

Topic- Banana Cultivation

Course- FSC-502 Subtropical and Temperate Fruit Production



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Other name- Apple of Paradise/Adam's fig/Plant of Virtue/Tree of wisdom/Antique fruit crop
Botanical name- *Musa spp.* **Chromosome no.-** 2n=22, 33, 44
Family- Musaceae **Origin-** Indo-Malaya region/South East Asia
Type of fruit- Berry **Inflorescence-** Peduncle
Edible part- Mesocarp and Endocarp (Starchy parenchyma)
Propagation method- Sword sucker and tissue culture
Pollination- Cross Ornithophilous or Chiropterophilous Mesocarp
Curve- Single sigmoid (In seeded Banana) Double sigmoid (In seedless Banana)

Banana is an important fruit of tropics. The fruit is recognized as the fourth most important global food commodity. India's share is 32 per cent of the total fruit production. This is the only tropical fruit which is exported in large quantities and is leading fruit in the international trade. It is one of the oldest and commonest of the Indian fruits that has been cultivated since ancient times.

The flower bud and also the central core of the pseudostem are used to prepare tasty dishes. Banana leaf is used as plates for serving food, leaf sheaths are used as wrapping material and dry leaves as fuel, while, tender pseudostems, leaves, underground rhizomes are used as cattle feed.

Apart from fresh consumption, some types are also used for culinary purposes.

Uses and composition: Banana by virtue of its, multiple uses is popularly known as “Kalpataru” (a plant with virtue). Usually banana is eaten when ripe as dessert / table fruit. Plantain or cooking bananas are the staple food of people in many countries of central and western Africa.

- ❖ Banana is thus called apple of paradise.
- ❖ It is also known as “Adam’s fig or tree of wisdom. It is used as staple fruit in most of the African countries and is used as ripe (table) or raw fruit (cooking). All the plant parts are being used.
- ❖ Eve was said to have used banana leaves to covers her modesty in the garden of paradise.
- ❖ Various processed products like banana chips, toffee, puree, powder, flour, vinegar, jam, jelly and wine can be prepared from the fruit. Banana fiber can be made in to attractive napkins, table mats and carry bags.

The fruits have a lot of medicinal properties and are used for treating various health disorders specially acidity, ulcer, joint pains, high blood pressure and heart diseases.

It contains 73 per cent moisture, 25-30 per cent carbohydrates, 1.4 per cent protein, 0.3 per cent fat, 0.5 per cent mineral matters (Ca, Fe, P,K) and Vit- C and K.

This fruit is available throughout the year. Banana leaf is used as plates for serving food, leaf sheaths are used as wrapping material and dry leaves as fuel, while, tender pseudostems, leaves, underground rhizomes are used as cattle feed.

Origin and distribution: The origin of banana is believed to be in the hot, tropical regions of South-East Asia, stretching from India to Papua New Guinea, Malaysia and Indonesia.

India has the second largest diversity of indigenous bananas in the world. India has more than 300 germplasms, out of 600 reported worldwide. Edible Banana has arisen as a result of natural crosses between two wild progenitors viz,. *Musa. paradisiaca* and *Musa. balbisiana*.

Banana is being grown in many of the African countries between 30° N and 50° S latitudes. Important countries are India (1st place) with a total production of 17 million tons from an area of 0.50 million hectare, and the other countries growing banana are Kenya, Uganda, Sudan, Fizi, Honduras, Hawaii, Canary Island, Philippines, Taiwan, Australia, Bangladesh, South Africa, Pakistan etc.

In India, it is the 2nd major fruits, occupying about 20 per cent of the total area under fruit crops and 32 per cent of total fruit production, Tamil Nadu (88,000 ha.), Maharashtra (59,000 ha.), Karnataka (61,000 ha.), Assam, Andhra Pradesh, Orissa.

Gujarat and Kerala are the leading producers. Though, India is the leader in banana production, Indian export of fresh banana is meager (12 million tons).

