near the collar zone of the trees, foliar application of NAA 200ppm in Oct. month.

- Jhumka:- Due to fluctuation of temp.

Control: Spray of NAA @ the rate of 300ppm.



Spongy tissue



Malformation

Spongy tissue

This is reported to be a physiological disorder which occurs in the ripe fruits. The disorder, which has become serious in Maharashtra, Karnataka, Gujarat and Andhra Pradesh, is manifested as a non-edible sour yellowish and sponge like patch with or without air pockets developing in the fruit during ripening and remaining small or involving the whole fruit pulp. “Alphonso” variety is more prone to this malady. However, solar radiation which keeps soil much heated and that heat emitted by soil by soil as convective flux which has been reported to cause spongy tissue.

Control measures

- Follow sod culture.

- Protect the mango orchard with tall growing shade plants on borders.
- Do mulching with paddy straw, mango leaves, dry grasses on soil surface covering whole canopy of the tree.
- Harvest fruits at $\frac{3}{4}$ maturity stage. Fully mature fruits have more chances of incidence of spongy tissue.
- Pre-harvest dipping of fruits in Calcium chloride at 2% solution.
- Post harvest dipping of fruits in 500 ppm Ethephon reduces the occurrence of spongy tissue.

Mango malformation

Mango malformation was first observed by a farmer. Maries of Darbhanga in Bihar in 1981.

Mango malformation is of two types- vegetative and floral. The vegetative malformation is generally affects seedling of young plants in which there is a swelling of buds and formation of small shoots with short internodes at the apical end and give an appearance of broom like structure. In floral malformation , panicles become deformed, axes become short and rachis thick due to this inflorescence look like a cluster.

Probable causes of malformation have been reported as

- (i) fungal (*Fusarium moniliformae*)
- (ii) Physiological and biochemical

Control measures

- Spray NAA at 200 ppm in the first week of October.
- Adopt timely cultural operations i.e. weeding, irrigation and manuring to make the plants healthy and more stout to bear a good crop.
- Use healthy seedling for propagation to check the spread of the disease.

Clustering in Mango ('Jhumka') :

A fruiting disorder, locally known as 'Jhumka', is characterized by the development of fruitlets in clusters at the tip of panicles. Such fruits cease to grow beyond pea or marble stage and drop down after a month of fruit set. Absence of sufficient population of pollinators in the orchards is the major reason. The other reasons causing the disorder are old and overcrowding of trees, indiscriminate spraying against pests and diseases, use of synthetic pyrethroids, monoculture of Dashehari and bad weather during flowering

Control :

Introduction of beehives in the orchards during flowering season for increasing the number of pollinators and restrict insecticidal sprays at full bloom to avoid killing of pollinators.

Pests and diseases should be controlled in time by spraying the recommended pesticides and concentrations. Spraying of NAA (300 ppm) during October-November is recommended.

The practice of monoculture of a particular variety may be avoided. Particularly in case of Dashehari, 5-6% of other varieties should be planted in new plantations.

Fruit Drop :

The intensity of fruit drop varies from variety to variety. Among the commercially grown varieties, Langra is more susceptible to drop, while Dasherri is the least. The fruit drop is more or less. This is a continuous process and can be classified into three phases, viz.

- (i) pinhead drop
- (ii) post-setting drop
- (iii) May-month drop.

The fruit drop in first two phases are insignificant compared to the third phase which affects the final yield significantly and needs more attention. Embryo abortion, climatic factors, disturbed water relation, lack of nutrition, attack of disease and pest and hormonal imbalances are the major factors that lead to fruit drop.

Control :

The foliar application of Alar (B-nine) @ 100 ppm or NAA 20 ppm at pea stage of fruit was found effective in controlling fruit drop in mango.

Insects - pest of mango

Mango hopper (*Idioscopus clypealis*)

Symptoms

Piercing and sap sucking of tender parts by nymphs and adults causing reduction of vigour that leads to shedding of flower buds, flowers and young fruits.

Management practices

- Avoid dense planting, maintain clean orchards, prune overlapping branches and infested shoots.
- Neem based sprays can be utilized at initial stage of hopper population (Azadirachtin 3000 ppm@2ml/l). Three to five sprays depending on pest intensity, first spray before flowering with 0.1 % carbaryl, second at panicle initiation stage with 0.07 % quinalphos.

Mealybug (*Drosicha mangiferae*)

Symptoms

- Pinkish nymphs and adult mealy bugs are present on leaves, inflorescence, branches, fruits and fruit stalk.
- The nymphs of this pest suck sap from leaves and inflorescence causing dryness leading to flower drop and negligible fruit set.
- They also secrete honey dew which gives rise to sooty mold attack.

Management practices

- Proper orchard maintenance by removal of weeds that harbor mealy bugs.
- Ploughing of the orchard during November-December.

- Flooding of orchard with water and raking of soil around tree trunk exposes the eggs to sun and natural enemies thereby destroying them.
- Banding of tree trunk with polythene sheets (400 gauge) 30 cm above ground level and just below the junction of branching to obstruct the ascent of the nymphs. Banding should be done well in advance before the hatching of eggs, i.e., around November - December.
- Application of Methyl Parathion dust 2% @ 250 g per tree in the soil around the trunk during 3rd or 4th week of December.
- Early nymphs of the mealy bug can be controlled by spraying of 0.05 % carbaryl from January to March.

Harvesting and Postharvest Management

- Mangoes should be harvested with pedicel.
- Injury to the fruits during harvesting brings down their quality and also makes them prone to fungal attack.
- An average mango tree yields 8 tonnes /ha. The number of fruits per tree during its bearing age generally varies from 1000 to 2000 fruits.
- The productivity of mango is higher in Andhra Pradesh and Bihar.
- The north Indian mangoes Langra and Dashehari are alternate-bearers, whereas most of the south Indian mangoes are regular bearers. Mango Mallika and Amrapali are also comparatively regular-bearers.

- After harvesting, mangoes are graded according to their size. To maintain the quality, proper packaging is a must.
- In western region, bamboo baskets are used for packing.
- A basket contains 50-100 fruits. Straw is used for packing. Wooden boxes are also used in some place.
- However, now perforated cardboard are generally used. In these boxes either fruits are individually wrapped with tissue paper before packing or paper shavings are used for cushioning.
- Minimizing the post harvest losses is one of the most important aspects.
- Usually green and mature mangoes are stored better than ripe ones harvested from trees.

- Low temperature storage, controlled atmospheric storage, use of chemical treatment for delaying ripening, irradiation, heat treatment, packaging and shrink wrapping are methods to increase their shelf life.
- The temperature of 5-16°C for different varieties is ideal for storing.
- Mangoes are highly susceptible to low temperature injury.
- Loss of flavour and development of undesirable softening are major symptoms of chilling injury.

controlled atmospheric storage

- Under controlled atmospheric storage, retardation of respiratory activity, delaying of softening, colour development and senescence of fruits take place.
- Hence, this method has not been adopted in mango.
- The combination of waxing (3%) along with hot-water treatment results in good quality fruits with extended storage life.
- Individual wrapping of fruit imparts uniform colour and reduces shrinkage. Hydro-cooling at 12°-15°C and holding for 2 weeks at 15°C followed by storage for 1 week at ambient temperature gives good storage life to fruits.