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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

- The mango, *Mangifera indica* L , belongs to the Anacardeacea family which grows in a perennial tree of medium to large size with a symmetrical top.
- The flowers are produced in panicles which are about ten to twelve inches in length.
- The flower is hermaphroditic with male and female flowers in the same flower panicle.
- The fruit varies in size and has a fleshy pulp. The skin is leathery and varies in color from yellowish green to red. The seed is found in the center of the fruit.
- The fruit weighs about 1/4 pound to 3 pounds. Fruit may be round, ovate, or obovate depending on the variety.
- The immature fruit has green skin that gradually turns yellow, orange, purple, red, or combinations of these colors as the fruit matures.
- Mature fruit has a characteristic fragrance and a smooth, thin, tough skin.
- The flesh of ripe mangos is pale yellow to orange.
- The flesh is juicy, sweet, and sometimes fibrous.

Importance and use

Mangoes are full packed with vitamins, minerals and anti-oxidants and contain like all fruits very few proteins, fats and calories. They are perfect to replenish salts, vitamins and energy after physical exercise.

- It is a mineral packed chemical free food that has amazing benefits for our health.
- The mango-milk cure is an ideal treatment for loss of weight.
- Mangoes are thought to help stop bleeding, to strengthen the heart, and to benefit the brain.
- Taking Mango regularly makes the complexion fair and the skin soft and shining.
- Feeding the powder of dried kernel of Mango seeds with fresh water cures the habit of eating soil in kinds.
- Dietary fiber has a protective effect against degenerative diseases, especially with regards to the heart; may help prevent certain types of cancer, as well as lowering blood cholesterol levels.

Origin and distribution

Native range

- The genus Mangifera originates in tropical Asia, with the greatest number of species found in Borneo, Java, Sumatra, and the Malay Peninsula.
- The most-cultivated Mangifera species, *M. indica* (mango), has its origins in India and Myanmar.

Current distribution

- Mango is now cultivated throughout the tropical and subtropical world for commercial fruit production, as a garden tree, and as a shade tree for stock.
- In the Pacific region, all mangos were introduced from other parts of the world.
- The earliest recorded introductions into Hawaii were prior to 1825; however, most introductions to the Pacific islands have occurred over the past 100 years.
- Few other Mangifera species are found in the Pacific. *Mangifera gedebe, M. minor,* and *M. mucronulata* are found in the Solomon Islands and M. minor in Micronesia, but these either do not fruit or the fruit is inedible.

Climate and Soil

- Mango thrives well in tropical and sub tropical climate.
- It can be grown from sea level to an altitude of about 1400meters.
- The optimum temperature range is 24^0C to 27^0C. However, it can tolerate up to 48C during fruit development with regular irrigations, which improve fruit size, quality and maturity. Low temperatures (13^0C-19^0C) are good for flower bud differentiation.
- It can be grown in areas with rainfall from 25 cm to 250 cm if no high humidity water stress or rest 2-3 months before flowering improves flower bud formation.
- Mango grows in all soils with good depth and drainage except black cotton soils. Optimum PH is 5.5 to 7.0. It cannot tolerate saline conditions.

Cultivars

Cultivars of Mango

- B74, Brooks, green eating, Haden, Irwin, Keitt, Kensington Pride, Kent, Nam Doc Mai, Palmer, R2E2, Calypso, Honeygold.
- **Bangladesh**: Ashini, Fazli, Himsagar, Khirshapat, Langra, Lokhon-bhog, Raj-bhog
- **Brazil**: Coquinho, Haden, Manga Espada, Manga Rosa, Palmer, Tommy Atkins
- **Cambodia**: Cambodiana
- **Cameroon**: Améliorée du Cameroun
- **China**: Baiyu, Guixiang, Huangpi, Huangyu, Macheco, Sannian, Yuexi
- **Costa Rica**: Haden, Irwin, Keitt, Mora, Tommy Atkins
- **Ecuador**: Ambassador, Alfonso, Ataulfo, Criollos, Haden, Julie, Keitt, Kent, Reina, Tommy Atkins
- **Egypt**: Alfonso, Hindi, Hindi Besennara, Beid El Agl, Oweisi, Fuss Oweis, Taymoor, Zebdiah

