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EXTENSION

Institute of Food and Agricultural Sciences

Florida Crop/Pest Management Profile: Carambola¹

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Production Facts

- The Florida production of carambola in 1994 (530 acres) represented 93 percent of all carambola grown in the U.S. Thirty-five acres of production were reported for Hawaii (1,2).
- The carambola acreage for 1996 was reported to be 650 acres, which represents approximately 104,000 trees (1).
- In the last year for which production statistics are available (1996), a reported carambola crop worth \$17.4 million was harvested. The average yield per acre was 40,000 pounds, and the price per pound was \$1.40. The packout was reported to be 60 percent (1).
- An estimated 98 percent of carambola sales (\$17.1 million) were made outside of Miami-Dade County in 1996 (1).
- The reported carambola acreage in 2000 was 250 acres. This is a 62 percent decline in acreage since 1996 (3).

- Over fifty percent of carambola production occurs in Miami-Dade County. The remaining acreage is located in counties in the vicinity of Miami-Dade County (3).

Production Regions

Carambola (*Averrhoa carambola*), also known as star fruit, is grown primarily in southern Florida. In 2000, 52 percent of Florida's carambola acreage was located in Miami-Dade County. The remainder of carambola acreage was located in Lee, Broward, Palm Beach, and other counties with the appropriate climate (4).

Production Practices

The carambola tree is classified as an evergreen and is in the Oxalidaceae family. It is a plant that is indigenous to India and Southeast Asia and was first introduced into Florida over a century ago. The tree is small to medium in height (20 to 30 feet), has a spreading canopy, and is either single or multi-

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trunked. The majority of the fruit production occurs in the middle of the canopy. Compound leaves are alternate, with five to eleven leaflets per leaf. The fruit are star-shaped in cross section with generally five longitudinal ribs. Edible seeds encased in a gelatinous aril are produced in the ribs. The star fruit berry may range from two to six inches in length, and does not produce sugar after picking. Consequently, sweetest fruit are tree-ripened. The crop is considered mature when the color begins to “break” from green to gold between the ribs (4).

Carambola should be planted in soil with adequate drainage, although some varieties withstand flooding for brief periods. Since carambola is adapted to lowland subtropical and tropical climates, it does have a high water requirement. During seedling establishment, and from bloom through fruit development, a low-volume irrigation system should be able to provide supplemental moisture. A high-volume irrigation system (0.25 inch per hour) is required for protection during freezing conditions. Carambola fields should also be well sheltered from the wind (4).

Cultivars commonly used in Florida carambola production are “Arkin” and “Golden Star” and others are under evaluation. Seedlings of “Golden Star” are better adapted to the alkaline limestone soils of southern Florida than those of “Arkin.” Consequently, the “Golden Star” variety is used as rootstock when bark or veneer grafting. Air-layering and tissue culture do not produce plants with well developed roots (4).

Carambola trees are planted from 15 to 20 feet apart within rows and from 20 to 25 feet between rows. Consequently, a mature stand would have about 130 trees per acre. For mature trees, removing upright limbs during late winter and then removing selected new regrowth in the early fall can maintain trees at a 10 to fifteen foot height without reducing yield potential (4).

The carambola flower is borne on panicles and is pink to lavender in color. Some cultivars require cross pollination while others produce abundant fruit when planted in solid blocks. There are two major bloom periods (April through May and September through October) in southern Florida. The

concomitant harvests are from August through September and December through February. Usually there are a few fruits available throughout the year and the grove is picked x to x times during the peak. Properly cultivated trees may begin to produce fruit within 10 to fourteen months after planting. Ten to forty pounds of fruit may be expected per tree during the first two to three years. This increases quickly as the trees mature, yielding 250 to 350 pounds per tree after as little as seven years (4).

Computer-aided pest management of tropical fruit has been implemented by the University of Florida, Institute of Food and Agricultural Sciences. The TFRUIT•Xpert diagnostic program has been developed to assist growers and others in determining diseases, insect pest problems and physiological disorders

(<http://it.ifas.ufl.edu/software/tropicalfruits-cd.html>).

Insect/Mite Management

Insect/Mite Pests

The principal pests on carambola in Florida are scales (*Philephedra*, plumose, long brown), *Diaprepes* weevil, and redbanded thrips. Minor and occasional pests include bugs (stink and squash) and fruit miners (4).

