



Florida Cooperative Extension Service

## The Carambola (Star Fruit)<sup>1</sup>

J. H. Crane<sup>2</sup>

- **Scientific name:** *Averrhoa carambola* L.
- **Family:** Oxalidaceae
- **Origin:** Southeast Asia

### DISTRIBUTION

Carambolas are cultivated throughout many tropical and warm subtropical areas of the world. In the U.S, carambolas are grown commercially in southern Florida and Hawaii. In Florida, carambolas are grown commercially in Dade, Lee, Broward, and Palm Beach counties.

### HISTORY

Carambolas have been cultivated in southeast Asia (e.g., Malaysia, India, Sri Lanka) for centuries and trees were introduced in Florida over 100 years ago. Fruit from the first introductions into Florida were tart. More recently, seeds and vegetative material from Thailand, Taiwan, and Malaysia have been introduced and sweet cultivars have been selected.

### IMPORTANCE

As consumers become more familiar with carambola (also called star fruit), commercial acreage and production will increase throughout the tropical and subtropical world. Currently, the major

producers include Taiwan, Malaysia, Guyana, India, Philippines, Australia, Israel, and the United States (Florida and Hawaii).

### DESCRIPTION

**Tree:** The carambola tree is small to medium in height (22 to 33 ft; 7 to 10 m), spreading (20 to 25 ft in diameter; 6 to 7.6 m), evergreen, and single or multi-trunked. Trees grow rapidly in locations protected from strong winds. The mid-canopy area (3 to 7 ft height; 0.9 to 2.1 m) is the major fruit-producing area of mature trees.

**Leaves:** Carambolas have compound leaves 6 to 12 inches (15 to 30 cm) long that are arranged alternately on branches. Each leaf has 5 to 11 green leaflets 0.5 to 3.5 inches long (1.5 to 9 cm long) and 0.4 to 1.8 inches (1 to 4.5 cm) wide.

**Flowers:** Carambola flowers are borne on panicles on twigs, small diameter branches, and occasionally on larger wood. Flowers are perfect, small (3/8 inch or 1 cm in diameter), pink to lavender in color, and have 5 petals and sepals. Depending upon the cultivar, carambola flowers have either long or short styles.

**Fruit:** The fruit is a fleshy 4- to 5-celled berry with a waxy surface. Fruit are 2 to 6 inches (5-15 cm) in length, with 5 (rarely 4-8) prominent longitudinal ribs; star-shaped in cross section. The fruit skin is thin, light to dark yellow, and smooth, with a waxy cuticle.

1. This document is Fact Sheet HS-12, a series of the Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: April 1994.
2. Jonathan H. Crane, Assistant Professor, Tropical Research and Education Center, Homestead, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville FL 32611.

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The flesh is light to dark yellow in color, translucent, crisp, very juicy, and without fiber. Good cultivars have an agreeable, subacid to sweet flavor. Fruit are sweetest when allowed to ripen on the tree. Green fruit will slowly turn yellow if picked before fully ripe. It takes about 60 to 75 days from fruit set to maturity depending upon cultivar, production practices, and weather. Green and ripe fruits are easily damaged and must be handled with great care. Carambola fruit is low in calories (36-57 cal/100 grams), a good source of potassium, and a moderate source of vitamin C.

**Seeds:** There are usually no more than 10-12 seeds per fruit and sometimes none. Seeds are edible, ¼ to ½ inch (0.6-1.3 cm) long, thin, light brown, and enclosed by a gelatinous aril. Seeds lose viability in a few days after removal from fruit.

**Cultivars:** There are many cultivars; however, some may be unavailable for purchase from nurseries due to a limited amount of plant-propagation material. There are two main types of carambolas, sweet and tart (see Table 1). Sweet types are recommended for fresh fruit while both sweet and tart types are useful for processing and home recipes. Some tart cultivars, such as 'Golden Star' attain a sweet flavor if they are allowed to ripen on the tree (i.e., become golden yellow).

**Pollination:** All the flowers on a given carambola cultivar have either long or short styles; this condition is called heterostyly. Some carambola cultivars may require cross pollination (short-styled by long-styled cultivar or vice versa) for good fruit set and yields. However, cultivars such as 'Golden Star' and 'Arkin' produce abundant crops when planted in solid blocks indicating that the need for cross pollination by opposing stylar types is not always necessary.