- **Guatemala**: Haden, Kent, Tommy Atkins
- **Haiti**: Francine (Madame Francis), Muscas, Labiche, Baptiste, Rosalie, Poirier, Corne, Fil
- **Honduras**: Haden, Kent, Lancetilla, Tommy Atkins
- ***India***: Chausa, Dusehri, Gaddamar, Ottu Mangai, Mulgoba, Langra Benarsi, Badshahpasand, Surkha, Totapuri, Fajli, HusanNara, Alphonso, Amrapali, Badami, Bangalora, Banganapalli, Bombay, Bombay Green, Cheruku Rasalu, Chinna Rasalu, Pedda Rasalu, Roomani, Fajri Kalan, Fernandian, Gulabkhas, Himayath, Himsagar, Imam Pasand, Jehangir, Kalami, Kesar, Kishen Bhog, Komanga, Lalbaug, Langra, Maldah, Malgis, Mallika, Mankur (GOA), Mankurad, Moovandan, Nattuma, Neelum, Pairi, Priyor, Rajapuri, Raspuri, Ratna, Safeda, Sammar Bahisht, Suvarnarekha, Totapuri, Vanraj, Zardalu, Alampur Baneshan, Puliyan, Kuttiyattor, Ela Manga, Nannari.
- **Indonesia**: Arumanis/Harumanis, Gadung/Gedong, Manalagi, Cengkir/Indramayu, Gajah, Bapang, Lalijiwo, Kueni, Golek, Kemiri, Boled, Bengkulu, Situbondo,Kelapa, Alor, Selaputih,
- **Israel**: Haden, Keitt, Kent, Maya, Nimrod, Palmer, Tommy Atkins
- **Italy**: Kensington Pride, Glenn, Tommy Atkins, Keitt, Maya, Van Dyke, Osteen, Kent
- **Kenya**: Batwi, Boubo, Ngowe
- **Malaysia**: Apple Mango, Apple Rumani, Arumanis, Golek, Kuala Selangor, Malgoa, Maha-65, Tok Boon
- **Mali**: Amelie, Kent
- **Mexico**: Ataulfo, Haden, Irwin, Kent, Manila, Palmer, Sensation, Tommy Atkins, Van Dyke, Petakon, Oro, Criollo, Niño.
- **Myanmar**: Aug Din, Ma Chit Su, Sein Ta Lone, Shwe Hin Tha
- **Pakistan**: Chausa, Dusehri, Langra, Desi, Anwar Rataul, Sindhri, Fajri, Saroli, BaganPali, Alphonso, Muhammad Wole, Neelum
- **Peru**: Criollos, Haden, Keitt, Kent, Tommy Atkins
- **Philippines**: Apple Mango, Carabao or Kinalabaw, Indian, Piko, Paho, Pahohutan
- **Reunion Island** : Carotte, Jose, Lucie, Auguste
- **Singapore**: Apple Mango, Arumanis, Golek, Kaem Yao, Mangga Dadol

- **South Africa**: Fascell, Haden, Keitt, Kent, Sensation, Tommy Atkins, Zill
- **Sudan**: Alfonso, Bez el-Anza, Oweisi, Taymoor
- **Sri Lanka**: Dampara, Hingurakgoda, Karutha Colomban, Malwanaamba, Parrot Mango and Peterpasand, Petti amba, Rata amba, Vellai Colomban, Willard
- **Tanzania**: Boribo Muyini, Dodo, Mawazo, Sindano
- **Taiwan**: JinHwang, Red JinHwang, Tainong No.
- **Thailand**: Khaew Sawei, Nam Dok Mai, Rad, Brahm Kai Meu, Okrong

United States

- **Florida**: Alampur Baneshan, Alice, Alphonso, Anderson, Angie, Bailey's Marvel, Bennet Alphonso, Beverly, Bombay, Brahm Kai Meu, Brooks, Carabao, Carrie, Chok Anon, Cogshall, Cushman, Dot, Duncan, Earlygold, East Indian, Edward, Eldon, Emerald, Fairchild, Fascell, Florigon, Ford, Gary, Gaylour, Glenn, Gold Nugget, Golden Lippens, Graham, Haden, Hatcher, Ice Cream, Irwin, Ivory, Jakarta, Jean Ellen, Julie, Keitt, Kensington Pride, Kent, Lancetilla, Langra Benarsi, Lippens, Mallika, Manilita, Mendoza, Mulgoba, Nam Doc Mai, Nam Tam Teen, Neelum, Nu Wun Chan, Okrung, Osteen, Palmer, Parvin, Pascual, Philippine, Pickering, Po Pyu Kalay, Rosigold, Ruby, Rutledge, Saigon, Sensation, Sophie Fry, Southern Blush, Spirit of '76, Springfels, Sunset, Suwon Tip, Tebow, Toledo, Tom Dang, Tommy Atkins, Torbert, Turpentine, Valencia Pride, Van Dyke, Zill
- **Hawaii**: Hawaiian Common, Gouveia, Hawaiian Dwarf, Kurahige, Mapulehu, Momi K, Pope, Rapoza, Sugai, Turpentine
- **Venezuela**: Haden, Keitt, Kent, Tommy Atkins
- **Vietnam**: Cao LãnhCát Chu mango, Bình ??nhElephant mango, Hoà L Sand mango
- **West Indies**: Amélie, Black (blackie), Bombay, Dou-douce, East Indian, Graham, Haden, Julie (St. Julian), Long, Madame Francis, Rose, Spice-Box, Starch

Propagation

Mango is commercially propagated by

1. Veneer grafting
2. Approach grafting
3. Soft wood grafting

- June to Sept/Oct is best for grafting. Polyembryonic seedlings are best in providing uniform root stocks.
- Totapuri red small and Olour are dwarfing root stocks. Mango does not show significant variation on different rootstocks.