Soil and Climate: Banana can be grown in almost all types of soil provided adequate soil moisture is available. Deep well drained, loamy soil with adequate organic matter is ideal for its cultivation. The plant has restricted root zone. It can grow well in slightly alkaline soils.

Though banana requires large quantity of water, it cannot tolerate water stagnation. The optimum soil pH is 6.5-7.5. Banana being a tropical fruit crop, adapted to wide range of climatic conditions. It is grown up to an altitude of 1200 m from mean sea level. The temperature range is 13- 40°C, but the optimum is 25-30°C for getting good yield, Heavy storms, frost, low temperature (Less than 10°C) or extremely high temperature are detrimental to plant growth which leads to abnormal or malformed condition.

Species and cultivars: The family musaceae has two genera viz., Ensete and Musa with about 50 species.

Ensete- is an old genus, which probably originated in Asia and spread to Africa. It has about 6-7 species, of which Ensete and Ventricosa has been reported to be grown as a food crop.

Musa: it is having 40-45 species, all the varieties under these species are under cultivation. The genus Musa is divided into following sections.

Eumusa (2n=22): This is the largest section with 13-15 species, all are cultivated forms; Pseudostem usually exceed 3m in height with pendent or semi pendent inflorescence, produces 10-25 nodes of flowers and covered with dull brown colour bracts, gives the edible cultivated parthenocarpic banana and are derived from 2 wild species. *Musa accuminata* (A) and *Musa balbisiana* (B)

Callimusa: (n=10): It is having 5-6 species. Plants with less than 3 mtrs in height, suited as ornamental, parthenocarpy absent completely.

Australimusa (2n=20): These fruits are parthenocarpic and predominantly female sterile; The fruiting bunch is erect and contains a red sap, the skin is orange in colour when ripe. eg-Musa *textilis* (*Manila hemp*).

Rhodochlamys (2n=22): It is having 5-7 species, spreads from India to Indonesia, pseudostem less than 3m height with erect inflorescence, parthenocarpy absent eg-M. ornate & M velutina are sometimes grown as ornamental plants.

Incertae sedis- ($x=7$; $2n=14$) - it is the largest among the Musaceae family, grows to a height of over 10m. eg-*M. ingens* & *M. beccarii* ($x=9$, $2n=18$).

All the edible bananas are descendents by natural cross between 2 wild ancestors, ie., *Musa acuminata* (A) and *Musa balbisiana* (B). These edible bananas have 22, 33 or 44 chromosomes i.e., Diploids, Triploids and Tetraploids respectively. Triploid cultivars are generally numerous, diploids somewhat less and tetraploid forms are very rare. The basic haploid numbers is 11.

Important Varieties of banana

Common Name	Synonym	Genome	Specific Features
Poovan	Champa	AAB	Resistant to panama wilt, tolerance to drought and disease
	Lal Velchi		Severely affected by banana streak virus
	Palyangodn		
Monthan	Bontha		Drought resistant.
	Kanch Kela		
	Ponthan		
Dwarf Cavendish	Basrai Dwarf	AAA	Occupies percent of cultivar grown in Indian banana industry
Harichal	Robusta	AAA	Semi- tall sport of Dwarf Cavendish
Rasthali	Martman	AAB	Choicest table variety
	Mutheli		Problem: Hard lump and fruit cracking
Hill Banana	Virupakshi	ABB	Suitable for higher elevation
	Vellavazhai		Perennial banana system
Nendran	Ethankai	AAB	Suitable for higher elevation, good keeping quality
Red Banana	Sevazhai	AAA	Long duration of cropping-16 Month, grown only backyard garden
Kunnan		AB	Popular dessert variety
Ney Poovan	Rasa Kadli	AB	Popular Dessert Variety
BRS-1	Agniswar× Pisang Lilin	AAB	Tolerant to Siktoka leaf spot
BRS-2	Vannan× Pisang Lilin	AAB	Tolerant to leaf spot and Panama disease, rhizome weevil and nematodes
CO-1	(Laden× <i>M. balbisiana</i> × <i>Kadali</i>)	AAB	Pome hybrid
HI			Highly resistant to leaf spot, <i>Fusarium</i> , wilt, nematode
FHIA-1	Golden Finger	AAAB	Resistant to sigatoka and wilt
Udhayam		AAB	Ratoon crop, field tolerant sigatoka, suitable for long distance and processing
Lady finger		AB	Resistant to bunchy top virus, Introduced from Australia
Grand Naine		AAA	Introduced from France, mutant of dwarf Cavendish
Pisang Lilin			Resistant to Panama wilt and nematode
Tongant			Resistant to Panama wilt and nematode
Anaikomban			Resistant to Panama wilt and nematode
Karpuravavali		AAB	Tolerant to drought, salt, wind, and suitable for juice and wine
Klue Tempod		ABB	Tall Mutant of dwarf Cavendish
FNTOM-1			Early flowering, mutant from Grand Naine
Red M... ..		AAAA	