Scale (*Philephedra tuberculosa*, *Morganella longispina*, *Coccus herperidum*). Scales are plant-feeding insects which are often controlled by natural and released parasites, predators, and pathogens. In cases when the natural balance of predation has been disrupted, scale populations may increase to levels requiring treatment. Since scale insects are relatively immobile and at least one month is required for the egg to reach the adult stage, an infestation builds up slowly (in comparison to mites or aphids) and may be hard to spot. It is also important to verify that the scale insects attached to the plant are alive, as mummies accumulate on the plant over time. Economic thresholds for scale have not been determined. Most effective control is obtained when the scales are in nymphal stages, as egg and adult stages are recalcitrant to insecticide applications (5).

Citrus Root Weevil (*Diaprepes abbreviatus*).

Female root weevils generally oviposit eggs in clusters between two leaves on newly flushed foliage. After ten or twenty days, eggs hatch and larvae fall to the ground. The larvae begin feeding on the fibrous feeder roots. Successively larger larval instars feed on larger roots. The final larval stages (of at least eleven) proceed to the tap root and major lateral roots of the tree. Even if direct feeding does not girdle these roots, lesions provide entry to debilitating fungi such as *Phytophthora*. Adult weevils emerge over a three month period which may begin as early as March. Larval development time ranges from nine to 18 months, which includes an inactive pupal stage of one to three months. Dry weather delays development and emergence (6).

Redbanded Thrips (*Selenothrips rubrocinctus*). The redbanded thrips is ubiquitous in its distribution throughout Florida, but it is generally found in damaging numbers from Orlando to Key West. Female redbanded thrips are slightly greater than 1 mm in length, and have a dark brown to black body underlain by red pigment, chiefly in the first three abdominal segments. The larvae is light yellow to orange, with the first three and last segments of the abdomen bright red. The life cycle of this thrips is about three weeks in Florida, and several generations are possible each year. Redbanded thrips prefer young foliage, which may lead to leaf drop, at times totally denuding trees. The frass and associated sooty mold from thrips feeding may give rise to fruit which is out-of-grade (7).

Chemical Control

In 1999-2000, 50 percent of responding carambola growers surveyed reported insecticide use. Those survey respondents that provided insect damage estimates indicated that from 10 to 50 percent of the carambola crop would be lost to insect damage (n=7, mean of 19 percent). Insecticides and miticides registered for use on Florida carambola include azadirachtin (Azatin®), *Beauveria bassiana* (Organigard®), fenoxycarb (Logic® - for ants only on non-bearing trees), insecticidal oil, insecticidal soap, methidathion (Supracide®), pyrethrin (Pyrenone®), pyrethrin plus rotenone (Pyrellin®), spinosad (SpinTor®), and sulfur.

Crop Oils. Crop oils work by smothering immobile 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 greatly based on amount and formulation used. The restricted entry interval (REI) for crop oils is 4 hours and there is no pre-harvest interval or PHI (8). In 1999-2000, 20 percent of surveyed carambola growers in Florida applied oil to their acreage once (50 percent) or six times (50 percent) per season for an average use of 3.5 times per season.

Methidathion (Supracide®). Methidathion is an organophosphate insecticide used to manage sucking insects such as scale (5). The price of methidathion is \$29.16 per pound of active ingredient and the approximate cost per application is \$10.94 per acre (9,10). There is a maximum of three applications per season and at least 30 days must elapse between applications. The PHI is 21 days and the REI is 48 hours (10). In 1999-2000, 20 percent of surveyed carambola growers applied methidathion to their acreage once per season.

Pyrethrin + Rotenone (Pyrellin®). These two natural compounds both have contact and stomach activity (11). The mixture is used to manage sucking and chewing insects. The median price of the mixture is \$892.86 per pound of active ingredient and the approximate cost per application is \$25.00 per acre (12,13). The PHI and REI are both 12 hours. In 1999-2000, 30 percent of carambola growers reported the use of Pyrellin® twice (67 percent) or six times (33 percent) for an average use of 3.3 times per season.

Fenoxycarb (Logic®). Fenoxycarb is a carbamate compound used as an insect growth regulator, which causes death in the last pupal stage (11). The bait product is used to control ants (particularly the imported red fire ant). The price of fenoxycarb is \$715 per pound of active ingredient and the approximate cost per application is \$14.30 per acre (14). In 1999-2000, 20 percent of surveyed carambola growers in Florida applied fenoxycarb to their acreage once (50 percent) or twice (50 percent) for an average use of 1.5 times per season.

Alternative Control

Several new “reduced impact” chemicals have been registered for use in carambola. Organigard® (*Beauveria bassiana*) and SpinTor® (spinosad) are two products which are just now being assessed for insect management.

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.

