Crop Profile for Atemoya and Sugar Apple in Florida

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Production Facts

- Atemoya (Annona squamosa x Annona cherimola) and sugar apple (Annona squamosa) are both deciduous trees of the Annonaceae. The plants are of tropical American origin and produce fruits that are similar. These two crops share other similarities in addition to fruit, such as environmental requirements and pest spectrum (1).

- The annual production of saleable atemoya is an estimated 50,000 pounds. At an average seasonal price of $4.00 per pound, the crop would be worth approximately $200,000. The annual production of sugar apple is approximately 20,000 pounds. At an average seasonal price of $3.00 per pound, the crop would be worth an estimated $60,000 (2).

- The acreage of atemoya and sugar apple peaked in 1989-90 at 120 and 75 acres, respectively (3). Current acreage is less than 25 acres for either crop (2,3).

Production Regions

Atemoya and sugar apple are grown exclusively in south Florida. Approximately three-quarters of the atemoya production is located in Miami-Dade County. For sugar apple, all of the production is in this same county (2). The remaining atemoya acreage is primarily located in counties adjacent to Miami-Dade County.

Production Practices

The atemoya tree is relatively small (10 m), with an open canopy. Leaves are elliptic, ovate, or lanceolate, and often variable in shape on the same tree. Leaf length is ten to 20 cm and width ranges from four to eight cm. Flowers are three to four cm in diameter with three fleshy, pale, yellowish-green petals. They are borne singly or in clusters of two to three in axils of leaves on year-old wood or on new shoots. The main bloom period in Florida is May through June, with a minor bloom in August through September. The flowers are protogynous, functioning first as female, then as male. Atemoya bears an aggregate fruit from five to six months after bloom that may weigh up to one pound. It is at first green, but becomes more light green or yellowish green upon maturity. The pulp is white, with a custard-like consistency and a sweet pleasant flavor. There are typically ten to 40 seeds per fruit (1).

The sugar apple tree is also small (5 m), with a rounded canopy and slender branches. Thin, lanceolate leaves range in length from six to ten cm. The leaves are a dull, pale green with
sparse hairs at flush, but become smooth at maturity. Flowers are about three cm in length and are produced singly or in clusters of two to four in late spring. The aggregate fruit produced is round, conical, or heart-shaped. The skin is thick and yellowish green. The pulp is creamy white and filled with numerous small dark seeds (4).

Most sugar apple trees grown in Florida are seedlings since there is little variability among them. When grafting is done, veneer grafting on custard apple (*Annona reticulata*) is the preferred method. Shield budding also produces acceptable trees. A number of selections have been made from atemoya seedling populations. “Gefner” produces satisfactory fruit without hand pollination. Other varieties either split upon maturity or produce few fruit without hand pollination. Atemoya grown from seed are extremely variable. Superior trees can be propagated by budding or grafting sugar apple, custard apple, or pond apple (*Annona glabra*). Chip budding or veneer grafting are the two most successful methods (4).

Both atemoya and sugar apple are intolerant of salty or freezing conditions, although mature trees may be able to withstand a few hours at sub-freezing temperatures. The trees become leafless during periods of cold. Both plants are adapted to moderate, evenly distributed rainfall. Leaf shedding is a mechanism used by both species to withstand periods of drought. The trees grow and bear best on neutral, fertile soils. Trees should be spaced five to six m apart between and within rows. Pruning for sugar apple is needed to remove dead wood and broken branches. However, atemoya is pruned just prior to the growing period to promote an open-centered form with few main branches (1,4)

Atemoya is self fertile but individual flowers usually are not self-pollinated because stigmas are no longer receptive when the pollen is shed. Poor fruit set is a serious problem in some areas, evidently because of poor pollination. Incomplete pollination will also result in misshapen fruit. Those flowers that open during warm, humid weather are more likely to set fruit than those borne when conditions are dry and/or cold. Hand pollinating when the female flower first opens increases fruit set in these problem areas (1).