Variety, score, genome, and polidy level of banana

Variety	Score	Genome	Polidy
Matt, Anai, Komban, Sanna, Chenkadali, Surya Kadali, Namarai, Pisanglilin, Tongat	16-23	AA	2 _x
Ney Poovan, Thaen Kunnan, Kunnan, Adakka Kunnan, Nattu Poovan, Nattu Poovan	46-48	AB	2 _x
Robusta, Red Banana, Dwarf Cavendish, Gross Michel, Amrit Sagar, Chankarakeli	15-21	AAA	3 _x
Poovan, Rashthali, (Silk), Nendran, Virupakhshi, Pachanadan, Sugandhi, Rajapuri	26-46	AAB	3 _x
Karpuravalli, Peyan, Monthan, Kari Bontha, Kallu Monthan	59-69	ABB	3 _x
Boldles Altafort (synthetic hybrid not existing in nature)	15-20	AAAA	4 _x
Kalu Temparod, Swai (synthetic hybrid)	63-69	ABBB	4 _x

Crop improvement: The commercially cultivated bananas are susceptible to pest and diseases. Also to increase the yield and improve the post-harvest quality of fruits, some of the national and international institutes are working out for improvement of banana crop.

International Network for Improvement of Banana and Plantain (INIBAP) - France. International Institute for Tropical Agriculture (IITA) - Nigeria.

ICAR- Aduthurai-Tamil Nadu i.e NRC on banana and later it was shifted to Trichy.

FHIA-Fundacion Hondurena de Investigacion Agricola, Handura released different banana hybrids

Indian Institute of Horticultural Research (IIHR), Bangalore, KAU, Kannara, Kerala, Fruit Research Station, Kavoor, Andhra Pradesh. All these institutions have worked on collections, evaluation and improvement of banana germplasm for further breeding programme. All the cultivated varieties i.e, 303 cultivars, which are all natural hybrids between *acuminata* and *bulbisia*. Cultivated and edible types belongs to pure *acuminata* (AA) family.

IC-1- The first hybrid between Gross michel x *Musa acuminata* sub species *Malacensis* developed in 1990 from IITA, Nigeria, resistant banana clone for wilt disease, which is similar to that of Gross michel, a premier cultivar in that zone. It was not accepted. Because it produces small fruits. Also IC-2, 5-19 - none of them are better than Gross michel. Later,

Propagation: Banana is traditionally propagated vegetatively through suckers or rhizome or tissue culture plants. Sexual propagation is not possible due to Parthenocarpic nature of fruits. Banana produces two types of suckers’.

1. Water suckers.

2. Sword suckers.

Water suckers: Water sucker is one which is characterized by broader leaves which do not produce a healthy banana clump, with slender pseudostem. Rhizome/corm is not well developed. It takes more time (more than 18 months) for yielding. Yield also less. These types normally develop from shallow buds away from pseudostem near the soil surface.

