

# **Tropical Fruit Production and Handling**

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# Genetic Resource Management and Development of Production Systems for Tropical/Subtropical Fruit Crops

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## **Introduction:**

Genetic erosion of cultivated tropical/subtropical fruit crop species has become a paramount problem worldwide. Natural disasters, environmental changes, disease and insect pests, changing intellectual property rights, political unrest and lack of financial support in countries where international research centers are located and germplasm collections are maintained, have all led to the decline in genetic diversity of valuable plant germplasm collections. Research projects housed at the USDA-ARS, Tropical Agriculture Research Station (TARS) in Mayaguez, PR, aim to preserve germplasm collections of cultivated tropical/subtropical germplasm of banana (*Musa acuminata*), plantain (*Musa acuminata* x *M. balbisiana*), cacao (*Theobroma cacao*), mamey sapote (*Pouteria sapota*), sapodilla (*Manilkara zapota*), species in the *Annona* and *Garcinia* genera, rambutan (*Nephelium lappaceum*), lychee (*Litchi chinensis*), longan (*Dimocarpus longan*), carambola (*Averrhoa carambola*), papaya (*Carica papaya*), and mango (*Mangifera indica*) through the introduction, maintenance, propagation, characterization and evaluation of these vegetatively propagated crops.

Limited genetic diversity observed in cultivated plant crops due to the selection for specific agronomic/horticultural traits has led to superior crops, but has predisposed these to new diseases and insect pests. For example, plantain and bananas are economically important crops grown in Hawaii, southern Florida, Puerto Rico, U.S. Virgin Islands and many other tropical/subtropical regions of the world. The entire dessert banana industry is dependent on 'Cavendish' cultivars, which are genetically similar in disease susceptibility. These cultivars are affected by major pathological problems: black sigatoka, nematodes, and viruses. In cacao, it has been estimated that diseases cause losses of up to 40%. These losses are detrimental to growers and to the cacao industry in general. There is a scarcity of basic information on how physiological, horticultural, environmental, entomological and pathological variables affect subtropical/tropical fruit production systems and how these interact to influence yield and fruit quality. Development of efficient and sustainable management systems as well as identification of superior clones yielding high quality fruits are of paramount importance to ensure the success and sustained production of the emerging tropical fruit industry in the U.S. Therefore, germplasm collections need to be characterized and accessions evaluated as an avenue to identify high yielding clones with better fruit quality traits and/or with pest and disease resistance.

### ***Research Interests and Accomplishments:***

#### ***Papaya:***

1. There is scarcity of information regarding the optimum water requirement for papaya (*Carica papaya*) grown under semiarid conditions with drip irrigation in the tropics. A 2-yr study was conducted to determine water requirement, yield, and fruit quality traits of papaya cv Red Lady subjected to five levels of irrigation. Highest marketable fruit weight (75,906 kg/ha) was obtained from plants irrigated with water application according to a pan factor of 1.25.
2. Five hybrids and an open-pollinated papaya cultivar were evaluated on an Oxisol and Ultisol under intensive management. At both locations, hybrid Tainung 3 produced greater number of marketable fruits averaging 133,659 fruits/ha. Significantly higher brix values were obtained from fruits of hybrid Tainung 3 at both locations whereas lower values were obtained from those of PR 6-65.
3. Papaya ringspot virus (PRSV), which is transmitted by aphids in a nonpersistent manner, is one of the most important limiting factors of papaya production. Reflective mulch was evaluated for efficacy to reduce the number of winged aphids and the incidence of PRSV and yield of papaya plants. At three locations in Puerto Rico, the results were similar in that there were significantly fewer (80%) aphids caught in water pan traps in plots containing reflective mulch when compared with no mulch for three months after transplanting. However, no significant difference was found between the total number of aphids caught in plots with and without mulch during the next three months and at the end of the harvest period most plants were infected.

#### ***Cacao:***

During a four-year evaluation period, individual tree yield data were obtained from 1,320 trees representing five cacao families, and three locations in Puerto Rico. Forty of the most consistent high yielding trees were initially selected and bud-grafted onto a common rootstock. Nine clones were finally selected and on the average these yielded 2,170 kg/ha of dry beans per year. This yield was highly superior to the combined mean yield of five of the parental clones involved in the crosses or than the highest individual yielding parent.