## CLIMATE

Although carambola grows best in tropical lowland climates, it also does well in warm subtropical areas that experience only occasional freezing temperatures. In Florida, carambola can be grown in warm locations along the southeastern (e.g., Merritt Island) and southwestern (e.g., Tampa Bay area) coasts, Dade, Lee, Broward, Palm Beach, Monroe, and Collier Counties, and in protected areas in Brevard, Pinellas, Highlands, and Polk Counties.

Air temperatures of 30° to 32°F (-1.1° to 0°C) may kill immature leaves, while young trees, mature twigs,

and leaves may be killed at 27° to 29°F (-2.8° to -1.7°C). Small branches on mature trees may be damaged after exposure to 25° to 29°F (-3.9° to -1.7°C) whereas temperatures of 20° to 24°F (-6.7° to -4.4°C) may kill large branches and mature trees.

Carambola cultivars vary in their susceptibility to wind damage. Symptoms of wind damage include defoliation, desiccation, twig dieback, stunted growth, and fruit damage (wind scar). Cultivars such as 'Golden Star' and 'Newcomb' can withstand windy conditions better than 'Arkin' and 'Fwang Tung.' Commercial growers typically select planting sites adjacent to natural (e.g., forest) wind protection or construct artificial wind breaks. Trees protected by wind breaks are generally more vigorous and productive than wind-exposed trees.

## PROPAGATION PRACTICES

Carambola cultivars are generally grafted on seedling rootstocks. Seedlings of 'Golden Star' are better adapted to the limestone (high pH) soils of south Dade County than seedling rootstocks of 'Arkin.'

Veneer grafting and chip budding during the time of most active growth have given the best results. Actively growing, healthy carambola seedlings of ¼ inch (7 mm) in diameter are best for rootstocks. Graftwood should be taken from mature twigs on which leaves are still present and, if possible, when the buds are just beginning to grow. Alternatively, graftwood can be prepared 3 to 4 days ahead of grafting by removing the leaves. This will stimulate the buds to begin growing.

Top-working of older trees has been done by bark and veneer grafting. Air-layering (marcottage) and tissue culture have not proved successful due to poor root development.

## PRODUCTION AND HARVESTING PRACTICES

Carambola trees grown in wind-protected areas may begin to produce fruit within 10 to 14 months after planting. Generally, 10 to 40 lbs (4.5 to 18 kg) of fruit per year per tree can be expected during the first two to three years. As trees mature, fruit production will increase rapidly so that by years 5 and 6, 100 to 150 lbs (45 to 68 kg) of fruit per tree can be expected. Mature trees 7 to 12 years old, may

produce 250 to 350 lbs (112 to 160 kg) of fruit or more per year.

The carambola has two major blooms in south Florida, April through May and September through October. However, some bloom may be found throughout the year. The harvest season is generally from June through February with peaks in fruit production during August to October and December through February. Usually there are a few fruits available throughout the year.

Commercially, carambola fruit are picked by hand when a yellow color begins to develop (at "color break") in the furrow between the ribs while the tips of the ribs (fins) remain green. Fruit at this stage of maturity store and ship well to distant markets. In the field, fruit are generally placed into 25 lb (11.3 kg) field boxes and placed in the shade until taken to the packinghouse for washing, grading, packing, and storage. Fruit for home use can be left on the tree until completely ripe (yellow to golden yellow in color).

### SPACING, PRUNING, AND IRRIGATION PRACTICES

A wide range of spacings are used for commercial carambola production in south Florida. However, most commercial plantings have 118 to 145 trees per acre (292 to 358 per ha) and use in-row spacings of 15 to 20 ft (4.6 to 6.2 m) and between-row spacings of 20 to 25 ft (6.1 to 7.6 m). After 5 to 7 years under commercial conditions, canopies from adjacent trees may begin to touch each other. If pruning is not initiated, shading of lower limbs will result in loss of the lower 2 to 3 feet of productive canopy. To prevent crowding, trees for the home landscape should be planted a minimum of 20 to 30 ft (6.1 to 9.1 m) from buildings and other trees.