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.*

Weed Management

Weed Pests

Weeds can reduce carambola 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 (15). However, species composition is less important as the trend has been toward use of non-selective, post-emergent herbicides.

Chemical Control

There are two herbicides labeled for use on carambola. Glyphosate (Roundup®) can be used on all carambola trees. Sulfosate (Touchdown®) is registered for use only in non-bearing carambola groves/nurseries. Both of these products are post-emergence non-selective herbicides.

Glyphosate (Roundup®). Glyphosate is a phosphorylated amino acid herbicide used for total vegetation control. Glyphosate is applied as a directed spray so that carambola foliage is not injured. The median price of glyphosate is \$9.49 per pound of active ingredient and the approximate cost per application is \$19.22 per acre for annual weeds and \$48.04 for perennial weeds (9,16). The REI for glyphosate is 4 hours and the PHI is 14 days (16). In 1999-2000, 100 percent of surveyed carambola growers in Florida applied glyphosate either two (10 percent), four (80 percent), or five (10 percent) times for an average seasonal use of 3.9 times.

Disease Management

Disease Pathogens

Fungi and algae are responsible for the principal diseases affecting carambola production in Florida. The most recurrent and problematic diseases include anthracnose (*Colletotrichum gloeosporioides*/*Glomerella cingulata*) and decline (*Pythium splendens*). Algal spot (*Cephaleuros virescens*) may become prevalent in late summer through late winter. Other diseases that intermittently affect carambola production are sooty mold (*Leptothyrium* sp.) and leaf spot (*Cercospora averrhoa*, *Corynespora cassiicola*, *Phomopsis* sp., *Gloesporium* sp., *Phyllosticta* sp.). Leaf spotting is more common on stressed or nutritionally deficient trees and occurs on older leaves that normally abscise during the winter and early spring (4,17).

Anthracnose (caused by *Colletotrichum gloeosporioides*/*Glomerella cingulata*). Anthracnose can occur on all parts of the carambola tree. Leaf infection starts as light green lesions that enlarge into irregular brown areas, giving the leaf a scorched

appearance. Infected leaves may abscise. Infections on flower panicles appear as small brown or black spots which enlarge and often coalesce to cause the death of the flower. Small fruit are rapidly invaded by the fungus once they become infected and will rot and mummify on the tree. On nearly mature or ripe fruit, the resultant lesion is small and relatively cosmetic with a shallow area of hardened tissue (17).

Decline (caused by *Pythium splendens*). This fungus has recently been identified as the cause of a general tree decline. Signs of decline include loss of tree vigor, leaf drop, and twig, shoot, and root die-back. Trees also demonstrate reduced fruit production in terms of number and size (4).

Algal Spot (caused by *Cephaleuros virescens*). This alga commences colonization late in the summer and progresses through the winter months. Initially hard to visualize, green, grey-green, or rust colored leaf spots become raised and circular. Stems may develop cracks where infestation is high. The alga eventually produces “spores” - which are rust colored (17).

Chemical Control

In 1999-2000, 60 percent of carambola growers surveyed reported fungicide use. Those survey respondents that provided damage estimates indicated that from 10 to 50 percent of the carambola crop would be lost to disease (n=6, mean of 23 percent). Fungicides registered for use on carambola include mefenoxam (Ridomil Gold®), copper (Kocide®/Basicop®), and azoxystrobin (Quadris®).

Copper (Kocide®/Basicop®). Copper has long been used as a fungicide and can be applied in multiple forms (copper hydroxide, copper sulfate, etc.). Copper is used to manage anthracnose, sooty blotch, leaf spot, and algal spot (17). The median price of copper hydroxide is \$2.11 per pound of active ingredient and the approximate cost per application is \$9.75 per acre (9,18). The PHI and REI for copper hydroxide are 0 day and 24 hours, respectively (18). Based on survey results, 60 percent of carambola growers in Florida applied copper either once (33 percent), twice (33 percent), three times (17

percent) or four times (16 percent) per season for an average seasonal use of 2.2 times.

Alternative Control

Several new chemicals have been registered for use in carambola. Mefenoxam (Ridomil Gold®) and azoxystrobin (Quadris®) are two products which have been recently registered for carambola and are now being incorporated into recommendations.

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 symptoms characteristic of nutrient deficiencies. Stunting and poor stand development tend to occur in patches throughout the field as a result of the irregular distribution of nematodes within the soil.

Chemical Control

The only product registered for use on carambola in Florida that claims nematode suppression is Clandosan® (chitin). Experience (and success) with this material has not been well documented.

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