Land Preparation

- For backyard planting, prepare the land simply by digging a hole wide and deep enough to accommodate the ball of soil that goes with the planting material.
- This is recommended particularly in fertile, deep and friable soil. On poor soil, dig big, deep holes with a diameter of 30-50 cm. Set aside the top soil to be used to re-fill the hole after planting or transplanting.
- For orchard planting in flat or slightly rolling terrain, plow the field as deep as possible and harrow the field twice until fine tilt is attained before the onset of the rainy season.
- To accommodate other cultural activities and to ensure straight alignment of trees, layout the field using the desired planting system such as, square, quincunx, or triangular system.

Manures and fertilizers

- 10 kg Fym, 2.5 kg Bone meal , 1.0 kg pot sulphate for 1 year old plant and increased by 5 kg FYM, 0.5 kg bone meal and 0.4 kg pot sulphate per year till 10th year.
- Bearing trees may be given 750 gm N, 200gm P2O5 and 700 gm K2O/year/tree. It is better always to apply organic manures during October.
- Manures should be applied in a small trench dug from about 1.5-2m from the trunk upto the drip line.
- Watering should be done soon if no rains.

Irrigation

- Irrigation should be according to the soil and weather conditions.
- Bearing trees should be irrigated regularly at 10-15 days interval from fruitset to maturity.
- Plant should be given rest by stopping irrigations at least 2-3 months before flowering for maximum fruit bud development.
- Under drip, plants may be applied with 40 liters/tree twice a week.

Cultivation

Land should be ploughed to proper tilth. Pits of 90 x 90 x 90 cm are dug at a spacing of 8-10 M. Pits may be filled with FYM.

Planting

Planting is done during rainy season graft union should be kept at least 6 inch above the soil at planting. Staking should be done and watered soon after planting.

Intercultural operations

- Intercropping can be done in prebearing period to keep the weeds under control and to get some additional income.
- Phalsa, Papaya and Pineapple or Vegetables can be grown if irrigation facilities are available.
- Cover crops like Sun hemp, Daincha, Cow pea, Cluster bean,etc, also can be grown during rainy season and ploughed into the soil before the end of the rains.
- Land should be ploughed twice an year during June and October.
- Weeds can be controlled by the application of 4 kg/ha Atrazine/oxyflurofen (Goal) @ 800ml/ha as pre-emergence and application of 2 liters/ha Gramaxone (Paraquat)/as post emergence.

Weed management

- Root zone area of the trees must be kept weed free all the time.
- Manual cultivation is not recommended as it will disturb active roots.
- Weed killers with a heavy mulch may be quite effective in controlling weeds.
- Weed control practices do not differ from what was explained for non bearing trees.

Pruning and Training

- Mango needs no regular pruning except removing dead and diseased branches.
- Young plants should be trained properly to have a good framework.

Flowering and fruit set

- Flower bud formation takes place 2-3 months prior to flowering.
- Flowering occurs from Nov-Dec to Feb-Mar depending upon locality and variety and continues for about 2-3 weeks.
- Flowers are polygamous-sex ratio can be improved by application of NAA 200ppm at flower bud initiation stage.

Fruit drop

1. Fruit drop is natural and is very high in mango specially during the first four weeks. Soon after flower opening
2. After pollination and fertilization

3. At grain stage of the fruit.

This occurs as an adjustment to the resources available in the plant for the development of fruits and is natural. Drop of grownup fruits is a major problem.
This may be due to competition between developing fruits, drought or lack of irrigation, adverse weather conditions and incidence of serious pests and diseases.
This can be avoided by regular irrigations during fruit development, application of optimum doses of nutrients effective control of pests and diseases and some hormonal sprays like 2, 4-D (10-30 ppm) NAA (5-50 ppm), 2,4,5-T (20 ppm) etc.,

Alternate Bearing

Irregular and alternate bearing in mango is a major problem faced by mango growers. This problem causes great economic loss to the growers with the poor yield or failure of crop during "off year" and the selling produce at low price during "on year" due to fruit glut in the market. Though planting of regular bearing varieties like Amrapali are suggested for getting regular fruits, most of the commercially grown varieties in North India, like Dussheri, Safedas, chousa and Langra are alternate bearers. In such trees regularity can be achieved by pruning, flower induction with paclobutrozol, fertilization, irrigation and pest control.

