

## **GUAVA (*Psidium guajava*) (2n=22)**

In guava, most of the commercial varieties are reported to be diploids, the chromosome number being  $2n=22$ , while the seedless varieties are triploids.

**Origin:** Tropical America / West Indies

**Distribution:** America, Canada, Australia, India, Burma, Indonesia, Bangladesh etc. In India Uttar Pradesh, Andhra Pradesh, Maharashtra, Karnataka etc.

### **Breeding objectives**

- Development of seedless variety
- Less pectin content for edible purpose
- More pectin content for processing
- Uniform ripening
- High keeping quality
- Resistance to tea mosquito bug and wilt.

### **Breeding methods**

#### **1. Clonal selection**

Propagation by seeds "during early days gave rise to considerable variation in the form and size of fruit, the nature and flavour of pulp, seediness and other morphological character such as spreading or erect growth habit of the tree. Improvement work for the first time was initiated during 1907 at Ganeshkhind Fruit Experimental Station, Pune primarily with the collection of seeds of varieties, grown in different places to isolate superior strains. About 600 seedlings were raised and evaluated for fruit and yield characters. One strain from open pollinated seedlings of Allahabad Safeda collected from Lucknow was selected and released as Lucknow49, which is a popular variety throughout India.

At Horticultural Research Station, Saharanpur, evaluation of seedling types resulted in a superior selection, S-I, having good fruit shape, few seeds, sweet taste and high yield. 11w w -

At IIHR, Bangalore, from 200 open pollinated seedlings of variety Allahabad Safeda collected from Uttar Pradesh, one seedling selection, Selection-8, was found to be promising.

#### **2. Hybridization**

At IIHR, Bangalore, by hybridization among Allahabad Safeda, Red Flesh Chittidar, Apple Colour, Lucknow-49 and Banaras, 600 FI hybrids were raised. One hybrid viz Arka Amulya has been released recently. It is a progeny from the cross Allahabad Safeda Triploid. Plants are medium vigour and spreading type. Fruits are round in shape. Skin is smooth and

yellow in colour. Fruits on an average weigh about 180-200g, Flesh is white in colour and firm.

TSS is around 12° Brix, soft seeded, weight of 100 seeds is 1.8g. Keeping quality is good.

At Fruit Research Station, Sangareddy (Andhra Pradesh), inter-varietal hybridization resulted in the isolation of two superior hybrids. .

**Safed Jam:** This is a hybrid between Allahabad Safeda and Kohir (a local collection from Hyderabad-Karnataka region). It is similar to Allahabad Safeda in growth habit and fruit quality. The fruits are bigger in size with good quality and few soft seeds.

**Kohir Safeda:** It is a hybrid between of Kohir x Allahabad Safeda. Tree is vigorous, the fruits are larger with few soft seeds and white flesh.

Haryana Agri. University, Hisar has released two hybrid varieties.

**Hisar Safeda:** It is a cross between "Allahabad Safeda" x 'Seedless,' which has upright growth with a compact crown. Its fruits are round, weighing about 92g each, pulp is creamy - white with less seeds, which are soft, TSS is 13.4% and ascorbic acid 185 mg / 100g.

**Hisar Surkha:** It is a cross between 'Apple Colour' x 'Banarasi Surkha'. Of the pink fleshed hybrids, it is ideal. Tree is medium in height with broad to compact crown, fruit is round weighing 86g each, pulp' is pink having 13.6% TSS, 0.48% acidity and 169 mg/100g of ascorbic acid. Yield is 94 kg/tree/year.

### 3. Polyploidy Breeding

Producing triploids will be futile since the fruit shape in triploid is highly irregular and misshapen because of differential seed size. However in order to evolve varieties with less seeds and increased productivity, crosses were made at the IAR!, New Delhi, between seedless triploid and seeded diploid variety Allahabad Safeda. Of the 73 F. hybrids raised, 26 were diploids, 9 trisomies, 5 double trisomies and 13 tetrasomics. Distinct variation in tree growth habit and leaf and fruit characters were observed

**Banana (*Musa paradisiaca*) – Fruit variety**  
**(*Musa sapientum*) – Vegetable variety**

(2n=22, 33, 44)

**Origin:** Tropical Asia

**Distribution:** USA, Canada, Europe, Brazil, India, Pakistan, Bangladesh, Indonesia, Burma and China. In India Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa and West Bengal.

The edible cultivated parthenocarpic bananas belong to the section 'Eumusa' which are derived from *Musa acuminata* and *M. balbisiana*. They have 22, 33 or 44 chromosomes; the basic number being  $n=11$  so that these cultivars are respectively diploids, triploids and tetraploids. Triploid cultivars are generally the most numerous, diploid somewhat less and tetraploids are very rare. Simmonds and Shepherd (1955) devised a method of indicating the relative contributions of these two wild species to the constitution of a cultivar. This involves a scoring technique using 15 morphological characters and applying the derived information to distinguish the *M. acuminata* types from those of *M. balbisiana*.