Sword sucker: Sword sucker is one with well developed rhizome, well developed pseudostem with sword like leaves. It takes 12-13 months to yield and gives bigger bunches. Sword suckers are closely associated with the mother plant and therefore develop strong thick rhizomes of their own.

Important criteria's to select the suckers for planting

- The orchard/mother block should be disease free.
- The weight of the suckers should be 1.0- 1.5 kg.
- The mother plant should be heavy yielder.
- Always select sword suckers for planting.
- Select the suckers free from rhizome weevils.
- Age of suckers: 3-4 months

The whole or split rhizomes can also be used when suckers are not available. Bits of rhizomes may also be used as a planting material. Tissue cultured plants were also used as planting material on commercial scale.

Pairing & Prolinage: It is the removal of older leaves, roots, adhered soil and other particles on the surface of rhizome and top portion of the suckers leaving 15cm from rhizome should be removed and immersed in cow dung slurry, sprinkle phorate granules @ 10-15 g/rhizome in order to avoid soil pathogen & rhizome weevils. Also rhizomes are dipped in fungicide solution by giving a slant cut

Planting: Banana can be planted throughout the year except in severe winter and during heavy rains. In general, June-July is the most common season of planting.

Pit method: Pit method and furrow methods are commonly followed. The pit size of 60cm³ should be opened at 1.8 x 1.8m or 2 x 2m (Tall varieties) adopting square system. These pits are filled with top soil with 20-30 kg. FYM should be applied at least 15-30 days prior to planting. During planting each pit will be supplied with 250gm neem cake and 50 gm of trichoderma to prevent nematode & rhizome rot problems. Planting of suckers at the centre of pit and irrigate immediately after planting. Spacing should be adopted variety wise.

Furrow method: This is the most common method of planting. Furrows of 15-20cm deep are opened at a regular distance and rhizomes are planted in the furrows. Paired row planting in tissue culture plants

Tissue culture plants: Banana is also grown commercially by using tissue cultured plants, these plants required much care throughout the growth period compare to suckers and yields about 10-20 per cent more than suckers.

In recent years the concept of HDP is being practiced, suckers are planted at closer spacing or planting two suckers per pit by accommodating more number of plants at specified spacing to get higher yield and reduced cost of production. The cultivar Robusta and Dwarf Cavendish spaced at 1.5x1.5m accommodates 4444 plants/ha is recommended by IHR was recorded highest yield. Irrigation: The soil in banana plantation should not be allowed to dry completely. Banana requires high amount of water ranging from 1800-2500 mm annually. About 40- 45 irrigations are required from planting to harvest at 4-5 days interval.

Nutrition Management: Banana is a heavy feeder, Due to shallow root system of the crop, it responds well to applied nutrients. The high fertilizers requirement of banana is mainly due to their rapid and vigorous growth and high fruit yield.

Fertilizers have to be applied before initiation of inflorescence in 3 splits i.e. 2nd , 4 th and 6th months after planting. The fertilizers should be applied at 30-45cm radius from the plant by making basin and mix with the soil then irrigates the plant.

Weed control: In banana, weed is a problem at the early stage of growth, for conservation of moisture, proper utilization of nutrients as well as for effective control of pests and diseases weed free environment is essential in banana. Integrated weed management programme should include growing of cover crops, use of herbicides, inter cropping and hand weeding where ever necessary. Pre emergence application of Diuron at the rate of 4kg/ha controlled grasses and broad leaved weeds without affecting the yield and quality of banana or application of Glyphosate 2kg/ha followed by gramoxone 1.8kg/ha proved effective in controlling weed growth.

Important cultural practices:

Desuckering: Desuckering is done by cutting the pseudostem of sucker at the ground level followed by application of kerosene/2-4, D @ 0.5 per cent also the growth of suckers can be inhibited by damaging the cut end to prevent further growth. As banana produces number of suckers, if allowed, they compete for moisture nutrition with mother plant; one or two healthy sword suckers may be allowed to grow for ratoon crop. Earthing up: To prevent uprooting of plant by wind soil is mounded around the pseudostem during rainy season.