**Worker Activities** Atemoya and sugar apple are harvested numerous times (approximately 25) each year. They are generally harvested every third day for the first peak in August and September, and weekly for the second peak in October and November (2). Since mature fruit tend to split, they are harvested a few days prior to full maturity. Trees are picked by hand or by using a long picking pole which has at its distal end a canvas or nylon bag attached to a metal ring with a cutting blade. Ladders and hydraulic lifts are also used to enable pickers to reach fruit high in the tree canopy. A worker can generally pick up to three acres daily. Workers may also spend several weeks a year pruning tree limbs (2). Sugar apple fruit are quite fragile, so they are sold locally. Atemoya can be held at temperatures as low as 13°C to facilitate shipment to market (1,4).
Insect/Mite Management

**Insect/Mite Pests**
The principal pest on atemoya and sugar apple in Florida is annona seed borer, while other pests such as ambrosia beetles, scales, mealybugs, aphids, and lepidopteran larvae are minor (5,6).

**ANNONA SEED BORER** (*Bephratelloides cubensis*)
This chalcidoid wasp was introduced into Florida in the 1920s. The female wasps lay eggs singly in small immature fruit. The larvae feed on seed endosperm and pupate within the seed. Adult wasps emerge by burrowing to the fruits exterior, which often leads to fungal infection and mummification of the fruit. The generation time for the wasp is about three months and the adults live no more than two weeks (5).

Both atemoya and sugar apple are attacked by this wasp. However, since atemoya blooms and fruits slightly earlier in the spring than sugar apple, it is generally infected at a higher rate than is sugar apple. Peak infestation rates for atemoya and sugar apple in southern Florida in late summer were approximately 80 and 20 percent, respectively. The wasp overwinters in bullock’s heart (*Annona reticulata*) and then attacks early season fruit, while late season fruit is attacked by newly emergent wasps (5).

**Chemical Control**
Twenty-five percent of responding surveyed atemoya and sugar apple growers reported insecticide use. Those survey respondents that provided insect damage estimates indicated that from 5 to 100 percent of the crop would be lost to insect damage (n=5, mean of 62 percent) (7). Insecticides and miticides registered for use on Florida atemoya and sugar apple in 2008 include azadirachtin, *Bacillus thuringiensis*, *Beauveria bassiana*, buprofezin, imidacloprid, insecticidal oil, insecticidal soap, methidathion, pyrethrin +/- rotenone, pyriproxyfen, spinetoram, spinosad, and sulfur, while pyriproxyfen and methoprene are available for fire ant control (8).

In non-bearing atemoya and sugar apple, bifenazate and bifenthrin are registered while pymetrozine, fenpropathrin, and hexythiazox are labeled for non-bearing nursery trees. Hydramethylnon and fenoxycarb are available for fire ant control in non-bearing atemoya and sugar apple (8).

**CROP OILS**
Crop oils work by smothering poorly mobile insects such as scales, aphids, and mites. The oils are usually made up as 1.5 to 3 percent solutions, which are applied thoroughly to each tree. Price varies based on amount and formulation used, but an average application cost is $6/acre (9). The restricted entry interval (REI) for crop oils is 4 hours and there is no pre-harvest interval (10). Thirteen percent of surveyed atemoya and sugar apple growers in Florida applied crop oil twice per season (7).

**AZADIRACHTIN**
Azadirachtin is a natural compound derived from the neem tree (*Azadirachta indica*) that has insect growth regulator as well as deterrent activity. The compound is used to manage lacewing bugs and mealy bugs. The price of azadirachtin is $2100 per pound of active ingredient and the
approximate cost per application is $90 per acre (9,11). The REI is 4 hours (11). Thirteen percent of atemoya and sugar apple growers applied azadirachtin to their acreage twice a season.

**Cultural Control**
Based on survey results of all tropical fruit growing respondents, 44 percent reported keeping records of pest problems, 50 percent adjusted applications (timing or rate) to protect beneficial insects and mites, and 52 percent alternated pesticides to reduce resistance. Sixty-two percent reported selecting the pesticide that is least toxic to beneficial insects and mites and 63 percent spot sprayed only infested plants or areas. Seventy percent reported selecting pesticides that are least toxic to the environment to make this the dominant form of cultural pest control (7).

**Biological Control**
Seven percent of the responding tropical fruit growers reported release of predatory wasps for control of lepidopteran pests. Additionally, 30 percent reported the use of biological-derived pesticides like *B.t* (7).