#### ***Banana and Plantain:***

1. A 40-month experiment was conducted to re-evaluate the nitrogen fertilization recommendation for banana grown on a clayey Ultisol under rain fed conditions. A maximum yield of 57,060 kg/ha/crop was obtained with a nitrogen application of about 240 kg/ha. This amount corresponded to a leaf nitrogen concentration of between 2.75 and 2.85 g/kg.
2. An experiment was conducted to characterize twenty-seven clones from the USDA plantain germplasm collection. Twenty morphological descriptors now posted in the USDA-ARS GRIN database were used to obtain information of the plant, bunch and individual fruits at bunch- emergence and at harvest.

3. An experiment was conducted to describe and determine the agronomic potential of the Huamoa plantain in comparison with the Common Dwarf. The Huamoa cultivar produced bunches significantly earlier than the Common Dwarf. It completed the planting to bunch-emergence cycle in 242 days and required only 63 days for fruit filling. The Common Dwarf needed 297 days to complete the cycle and required 92 days for fruit filling. The latter, however, produced significantly larger and heavier bunches which on average contained eight hands, 39 fruits and weighed 14.0 kg.

4. Black sigatoka is caused by *Mycosphaerella fijiensis* Morelet. It is the most significant disease of bananas and plantains, and most of the economically important cultivars of these export and staple commodities are highly susceptible. In August, 2004, symptoms of what appeared to be black sigatoka were first observed in Puerto Rico by Extension personnel from the University of Puerto Rico. Since black and yellow sigatoka produce similar disease symptoms, a survey was conducted in the western banana and plantain production region of Puerto Rico, to confirm the presence of black sigatoka. Diseased leaf samples of sigatoka infected plants were collected from production fields and DNA was extracted from mycelium for 29 isolates and analyzed using PCR. Amplification products were observed for 18 of the 29 isolates, six of which were *M. fijiensis* and the remaining 12 were *M. musicola*; positive controls for both species also amplified. The presence of black sigatoka in Puerto Rico will most likely increase production costs. The USDA-ARS, Tropical Agriculture Research Station is the official *Musa spp.* germplasm repository for the National Plant Germplasm System. As such, efforts are underway to introduce and evaluate black sigatoka disease-resistant clones that can satisfy local and export market criteria.

5. Two introduced French-type plantain (*Musa*, AAB) clones, Maiden and Dominican Red, were evaluated to determine the effect of bunch pruning on fruit grade and marketable yield. Regardless of the pruning treatment, bunches from Maiden were always significantly heavier than those of Dominican Red and the unpruned Maricongo. All fruits obtained from the Maiden plantain bunches pruned to five hands exceeded the local market fruit weight criteria of 270 g

#### *Mangosteen:*

The major impediment to the development of a mangosteen industry is the long pre-bearing stage that seedlings take to produce fruits. There is little information regarding optimum nursery practices to enhance growth and development of mangosteen seedlings. Two experiments were conducted to determine the effect of various shade and fertilizer treatments on growth of young mangosteen plants. Plants grown under 50% shade and supplied with 9 g of a 15-11-13 fertilizer accumulated significantly more dry matter, had thicker stems, grew taller and developed a larger leaf area. Plants grown under full sunlight grew little or died.

#### *Carambola:*

Nine carambola (*Averrhoa carambola*) cultivars grown on an Oxisol, Ultisol, and Mollisol were evaluated for four years under intensive management at Isabela, Corozal and Juana Diaz, PR, respectively. Significantly higher yield of marketable fruits were

obtained by cultivar B-17 at Corozal, Sri Kembangan and Thai Knight at Isabela and Kajang, B-17 and Sri Kembangan at Juana Diaz. Significantly higher brix values were obtained from fruits of cultivar B-17 at all locations whereas lower values were obtained from those of Arkin.

*Mamey sapote, Sapodilla, Rambutan:*

1. Cone emergence traps were used to monitor the abundance of *Diaprepes abbreviatus* and *Phyllophaga spp.* adults emerging from the soil at the base of mamey sapote, sapodilla, and rambutan trees at three locations in Puerto Rico. Although there were no consistent differences in susceptibility among the varieties within any of the crop species, there were significant differences in the number of both beetle species at the different sites and in "preferences" of both beetles for certain crop species.