Depending upon the contribution of these parents to the constitution of the progeny and their chromosomal status, the naturally occurring edible bananas fall into seven groups; two diploids (AA, BB), three triploids (AAA, AAB, ABB) and two tetraploid (AAAA, AAAB).

**Principal clones:** There is a wide range of diversity in the clonal cultivars ranging from edible diploid *M. acuminata* (AA) types, nurtured only in sheltered and humid environments, to the hardy hybrid triploids (ABB) which can tolerate seasonal monsoon as well as dry conditions prevailing in most part of the country. There are many synonyms and the classification of the Indian AAB and ABB groups is exceedingly complex. With possible exception of Dwarf Cavendish, all the important clones are of Indian origin. The important clones are given below.

AB Group : Ney Poovan, Thaen Kunnan, Kunnan, Adakka Kunnan, Nattu Poovan

Group : Anaikomban, Matti, Sanna Chenkadali, Kadali, Surya Kadali, Namarai, Pisang Lilin, Tongat

## **Breeding objectives**

**Group :** Bodies Altafort

**ABBB Group :** Klue Teparod, Sawai (synthetic hybrid)

**AAA Group :** Amritsagar, Gros Michel, Cavendish, Giant Cavendish, Robusta, Lacatan, Wather, Red Banana, Chakkarakeli, . Manoranjitham

**AAB Group :** Poovan, Rasthali (Silk), Sugandhi, Pachanadan, Rajapuri, Virupakshi, Nendrapadthai, Nendran

**ABB Group :** Nalla Bontha, Monthan, Karibontha (S), Ney Vannan (S), Peyan (S), Karpuravalli, Bhimkol, Enn Beman (S), Kallu Monthan (S)

### **1 . Dessert varieties for export**

At present, the entire dessert banana export industry is dependent on Cavendish cultivars, all of which are genetically similar with respect to response.

The characteristics sought by the banana breeder for export varieties are:

Yield equal to Cavendish varieties.

Quality, especially finger length, finger curvature and finger pedicel strength as in Cavendish varieties.

Flavour, ripening and carrying qualities similar to present varieties.

Pseudostem height similar to 'Grand Nain' or at least less than in the Cavendish varieties such as 'Valery', 'Poyo', 'Robusta' or 'Giant Cavendish' .

Foliage characteristics and production efficiency not inferior to 'Grand Nain'.

Resistance to all known races of Fusarium wilt.

Resistance to black Sigatoka and similar leaf spot diseases.

Tolerance to nematodes.

It is most unlikely that all these characteristics could be incorporated into one variety.

### **2 . Dessert varieties for local use**

In many parts of the tropics, dessert bananas of the 'Silk' and 'Pome' clones (AAB) are preferred to the Cavendish clones (AAA). Unfortunately, 'Silk' is highly susceptible to Panama disease and the 'Pome' variety is attacked by Panama disease in some situations and is somewhat susceptible to the common Sigatoka. In addition to disease susceptibility, the AAB varieties are very low yielders (6-12 tons/ha) in comparison to the Cavendish varieties (40 -50 tons/ha per year). Therefore, the main objective of a breeding programme for AAB dessert varieties is to produce disease resistant, high yielding varieties having the flavour and texture of the 'Silk' and 'Pome' cultivars.

**3 . Cooking varieties:** Cooking varieties of the AAB plantain group and AAB and ABB cooking bananas have several major defects. All plantain cultivars are susceptible to black Sigatoka. Some of the ABB cooking bananas are susceptible to Race 2 of Panama disease and to Moko diseases. All, however, are relatively low yielders in comparison to the Cavendish varieties. Most of them are tall with consequent high losses from wind. In addition to disease resistance, good culinary traits and modest increase in yield should be the main objectives of breeding new cooking varieties.

## **Breeding methods**

### **1. Hybridization**

Technique of hybridization in banana is different from other crops. Pollination is best carried out in the morning. The bunches of female parent are bagged at shooting and each successive hand is pollinated as it is exposed. At maturity and ripening the bunch is cut and seeds are extracted. Seeds are sown at once in the green house.

Seed germination in banana is found to be very poor, the percentage ranging from 0.003 to 0.60. The seeds are soaked in water for a week before sowing in seed pan kept in mist chamber. The time taken for seeds to germinate ranges from 24-101 days, sometimes even 6 months. The seeds of wild bananas germinate in 24 days. Under better conditions (hot days and cool winter), the germination improves (25-70%).

Evaluation of hybrid progenies from seedling to harvest may not be the correct phase instead, evaluation of the same under next vegetative phase i.e. sucker to harvest stage will be ideal as full expression of yield potential could be observed only in the second crop of the F I progeny. The first crop (seedling to harvest) takes more than 15-19 months, where most of the energy of the plants is needed for corm formation.