In a commercial setting, tree size control is important for retaining fruit production in the lower tree canopies and facilitating foliar spraying and harvesting. Currently, there are no recommendations for training young carambola trees in commercial orchards. However, research with mature trees has demonstrated that removing upright limbs during late winter (Feb./March) and then removing selected new regrowth (shoots) and heading back remaining new shoots to one-half their length in early fall (Sept./Oct.), can maintain mature (7 to 9 year old) trees at a 9 to 13 feet (2.7 to 4.0 m) height without significantly reducing fruit production. A healthy tree

in the home garden requires no pruning except for occasional removal of dead branches. Removal of upright limbs will reduce tree height and maintain fruit production in the lower canopy if tree size or crowding becomes a problem.

Irrigation is recommended for commercial carambola orchards. The most beneficial application rates and frequencies, however, have not been determined. The general recommendation is to apply one-half inch (1.3 cm) of water per acre twice a week during dry periods throughout the year.

High volume under or over tree-sprinkler irrigation has been observed to adequately protect carambola trees during freezing weather. The irrigation system should be designed to apply at least 0.21 inches (0.53 cm) of water per hour and proper coverage of the grove is critical in order to protect the trees. Sprinklers should be turned on when air temperatures are 3 to 4°F above freezing (35 to 36°F; 1.7 to 2.2°C) and continue to run until air temperatures exceed 32°F (0°C) or until ice has melted. **Caution:** irrigation during freezing weather that is accompanied by strong winds (greater than 5 mph) may not be advisable. For more information consult your county agricultural extension agent.

### SOILS

Carambola trees are well adapted to many types of well-drained soils. Trees grow best where the soil reaction is moderately acid to neutral in pH. In calcareous soils, special care is required to prevent minor element deficiencies, particularly iron, manganese, and zinc (see FERTILIZER section).

Research with containerized 'Golden Star' carambola trees demonstrated that carambola is moderately flood tolerant under disease free soil conditions. However, shoot and root growth of flooded trees were reduced compared to non-flooded plants.

### FERTILIZER PRACTICES

Current fertilizer recommendations are based on observation. In soils of low fertility, young trees (1 to 2 years old) should receive light applications of a mixed fertilizer containing nitrogen, phosphorus, and potassium ( $\frac{1}{4}$  to  $\frac{1}{2}$  lb per tree per application; 0.6 to 1.1 kg per tree per application) every 30 to 60 days until trees are well established. As trees mature, the fertilizer rate should increase (1 to 3 lbs per tree per

application; 0.45 to 1.4 kg per tree per application) with an application frequency of 4 to 8 times per year. Fertilizer mixtures containing 6-8% nitrogen, 2-4% available phosphoric acid, 6-8% potash and 3-4% magnesium are satisfactory.

In acid to neutral pH soils, micronutrients such as manganese, zinc, and iron may be applied in dry applications to the soil or in a liquid form and sprayed onto the leaves. Three to 6 applications should be made per year. Trees growing in calcareous soils should receive 4 to 8 foliar applications per year of zinc and manganese. Iron deficiency may be corrected by 3 to 6 yearly soil drench applications of chelated iron specifically formulated for calcareous soils.

## PESTS

Carambola trees are attacked by a number of scale insects including Plumose [*Morganella longispina* (Morgan)] and Philephedra [*Philephedra tuberculosa* (Nakahara and Gill)] scales which attack leaves and twigs causing defoliation and stem dieback. The weevil *Diaprepes abbreviatus* (L.) causes damage to the roots, which may lead to root and shoot dieback.

Fruit damage caused by stink bugs (*Nezara* sp.) and squash bugs (*Acanthocephala* sp.) results in pinhole-sized markings on the fruit surface and dry areas of the flesh under the puncture wounds. This may lead to infection by fungi which cause soft rot of the fruit. Fruit blotch miner (*Lepidoptera:Gracillaridae*) causes a superficial damage to the waxy cuticle and can be identified by meandering brownish colored trails on the fruit surface. Brown scales [*Coccus hesperidum* (L.)] and red-banded thrips [*Selenothrips rubrocinctus* (Giard)] have also been observed feeding on carambola fruit. Birds, opossums, and racoons may attack fruit especially early in the season. Their damage can be identified by the V-shaped marks left on the ribs of the fruit. For more information and control measures, consult your county agricultural extension agent.