**Weed Management**

**Weed Pests**
Weeds can reduce yields by competing primarily for water and nutrients. Although individual weed species may vary regionally, predominant weed species in groves are grasses, sedges, and pigweeds (12).

**Chemical Control**
There are few herbicides labeled for use on bearing atemoya and sugar apple (glyphosate, oxyfluorfen, carfentrazone, and pelargonic acid). Flumioxazin can be used on non-bearing trees (8). Eighty-eight percent of growers surveyed reported herbicide use (7).

**GLYPHOSATE**
Glyphosate is a phosphorylated amino acid herbicide used for total vegetation control. Glyphosate is applied as a directed spray so that foliage is not injured. The median price of glyphosate is $10 per pound of active ingredient and the approximate cost per application is $20 per acre for annual weeds and $50 per acre for perennial weeds (9,13). The REI for glyphosate is 4 hours and the PHI is 14 days (14). Eighty-eight percent of surveyed growers in Florida applied glyphosate either three (14 percent), four (43 percent), five (14 percent), or six (29 percent) times for an average use of 4.6 times (7).

**Disease Management**

**Disease Pathogens**
The principal diseases affecting atemoya and sugar apple production in Florida include anthracnose (*Colletotrichum gloeosporioides*) and rust (*Phakopsora cherimoliae*). Fungal diseases which are non-manageable (removal and destruction) include mushroom root rot (*Armillaria tabescens*) and *Pythium* root rot (15,16).
ANTHRACNOSE (caused by *Colletotrichum gloeosporioides*)
This fungus infects flowers, leaves, and fruit. Infected flowers develop dark lesions on the petals that enlarge and cause flower blackening and death. Young fruit that are infected will rot and mummify on the tree. When the fungus invades mature fruit, the resultant lesion is small and relatively cosmetic with a shallow area of hardened tissue. Infected leaves develop light green lesions that enlarge into irregular brown areas, giving the leaves a scorched appearance. It can also cause premature leaf drop (15).

RUST (caused by *Phakopsora cherimoliae*)
This fungus infects leaves during the summer through fall. Slightly yellow spots develop in response to the infection. The fungus reproduces rapidly in the form of a slightly raised pustule or blister. Severe levels of infection can cause defoliation (15).

**Chemical Control**
Sixty-three percent of surveyed atemoya and sugar apple growers reported fungicide use. Those survey respondents that provided damage estimates indicated that from 10 to 100 percent of the crop would be lost to disease (n=4, mean of 55 percent) (7). Fungicides registered for use on atemoya and sugar apple include azauxystrobin, copper hydroxide/sulfate, mefenoxam, hydrogen dioxide, *Bacillus subtilis*, phosphoric acid, sulfur, and *Trichoderma harzianum*.

COPPER
Copper has long been used as a fungicide and can be applied in multiple forms (copper hydroxide, copper sulfate, etc.). Copper is primarily used in an attempt to manage anthracnose. The median price of copper hydroxide is $2 per pound of active ingredient. For atemoya, the approximate cost per application is $5 per acre. The cost per acre for sugar apple is $20 (9,17). The REI for copper hydroxide/copper sulfate is 24 hours (17). Sixty-three percent of surveyed atemoya and sugar apple growers in Florida applied copper. Copper was applied either one (40 percent), two (20 percent), three (20 percent), or four (20 percent) times for an average use of 2.2 times per season.

Nematode Management

*Nematode Pests*
Plant-parasitic nematodes are microscopic roundworms, found in soils, which primarily attack plant roots. General signs of nematode damage include stunting, premature wilting, leaf yellowing, root malformation, and related signs characteristic of nutrient deficiencies. Stunting and poor stand development tends to occur in patches throughout the grove as a result of the irregular distribution of nematodes within the soil.

**Chemical Control**
There are no currently registered nematicides for use on atemoya or sugar apple. None of the surveyed growers reported the use of nematicides (7).
Key Contacts

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11) Certis USA labels, Columbia, MD.


14) Monsanto Company labels, St. Louis, MO.


17) DuPont labels, Wilmington, DE.