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# CULTIVATION OF FRUITS OF THE ANNONACEAE IN FLORIDA

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## ABSTRACT

Many species and cultivars of Annonaceae have been introduced and tested in Florida. The atemoya (*Annona cherimola* x *A. squamosa*) and the sugar apple (*A. squamosa*) are now grown commercially and production is increasing. Cherimoya (*A. cherimola*), ilama (*A. diversifolia*), soursop (*A. muricata*), custard apple (*A. reticulata*) and biriba (*Rollinia pulchrinervis*) are grown in home gardens for their edible fruits. The mountain soursop (*A. montana*) and pond apple (*A. glabra*) are grown as ornamental trees and as rootstocks.

The most important limiting factor to annona cultivation in Florida is freeze injury. Biriba, ilama and soursop are especially susceptible to cold injury. The cherimoya does not produce fruit well because the climate is too hot.

All of the annonas can be grown from seed, but superior selections can be reproduced true-to-type only by vegetative propagation. Veneer-grafting and chip-budding are the preferred methods. Superior selections of atemoya, sugar apple, ilama and soursop are propagated in this way, Custard apple and atemoya are used most commonly as rootstocks, but more research is needed because of problems with incompatibility.

Important pests and diseases include the annona seed borer, *Bephatelloides cubensis*, a fruit rot, caused by the fungus *Colletotrichum gloeosporioides*, and a leaf rust caused by the fungus *Phakopsora cherimoliae*. Research is needed on effective means of control.

## RESUMEN

Se han introducido muchas especies y variedades de la familia Annonaceae al estado de Florida. Hay producción comercial de la atemoya (*Annona cherimola* x *A. squamosa*) y del anon (*A. squamosa*) y esta producción está incrementada. La chirimoya (*A. cherimola*), la ilama (*A. diversifolia*), la guanábana (*A. muricata*), el corazón (*A. reticulata*), la biriba (*Rollinia pulchrinervis*) se cultivan para sus frutas comestibles en los huertos caseros. La guanábana cimarrona (*A. montana*) y el guanábana de corcho (*A. glabra*) se utilizan como portainjertos y como árboles ornamentales.

El factor que más limita la producción de las anonáceas en Florida son las heladas invernales. La biriba, la ilama y la guanábana son especialmente susceptibles al daño de temperaturas bajas. Por otro lado, la chirimoya no produce bien a causa del clima caliente.

Todas las anonáceas pueden ser propagadas por semilla, pero las plantas procedentes de semilla son variables. Selecciones superiores deben ser propagadas vegetativamente. Los métodos preferidos en Florida son el injerto de chapa lateral y el injerto de yema de astilla. Las variedades que más se usan para portainjertos son el corazón y la atemoya, pero debido a problemas de incompatibilidad se requiere más investigación de portainjertos.

Las plagas y enfermedades importantes incluyen un insecto perforador de la semilla (*Bephatelloides cubensis*), la anthracnosis de la fruta (causada por el hongo *Colletotrichum gloeosporioides*) y una roya de la hoja (causada por el hongo *Phakopsora cherimoliae*). Se precisan más estudios sobre controles efectivos de estas problemas.

Additional index words: Annona, Rollinia, cold injury, propagation, grafting, rootstocks.

Two genera of the family Annonaceae are present in the native flora of southern Florida. *Asimina*, primarily a genus of the North Temperate Zone, is represented by *A. reticulata*, a shrubby plant which bears a small fruit not considered to be edible. The genus *Annona* is represented by *A. glabra*, the pond apple, a tropical tree at the northern limit of its range. It bears a fruit which is large and fleshy, but is not palatable because of undesirable flavor.

For a long time there has been interest in introduction and cultivation of tropical species of this family (3) in Florida. The most commonly cultivated species are listed in Table 1, along with their English common names and places of origin. Two species, the atemoya and the sugar apple, are now grown commercially (4, 6, 11). The others are grown in home gardens for their edible fruit, except for the mountain soursop and the pond apple, which are grown as ornamental trees and to a small extent as rootstocks for other species. This paper describes the current status of cultivation of the Annonaceae in Florida.