Propping: Providing support to the plant when it is at bunching stage. If dwarf variety and closed spacing no propping is required but for all tall varieties, it is required by using bamboo poles or any other supports.

Denaveling: Removal of male buds after the last set of fruit. It increases the bunch weight/fruit weight and quality of fruits also.

Thrashing: A process of removal of old, dry, diseased and senescent leaves this could reduce the disease and facilitate better light, temperature and air. However, if leaves are pruned before bunch initiation, flowering is delayed and cycle time increased. A minimum of 12 leaves are required to be retained for maximum yields

Bunch covering: Bagging of bunch with perforated polythene cover or dried leaves to protect against cold sun scorching, attack of thrips and other scrapping insects, during bunch maturity stage, the bags may be coated with pesticides.

Growth and development of the plant: During the life cycle, the plant produces 30-40 at 4 leaves per month depending on variety. The last leaf produced at shooting which is small in size is called flag leaf. The first distinguishing feature between vegetative and reproductive phase is the production of bract primordium. The basal (proximal) nodes of the inflorescence bear female and the upper (distal) nodes contain male flowers. In between male and female buds, hermaphrodite flowers and have stunt ovaries.

The edible bananas are vegetative parthenocarpic, the female sterility gene and lack of pollen due to triploidy causes seedless nature.

Use of Plant Growth Regulators: The process of flowering governed by Gibberlin like substances helps in development of plant, later on antheclin hormone inducing flowering of plant, both combiningly called as “Dual factors hypothesis”. Spraying of NAA at 100 ppm after 5 and 7 months of planting markedly increases fruit size and yield. Spraying of 2-4 D@ 20ppm increased the quality of fruits. It is poured in the growing apex, than bunch will have more of female flowers/fingers. Application of GA₃ at 50mg/L resulted in maximum yield and required less number of days for fruit maturity in Giant Governor Banana.

Fruit maturity and harvest: Under favorable conditions, banana starts flowering in 9-12 months and fruits matures in about 4-5 months depending upon varieties, climate etc. Banana are harvested at 3/4th maturity stage for distant markets or for chips making purpose while, for local markets are harvested at full maturity. The following are the indications of maturity of banana.

- Drying of top leaves.
- Changing of fruit colour from green to light green.
- The floral ends of fruits are shed with slight hand touch at apices.
- Fruit become plumpy and angles are filled & disappear.
- One or two fruits ripe at the basal end (yellow colour).
- Starch content of the fruit (22-25%).

The bunches are to be harvested by leaving 2 ft of peduncle on the bunch.

Mattocking: It is the process of cutting the pseudostem after harvesting of bunches. After harvesting the pseudostem should be cut leaving a stump of about 0.6m high, the left over stump with its stored food material continues to nourish the daughter sucker (follower) till it withers and dries up. Yield: Yield of banana varies with variety, production practices. Tall cultivars usually yield 15-20 tones/ha. Cavendish group varieties yield about 40t/ha, whereas the hill banana/cooking varieties yield about 11-15 tones/ha.

Post harvest management: Banana can be stored at about 13°C with the Relative Humidity of 85-95 per cent for 3 weeks and is ripened in a week at 16.5-21.0°C. The fruits should not be stored / shifted under refrigerated condition. The storage life can be increased by keeping the fruits in high concentration of carbon dioxide and low concentration of oxygen. Also storing in sealed polythene bags containing ethylene absorbent like potassium permanganate. Shrink film wrapping or Waxol (12 per cent) treatment can extend shelf life up to 3 weeks. Bananas are not usually allowed to ripen on the tree; Smoking done with straw, leaves & cow dung in a closed chamber for 18-24 hours in summer and 48 hours in winter and later shifted to ventilated room for uniform ripening. The exogenous application of 100 ppm ethylene gas in an enclosed chamber for 24 hrs for will produce uniform colour and ripening.

