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CIR 1417

Florida Crop/Pest Management Profile: Atemoya and Sugar Apple[1]

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Production Facts

- Atemoya (*Annona squamosa x Annona cherimola*) and sugar apple (*Annona squamosa*) are both deciduous trees of the Annonaceae family. The plants are of tropical American origin and the two species produce similar fruits. In addition to their similar fruit, these two crops are alike in other ways, 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 and 1990 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 next 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 protogyrous, 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).

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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 and they grow true to type. When grafting is done, veneer grafting on custard apple (*Anonna 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 before 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 about 25 times a year. Harvest is generally every third day for the first peak in August and September, and then weekly for the second peak in October and November (2). Since mature fruit tend to split, they are harvested a few days before they reach full maturity. Trees are picked by hand or by using a long picking pole with a canvas or nylon bag at the end attached to a metal ring with a cutting blade. Ladders and hydraulic lifts allow pickers to reach fruit high in the tree canopy. A worker can generally pick up to three acres a day. 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 fruit's 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 atemoya and sugar apple growers who responded to a survey reported that they used insecticide. Those survey respondents who 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. 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. The price of crop oils varies based on the amount and the 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 acts as an insect growth regulator and a deterrent. 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

Survey results of all respondents who grew tropical fruit show that 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 biologically 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 that are non-manageable and require 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 finally blacken and then kill the whole flower. Infected young fruit rot and mummify on the tree, but with mature fruit, the damage is mostly cosmetic: a small, 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 azoxystrobin, copper hydroxide/sulfate, mefenoxam, hydrogen dioxide, *Bacillus subtilis*, phosphoric acid, sulfur, and *Trichoderma harzianum*.

Copper

Copper has long been used as a fungicide, primarily to manage anthracnose. It can be applied in multiple forms (copper hydroxide, copper sulfate, etc.). 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. These growers applied copper once (40 percent), twice (20 percent), three times (20 percent), or four times (20 percent) for an average use of 2.2 times per season.

Nematode Management

Nematode Pests

Plant-parasitic nematodes are microscopic roundworms found in the soil. They tend to 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 tend 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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References

1. Crane, J.H., Balerdi, C. F., and Maguire, I. 2008. Atemoya Growing in the Florida Home Landscape. EDIS publication HS64, http://edis.ifas.ufl.edu/MG332. Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
2. Personal communication, Jonathan Crane, Tropical Research and Education Center, Homestead, FL.
3. Degner, R.L., Moss, S.D., and Mulkey, W.D. 1997. University of Florida, Institute of Food and Agricultural Sciences Report: Economic Impact of Agriculture and Agribusiness in Dade County, Florida. Florida Agricultural Market Research Center Industry Report 97-1.
4. Crane, J.H., Balerdi, C. F., and Maguire, I. 2005. Sugar Apple Growing in the Florida Home Landscape. EDIS publication HS38, http://edis.ifas.ufl.edu/MG330. Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
5. Pena, J.E. and Crane, J.H. 2006. Insect/Mite Management in *Annona* spp. EDIS publication ENY-834, http://edis.ifas.ufl.edu/IG166. Department of Entomology and Nematology document, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
6. Nadel, H. and Pena, J.E. 1991. Seasonal Oviposition and Emergence Activity of *Bephratelloides cubensis* (Hymenoptera: Eurytomidae), a Pest of Anonna Species in Florida. *Environ. Entomol.* 20(4), 1053-1057.
7. UF/IFAS Pesticide Information Office. 2001. Tropical Fruit Management Survey. Agronomy Department, Institute of Food and Agricultural Sciences, University of Florida.
8. Crane, J.H., and Mossler, M.A. 2006. Pesticides Registered for Tropical Fruit Crops in Florida. EDIS publication HS929, http://edis.ifas.ufl.edu/HS177. Horticultural Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
9. Anonymous pricing.
10. JMS Flower Farms labels, Vero Beach, FL.
11. Certis USA labels, Columbia, MD.
12. Knapp, J.L. 1999. Citrus Commodity: A Biologic and Economic Assessment of Pesticide Usage. USDA National Agricultural Pesticide Impact Assessment Program Report No. 1-CA-99.

13. Weed Science Society of America. 1994. Herbicide Handbook - 7th Edition.
14. Monsanto Company labels, St. Louis, MO.
15. Simone, G.W. 1999. Disease Control in Atemoya (*Annona cherimola x A. squamosa*). Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.
16. Aflieri, S.A., Langdon, K.R., Wehlburg, C., and Kimbrough, J.W. 1984. Index of Plant Diseases in Florida. Florida Department of Agriculture & Consumer Services, Division of Plant Industry Bulletin 11.
17. DuPont labels, Wilmington, DE.