## DISEASES

Leaf spot diseases are caused by *Cercospora averrhoa* Petch., *Corynespora cassicola* Berk. and Curt., *Phomopsis* sp., *Gloesporium* sp. and *Phyllosticta* sp. Observations indicate that these diseases are more common on stressed or nutritionally deficient trees and occur on older leaves that normally abscise

(drop) during the winter and early spring. Twigs and limbs may be attacked by red alga (*Cephaleuros virescens* Kunze). Symptoms include rough circular greenish-grey or rusty-red areas and shoot dieback.

Ripe fruit that is injured may be attacked by the fruit-rotting fungus, (*Colletotrichum gloeosporioides* Penz) which causes anthracnose. A superficial blackish discoloration on fruit ("sooty mold") caused by *Leptothyrium* sp. may be found on fruit surfaces. Recently, the fungus *Pythium splendens* Braun has been identified as the cause of a general tree decline syndrome. Decline symptoms include loss of tree vigor, leaf drop, twig, shoot, and root die-back, and reduced fruit size and production. For more information and control measures, consult your county agricultural extension agent.

## RIPENING AND STORAGE

Commercially, carambola fruit are picked at color break and taken to the packinghouse for washing, sorting, packing, storing, and shipping. Fruit can be stored for about 21 days at 41 to 50°F (5 to 10°C) and 85 to 95% relative humidity without cold damage or any significant loss in fruit quality. Fruit stored at color break will develop normal color after they are transferred to room temperatures (72 to 73°F; 22 to 23°C).

Carambolas do not increase in sugar content after picking. Therefore, home owners interested in fruit with optimum sweetness should pick fruit when all traces of green disappear from the fruit surface (yellow to golden yellow color). Fruit picked at color break will develop yellow color at room temperature after storage. Fruit can be stored at cold temperatures (41 to 45°F; 5 to 7°C) in the refrigerator.

## USES

Carambolas are primarily sold as a fresh fruit. However, processing into pickles, sauces, wine, and jellies is done on a limited scale.

Carambola trees are excellent for home landscaping. The foliage is dark green, attractive and flowers and fruit are beautiful. The fruit is valued for its appearance and unusual shape. It is eaten fresh, cut up in fruit salads, or used as a garnish for meat dishes. The juice makes a delicious iced drink alone or in combination with other beverages. The fruit may also be canned, preserved and dried.

**Table 1.** Carambola cultivars introduced into or selected in South Florida.

Cultivar	Origin <sup>1</sup>	Flavor	Rec.use <sup>2</sup>		Comments
			H	C	
Arkin	Florida	sweet	Y	Y	commercially important
B-2	Malaysia	sweet	U	U	under evaluation
B-10	Malaysia	sweet	Y	U	under evaluation
B-16	Malaysia	sweet	Y	U	under evaluation
B-17	Malaysia	sweet	Y	U	under evaluation
Dah Pon	Taiwan	sweet	N	N	poor color, insipid taste
Demak	Indonesia	sweet	N	N	bitter after-taste
Fwang Tung	Thailand	sweet	Y	N	poor color, thin ribs, good flavor
Golden Star	Florida	tart	Y	M	sweet when fully ripe, very productive
Hew-1	Malaysia	sweet	Y	N	whitish spots on fruit, good flavor
Kary	Hawaii	sweet	Y	U	under evaluation
Maha	Malaysia	sweet	N	N	poor color, thin ribs, insipid taste
Mih Tao	Taiwan	sweet	N	N	insipid taste
Newcomb	Florida	tart	Y	N	tart
Sri Kembangan	Malaysia	sweet	U	U	under evaluation
Star King	Florida	tart	N	N	very tart
Tean Ma	Taiwan	sweet	N	N	insipid taste
Thayer	Florida	tart	Y	N	tart
1. Florida cultivars originated from seeds introduced from other countries (e.g., Thailand, Malaysia) or Hawaii (i.e., 'Golden Star').					
2. Rec. use = recommended use; H = home, C = commercial; Y = yes, N = no, M = maybe; U = no recommendation available.					