Rhizome and sucker production: The true stem of banana is technically tuberous. The mature rhizome is about 300 mm in diameter and has extremely short internodes covered externally with closely packed leafscars. The rhizomes should remain completely below the surface of the soil for stability of the plant. Production of banana suckers in large quantities is currently receiving attention in the wake of great demand for elite planting material. Suckers production in banana is influenced by a complexity of factors.

Puer accuminata diploids and triploids produced larger number of suckers than the *balbisiana* derivatives. The nutritional status of the mother plant has an overwhelming influence on sucker production. Among the cultivars, greater uptake of nutrients by a cultivar of the same ploidy level resulted in more sucker production. for instance, Anaikomban (AA among the diploids and Monthan (ABB) among the triploids showed higher uptake of nitrogen with resultant increase in the production of suckers.

Diseases of banana

Diseases	Causes	Control measure/ remark
Buncy top of banana	<i>Pentalonia nigronervosa</i> viral disease	First recorded in FiJi 1891, spray Rogor @ 0.05 percent or Metasystox @ 0.1 percent at interval of 15 days to control
Leaf spot	<i>Cercospora musae</i>	Spray copper based fungicides, sexual stage from java
Yellow/black sigatoka leaf spot	<i>Mycosphaerela musicolla</i>	Most serious disease in subtropics region, spray 1.0 percent Bordeaux mixture and dip the fruits in mycostain @ 400ppm
Panama disease	<i>Fusarium oxysporum</i> f. sp. Cubense	Applied bioagent Tricoderma viride and Pseudomonas flourescence, plant resistant variety like Basari Dwarf and Poovan
Moko disease or bacterial wilt	<i>Ralstonia solanacearum</i>	All tools thoroughly disinfected, infected plants need to be destroyed
Banana bract mosaic virus (BBMV)	Transmitted by aphids	Remove susceptible host plants around plantation, plant virus-free material
Anthracnose	<i>Colletotrichum musae</i>	Dipped in fungicide prior to shipping; protect fruit from injury, remove flower parts

Insect-Pests of banana

Insect-Pests	Causes	Control measure/ remark
Rhizome or crome weevil	<i>Cosmopolites sordidus</i>	Pit application of phorate or dip treatment of sucker with monocrotophos 0.1 percent for 30 minute
Pseudo stem weevil	<i>Odoiphorus longicollis</i>	Application of monocrotophos 36WSC 2ml/lt, exudation of sap, apply carboburan granules 3 g stool before the expected attack of borer
Banana burrowing nematode	<i>Radopholus similis</i>	injection of glyphosate in the pseudo-stems to the usua, most destructive pest, reported by Nair <i>et al.</i> 1969
Banana aphids	<i>Pentalonia nigronervosa</i> vector of bunchy top virus	Natural ladybird beetles, hover flies, earwigs and lacewings usually maintain low aphid populations
Lesion nematode	<i>Pratylenchus coffee</i>	Incorporation of green manure such as oat, sudangrass, sesame, rapeseed, white mustard the season before dry beans are planted can reduce some nematode populations, reported by Rajagopalan and Chinnarajan in 1976

Physiological disorder of banana

Disorder	Causes	Control measure/ remark
Neer Vazhi- immature unfilled fingers lanky bunch and delayed shooting	Transmitted through sucker	No remedial measure, Nendran is susceptible variety
November dump	When the flower initiation occurs during the winter	A good orchard practice is to cut down all the plants producing severe November dumps
Kotta vazhi- Enlarge ovule with immature fruit	It is noticed only in Tamil Nadu	Poovan susceptible causes unknown, spraying of 2,4-D 20 ppm (1g in 50 litres of water) immediately after the last hand opens.
Yellow orange chlorosis, leaf bending rapid desiccation	Potassium deficiency	Spraying Potassium Sulphate (1 percent) solution
Goose flesh	Ripen under dry conditions	There is no remedial measure to overcome this disorder.
White leaf	Unbalanced nitrogen	Application of urea (300g/plant)
Blue disease	Mn deficiency	Application of Magnesium Sulphate (25g/plant)

THANKS