2. Field trials in Puerto Rico were conducted to compare the attractiveness of the standard bait of pelletized torula yeast/borax with a two component (ammonium acetate and putrescine) synthetic lure for *Anastrepha spp.* within orchards of sapodilla, mamey sapote, and carambola. Significantly more female and male flies were collected over the entire collection periods in traps containing torula yeast when compared with the two component synthetic lure in sapodilla and mamey sapote. Fruit fly pressure from predominantly *A. suspensa* within sapodilla was extremely high; in contrast, very few of either species was found in mamey sapote. Within carambola, significantly more flies were captured with the two component synthetic lure, and the predominant species was *A. obliqua*. For both lure types, there was a distinct female bias for the sex ratio of flies captured within all fruit plots.

3. Little information is available on yield performance of rambutan. Experiments to evaluate eight rambutan cultivars for yield and fruit quality traits at two locations in Puerto Rico were established in 1999. In their first year of production (2003), cultivars R-162 and Rongrin were the highest yielders at Corozal and Isabela with a yield of 3066 kg/ha/year and 4978 kg/ha/yr, respectively. Cultivar Rongrin showed the highest average brix value (20.3). Results provide preliminary information to potential growers on which rambutan cultivars have the greatest potential for commercial production in the Caribbean.

4. Flowering pattern of longan trees is very erratic resulting in inconsistent yields. Six longan cultivars established on replicated plots were sprayed with potassium chlorate to induce flowering. All sprayed trees flowered and produced fruits with the highest yield (24,214 kg/ha/yr) obtained in cultivar Biew Kiew; none of the control (non sprayed) trees flowered. These results confirm that field application of potassium chlorate is a viable management strategy to promote longan flowering and fruiting and that it is effective in various longan cultivars.

5. Little, if any information is available on yield performance and fruit quality traits of mamey sapote. Experiments to evaluate six mamey sapote clones at two locations in Puerto Rico were established in 2000. In their first year of production (2003), cultivars Magana and Tazumal were the highest yielders at Isabela and Corozal with a yield of

9,149 and 9,135 kg/ha/yr, respectively. Cultivar Pace showed the highest average brix value (31.0). In 2005, cultivars Pace and Magana were the highest yielders at Corozal with a yield of 15,693 and 21,969 kg/ha/yr, respectively. In Isabela, the highest yielders in 2005 were cultivars Pantin and Tazumal with a yield of 13,079 and 15,089 kg/ha/yr, respectively. In 2005, cultivar Pace continued to have the highest brix averaging 29.4%.

**Research Priorities:**

Research leading to the development of papaya germplasm with resistance to PRSV should continue to be supported as this disease represents the major impediment to develop a profitable papaya industry in the Caribbean.

Current research has shown highly significant genotype x environment interactions for yield and fruit quality traits of clones of various tropical/subtropical fruit crop species. Therefore, evaluation of rootstocks and clones across a wide range of agroenvironments to screen for tolerance to abiotic/biotic stresses (e.g. soil acidity, alkalinity, salinity, diseases) is essential to provide growers with useful recommendations. This is a long-term effort because field testing of rootstocks often comprise a period exceeding a decade in order to properly assess their potential.

Ongoing research has shown that tropical/subtropical fruit crops are very sensitive to attack by root weevils (e.g. *D. abbreviatus*). Development of biorational insecticides will become a necessity as environmental policies concerning use of pesticides become stricter.

In general, tropical/subtropical fruit crops have been little studied. There is a need to conduct replicated field studies on crop management practices (e.g. fertilization, irrigation, pruning, etc.) to provide eventually growers with recommendations leading to full yield potential of these crops.

There is a need to develop production systems that promote growth of mangosteen in order to shorten its long pre-bearing stage.

Use of air layers as a method of tree propagation for lychee and longan usually results in lack of development of a tap root making trees of these crops more susceptible to lodging particularly in hurricane prone areas. Hence, there is a need to test grafting methods on these crops for scion/rootstock compatibility and field performance.

**Relevant Publications:**

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