Three main approaches in breeding dessert bananas of the Cavendish types are:

3N x 2N superior diploids; there is no chromosome reduction in the egg cells thus yielding tetraploids;

4N bred tetraploid hybrids x 2N superior diploids producing 'Natural triploids' .

2N meiotic restituting clones x 2N superior diploids producing 'Natural triploids'.

Method (1) has been used extensively and method (2) has been tested relatively to a lesser extent. Method (3) has shown no promise thus far. One other method not evaluated is production of unreduced triploid egg cells from selected seeded triploids from 4N x 2N crosses. When crossed with diploids, the tetraploids produced would have three introductions of diploid parents in the pedigree.

## 2. Developing new diploid male parent

In many banana growing countries, initially wild diploid bananas (AA) were utilized as male parents and as a result, the resultant tetraploids had inherited many undesirable traits. Hence, it has been felt by banana breeders that the primary objective is to synthesise a good male parent. An ideal male parent must be highly resistant to Panama and Sigatoka diseases, must have vertical and compact bunch and fruits as large as the diploidy can allow and must be parthenocarpic having sufficient pollen to permit its use as a male parent. *Musa acuminata* subsp. *burmannica* and its hybrids offer a good source of resistance to black Sigatoka. One such diploid developed in Honduras is SH 2989. Other male diploids meriting mention are SH 3142 for nematode resistance and SH 3176 evolved through multiple crosses for resistance to black Sigatoka with desired horticultural traits.

In India, the banana breeding goal has been set to develop malefertile, parthenocarpic diploids with resistance to Sigatoka disease, burrowing nematode and *Fusarium* wilt, along with high yield, longer fruits and better bunch hang. Dwarf stature is desirable for developing resistance against wind damage. The basic approach has been oriented primarily towards improving the diploid male parents.

**Mutation breeding** : Bud mutation in Indian banana is very common perhaps due to spontaneous rearrangement of chromosomes in somatic meristem and structural reassortment. A great majority of edible bananas are triploids, a condition that interferes with normal equilibrium of plants and may provide the requisite stimulus to structural rearrangement of chromosomes, leading ultimately to the evolution of a new gene complex. Clonal propagation and selection have helped in perpetuation of these mutants continually adding to these changes.

Large number of mutants is reported from the cultivated clones of banana in South India. In Nendran variety alone, more than six mutants have been recognized. One of these, Moongil, has undergone such a radical change that there is no male phase and a bunch has only one or two hands with biggest size fruits. Attu Nendran, Nana Nendran, Myndoli, Velathan and Nenu Nendran are a few mutants which have been selected for one or the other desirable character

Dwarf Cavendish itself is a mutant of an important clone and is known to have given rise to many clones. A semi-tall mutant known as Pedda Pacha Arati in Kumool district of Andhra Pradesh and Harichal or Bombay Green of Maharashtra have assumed commercial status. More than six clones have been isolated from Basrai based on robust growth of pseudostem and large bunch size. Ambalakadali and Erachi Vazhai are mutants of Red Banana. The superior table variety, Rasthali in which the male bud is aborted giving rise to many number of fruits in a bunch. This variety is popularly called 'Ayirankai Rasthali', meaning too-fruited Rasthali. The Kunnan variety of Malabar has provided a few mutants known as Thattilla Kunnan (male phase absent), Vennettu Kunnan, Adakka Kunnan and Thaen Kunnan.

A number of sports have been recognized in cv. Monthan, viz., Sambal Monthan, Nalla Bontha B athees, Sambrani Monthan, pidi Montha and Thellatti Bontha. In Puri district of Orissa, Monthan banana is largely cultivated and more than 5 bud sports have been identified which are under commercial cultivation. The sports differ with respect to plant size, colour and shape of finger. From Poovan cultivar, Motta Poovan (absence of prominent nipple at distal end of the fruit) has been developed as a bud sport. These are some of the outstanding mutants recognized mainly in south India.

**Induced mutations have now been used in banana breeding.**

b. Iso/ation of somaclona/ variants: In vitro production of crop plants has resulted in substantial variability called "somaclonal variation". A wide range of stable variants involving dwarfism, leaf shape, pigmentation of foliage and pseudostem and bunch characteristics was also observed. Few somaclonal variants isolated in cv. Robusta at TNAU, Coimbatore is reported to be dwarf in stature.

FATOM- I, an early flowering mutant derived from *in vitro* gamma irradiated meristem culture of cv. Grand Nain has been released in Malaysia.

It is a selection from M<sub>1</sub> V<sub>4</sub> generation, which flowers within 9 months, as against 15 months in the parent material. It yields a bunch weight of 26 kg! plant as against 23 kg/plant in cv. Grand Nain.