## Climatic Adaptation

The most important limiting factor to survival of tropical annonas in Florida is the occasional freeze which can occur during the months of December, January or February. The soursop is especially susceptible to cold injury, often losing its leaves even when exposed to air temperatures a few degrees above freezing if they are accompanied by strong winds. Exposure to temperatures a few degrees below freezing can kill large trees. The biriba and the ilama are also very susceptible to injury by low temperature. These species can be grown only in the warmest areas and must be given good cold-protection when freezes occur.

The remaining species listed in Table 1 have sufficient cold tolerance to survive most of the cold periods which occur in the coastal areas of southern Florida. They, too, must be given some cold protection to survive freezes in the colder areas.

Table 1. Species of Annonaceae commonly cultivated in Southern Florida.

Scientific name	Common name	Area of origin
<i>Annona cherimola</i> Mill.	cherimoya	South America
" <i>diversifolia</i> Saff.	ilama	Central America, Mexico
" <i>glabra</i> L.	pond apple	Tropical America, West Africa
" <i>montana</i> Macfady	mountain soursop	West Indies
" <i>muricata</i> L.	soursop	Tropical America
" <i>reticulata</i> L.	custard apple	Tropical America
" <i>squamosa</i> L.	sugar apple	Tropical America
<i>A. cherimola</i> × <i>A. squamosa</i>	atemoya	Australia, Israel, Florida, etc.
<i>Rollinia pulchrinervis</i> A.DC. ( <i>R. deliciosa</i> )	biriba	South America

One species, the cherimoya, is poorly adapted to the Florida climate because the mean temperatures are too high. The plant originated in cool highland areas of the American tropics and it grows well in some cool subtropical regions also. In Florida it makes relatively poor vegetative growth and does not flower and fruit well, so it is not recommended for planting although it is grown by some home gardeners.

#### Variety Selection

All of the species cultivated in Florida can be grown from seed. The plants grow fast and usually begin to flower and bear fruit at 3 to 4 years of age. Some species can be grown from seed more successfully than others. Sugar apple seedlings come relatively true from seed and bear fruit at an early age, with a significant crop in the third year after planting. Nearly all of the commercial plantings of sugar apple in Florida are of seedling trees. There is variation within seedling populations of all the species, however, and the only way to reproduce superior selections dependably is by vegetative propagation.

The atemoya is the most variable of the Annonaceae grown in Florida, which is not surprising considering its hybrid origin. Many selections have been tested, including 'African Pride', 'Bernitski', 'Bradley', 'Chirimorifion A', 'Chirimorifion B', 'Gefner', 'Guzman', 'Lindstrom', 'Malali', 'Page', 'Pink's Mannoht', 'Priestley' and 'Stermer'. Of these, the 'Gefner' is the most widely planted. It makes up nearly all the commercial plantings of atemoya.

A few selections of sugar apple have been made, including 'Lessard', 'Lincoln', 'Purple' and 'Seedless'. The 'Imery' ilama was introduced in 1961 from El Salvador. Selections of soursop include 'Cuban Fiberless' and 'Youngmans'. Other selections have been made, but are not generally available.

#### Propagation

Species of Anonaceae are propagated commonly by seed. Seeds of most species will remain viable for a period of a few weeks to several months after removal from the fruit. Seeds of some tropical species remain dormant for a time after harvest and will not germinate until they pass an "after-ripening" period or, in some cases, are treated with chemical dormancy-breaking compounds like gibberellins (7).

Some method of vegetative propagation is required for true-to-type reproduction of superior selections. Rooting of cuttings or air layers have been tried in Florida for most species, but have not been successful. The most successful methods are veneer grafting and chip-budding (9). If the branches from which scions are to be taken have leaves, it is well to remove the leaves 1-2 weeks before the scions are cut. This causes the stumps of the leaf petioles to drop and the buds to swell, and in this way it can be determined whether or not the buds are alive. Grafting is used especially with atemoya, as noted above, but also for propagation of selections of ilama, soursop and sugar apple.