- Mango normally flowers during February-March and is ready for harvest during June-July. Fruits are borne largely on previous years shoots, so pruning should not be very severe. Light pruning limits the vegetative growth and activates the quiescent fruit bearing buds by redistributing the endogenous hormonal substances and favours flowering, fruiting and improves fruit yield. After harvesting the fruits, troop off branches to open the centre. Also remove dead wood, weaker branches and criss-cross branches to allow sunlight to enter the canopy.
- This should be followed by tractor ploughing and fertilizer application. Though recommended doses of fertilizer differ with locality and variety, in general apply 1.5 kg N, 0.75 kg P2 O5 and 1.5 kg K2O (in two split doses) along with 250 kg FYM/tree, in the drip circle.
- Foliar spray of 1 per cent potassium nitrate or 1 per cent potassium dihydrogen phosphate + 1 per cent urea thrice at monthly intervals should also be done to achieve a balance in carbon and nitrogen ratio. During September-October months, treat the soil with paclobutrazol (5g/ plant).
- The field should be irrigated immediately after treatment to increase efficiency. Paclobutrazol checks Gibberelic Acid biosynthesis, increases cytokinin level, Chlophyll content, improves mineral uptake and carbohydrate gradient of the entire plant system. This helps in achieving a balance in C:N ratio which induces flowering normally.
- After flowering, attack by mango hoppers and powdery mildew a fungal disease will completely destroy the inflorescence. Two fortnightly sprays with Carbaryl (0.25 per

cent), Diazinon (0.1 per cent) or Endosulfan (0.07 per cent) in the month of February and March, will check attack by mango hoppers.

- Similarly spraying with wettable sulphur (2g/ lt of water) is quite useful to control Powdery mildew. A liquid soap should be mixed along with pesticides for proper retention of the chemical on the plant surface. The trees thus treated will give bumper crops regularly year after year.

Harvesting and yield in mango

Stage of harvesting is very important, which will be indicated by

1. Starting of Colour development
2. Falling of one or two fruits from the plant
3. Specific gravity of 1.0 to 1.02(more reliable)

Mango normally takes 90-120 days from fruit set to maturity. Harvesting is done using pole harvesters without causing any damage to the fruit.

- Mango grafts come to bearing in about 2-3 years but commercial yields can be had from 8-10 years and may continue up to 40-60 years.
- Average yield is 8 tonnes/ha and may vary according to variety and locality.

Packing and transport

- Mangoes are normally packed in bamboo baskets using straw as the padding material.
- Wooden and card board boxes are also used. Wrapping fruits individually maintains the quality of the fruit.
- Waxing 3% with hot water treatment improves storage life mangoes can be stored at 5-14^{0}c and 90% RH for about 2-7 weeks depending upon the variety.

Mango malformation

Production of thick vegetative shoots and transformation of floral parts into a compact mass of sterile flowers.

Two types of malformation

1. Vegetative malformation
2. floral malformation

Vegetative malformation resembles “bunchy top” which may dry and die in due course. Floral malformation results in enlargement of flowers with new flowers being produced even after fruit set but with less % of hermaphrodite flowers.

Malformed panicles may be

1. Loose
2. Compact.

Malformation is serious in North than in South. It may result in loss of about 50-60% of the total crop. Krishnabhog, Collecter, Langra, Neelum are tolerant (seedling trees are found to be tolerant)
Virus, fungus, mites, nutrients, C/N ratio, carbohydrates, nucleic acids, amino acids, proteins, phenolic compounds, enzymatic activity in the plant, phytohormones and occurance of malformation like substance are all supposed to be the probable causes for malformation.

Control measures

1. Application of plant growth regulators and phenolic compounds (NAA,Ethrel,GA, Paclobutrozol, etc.)
2. Deblossoming: at bud brust stage-ethrel
3. Use of antagonists and antimalformins: Glutahione, Ascorbic acid, Silver nitrate
4. Application of nutrients: High NPK added with FeSO4, Cobalt sulphate
5. Pruning of malformed parts.
6. Application of pesticides: Parathion,Kelthane,Kerathane.
7. Covering panicles with polythene film to raise the temperature around the panicle.

Inspite of this, malformation is still a puzzling problem. It is therefore concluded that malformation can be kept under check by maintaining

1. Orchards cleanly using disease free planting materials only.
2. Regularly inspecting the orchard
3. Regularly removing all malformation parts and
4. Spraying of insecticides after each pruning.