#### Rootstocks

The rootstock and scion combinations which have been used in Florida are listed in Table 2, with symbols indicating the degree of success which has been obtained. More research is needed before we can be sure of the best rootstocks for use in Florida.

The main problem with interspecific grafting of the annonas is incompatibility. This has been recognized for a long time, but has become particularly evident during the past few years when large numbers of trees have been grown in orchard plantings. In some cases the incompatibility seems to be simply between species. In others it is more complicated, with some cultivars compatible while others are not. For example, the atemoya cultivars 'Bradley' and 'Page' are compatible with rootstocks of custard apple, but the cultivar 'Gefner' is at least partially incompatible. This has caused considerable loss of plants in some commercial orchards.

Some areas in which annonas are grown are subject to occasional flooding. Pond apple is the only rootstock which is not injured by flooding; all of the others in common use are severely injured or killed if the root system is covered by water for more than about a day. It is recommended that planting sites in areas subject to flooding be mounded up or bedded to avoid the problem.

#### Economic Considerations

We are still in the process of determining the best cultivation methods in Florida. Growers use plant spacings between rows of 6 - 7m and spacings between plants in the row of 4 - 6m. Regular applications of NPK fertilizers are used, and sprinkler irrigation is used during dry periods.

Table 2. Rootstock-scion combination of annonas in Florida.

Rootstock	Scion			Sugar apple
	Atemoya	Ilama	Soursop	
Atemoya	+	?	0	?
Cherimoya	?	0	0	?
Custard apple	+	?	—	?
Ilama	0	+	0	0
Mountain soursop	0	0	?	0
Pond apple	+	—	?	—
Soursop	—	0	+	—
Sugar apple	?	?	—	+

+ Grafts successful in most cases

? Will form graft union; ultimate success not known

— Grafts not successful

0 No information available

The most important pest is an insect, *Bephratelloides cubensis*, which feeds as a larva and pupates inside the seeds and then bores through the fruit when it emerges as an adult (10). The life history of this insect was determined by Burner and Acuna (2). Work is in progress to determine suitable methods for its control.

Scale insects, particularly those of the genus *Philephedra*, can build up harmful populations on leaves, young stems and fruit of annona plants (10). Ambrosia beetles (possibly *Xyleborus* sp.) bore holes in young branches and reduce their viability (10). Work is in progress to determine the extent of damage done by pests and methods for their control (10).

A number of fungus diseases have been reported on annona plants in Florida (1). Two diseases cause serious damage. Anthracnose, caused by *Colletotrichum gloeosporioides* infection, damages fruit severely, causing it to drop from the tree or to remain on the tree and become mummified (1, 8). Spraying with fungicides during the early stages of fruit development gives some control, but work is needed to develop better methods. A rust fungus, *Phakopsora cherimoliae*, infects annona leaves and causes them to fall prematurely. This disease, which causes relatively little damage to isolated plants in home gardens, is becoming increasingly important in orchard plantings.

Diseases which cause relatively little damage at this time include root rots (*Armillariella*, *Phomopsis*) and leaf spots (*Alternaria*, *Cercospora*, *Gloeosporium*, *Helminthosporium*, *Phomopsis*, *Phyllosticta*).

The yield potential of annona plantings in Florida has not been determined with accuracy. Satisfactory crops are produced in Florida by natural pollination (5) although in some other places hand pollination is needed. With atemoya annual yields of 50 pounds or more of fruit per tree can be expected.

Yields of sugar apple are less because the plants are smaller. Prices in the United States market have been good and growers have made good profits from their plantings. Presently there are around 20 acres of atemoya and 40 acres of sugar apple orchards in Florida, and plantings are increasing.

#### Possibilities for the Future

There are many possibilities for genetic improvement of the Annonaceae, particularly in the selection of better atemoya cultivars. The current interest in commercial production in Florida may provide impetus for more of this work to be done. In addition to the species which presently are valued for their fruit (atemoya, ilama, soursop and sugar apple) others may have promise for improvement by hybridization. These include the custard apple and the soncoya (*Annona purpurea*). It seems certain that improvement of fruits of the Annonaceae will continue in the future and that production in Florida will increase.

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