

## The Pawpaw Regional Variety Trial

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The pawpaw [*Asimina triloba* (L.) Dunal, Annonaceae] tree produces the largest edible tree fruit native to the United States (Darrow 1975; Layne 1996). This fruit, known commonly as the “poor man’s banana,” may reach up to 1 kg in size. Pawpaws grow wild in the mesic hardwood forests of 26 states in the eastern United States, ranging from northern Florida to southern Ontario (Canada) and as far west as eastern Nebraska (Kral 1960); as shown in Fig. 1. Pawpaws are hardy to USDA growing zone 5 (−15°F, −9.4°C) and flourish in the deep, rich fertile soils of river-bottom lands where they grow as understory trees or thicket-shrubs (Sargent 1890). The unique qualities of the pawpaw fruit, ornamental value of the tree, and the natural compounds in the leaf, bark, and twig tissues that possess insecticidal and anti-cancer properties (McLaughlin 1997), suggest that pawpaw has great potential as an alternative high-value crop.

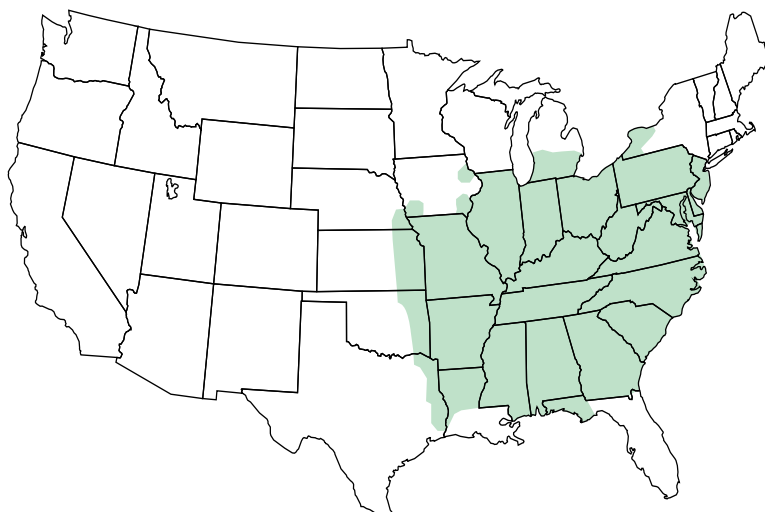
### THE PAWPAW

#### Taxonomy

Pawpaw is the only temperate member of the tropical Custard Apple family (Bailey 1960), which includes several delicious tropical fruits such as the custard apple (*Annona reticulata* L.), cherimoya (*A. cherimola* Mill.), sweetsop or sugar apple (*A. squamosa* L.), atemoya (*A. squamosa* × *A. cherimola*), and soursop (*A. muricata* L.). There are also eight other members of the *Asimina* genus that are native to the extreme south-eastern states of Florida and Georgia. These include *A. incarna* (Bartr.) Exell. (flag pawpaw); *A. longifolia* Kral; *A. obovata* (Willd.) Nash; *A. parviflora* (Michx.) Dunal (dwarf pawpaw); *A. pygmaea* (Bartr.) Dunal; *A. reticulata* Shuttlw. ex Chapman; *A. tetramera* Small (opossum pawpaw); and *A. × nashii* Kral (Kral 1960).

#### Description of the Plant

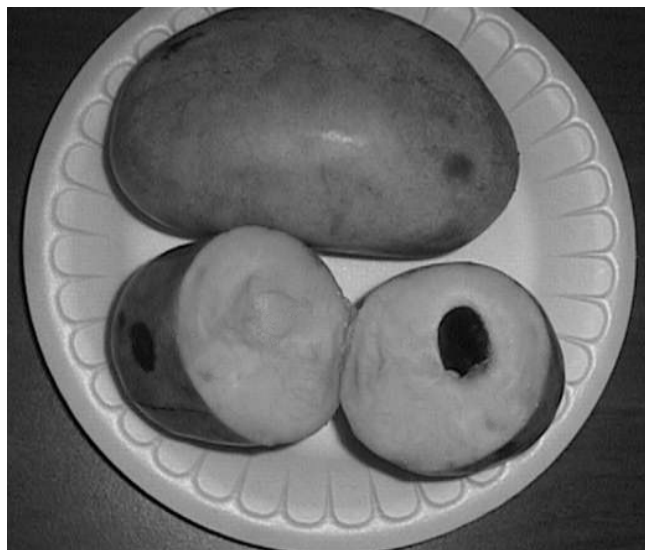
Pawpaw is a small, deciduous tree that may attain 5 to 10 m in height and tends to be found in patches due to root suckering (Layne 1996). In sunny locations, trees typically assume a pyramidal habit, with a straight trunk and lush, dark green, long, drooping leaves (Fig. 2). The blossoms occur singly on the previous year’s wood, reaching up to 5 cm in diameter, emerging before leaves in mid spring (about April in Kentucky). Flowers have a globular androecium and a gynoecium composed of 3–7 carpels or 3–7 fruited clusters (Kral 1960). Flowers are strongly protogynous, self-incompatible and require cross-pollination (Wilson and Schemske 1980), although some trees may be self-compatible. Pollination may be by flies (Wilson and Schemske 1980) and beetles (Kral 1960).



**Fig. 1.** Native range map of pawpaw (*Asimina triloba*).



**Fig. 2.** 25 yr. old pawpaw tree in full sun location. Photograph by R.N. Peterson.



**Fig. 3.** Pawpaw fruit from the cultivar Zimmerman. Photograph by S.C. Jones. Plate diam. = 18 cm.



**Fig. 4.** Pawpaw fruit from the PawPaw Foundation advanced selection 1-7-1. Photograph by S.C. Jones. Plate diam. = 18 cm.



**Fig. 5.** Pawpaw fruit cluster. Photograph by D.R. Layne.

### Description of the Fruit

Fruit set in the wild is usually low and may be pollinator or resource-limited (Wilson and Schemske 1980), but under cultivation, tremendous fruit loads have been observed. The fruits are oblong-cylindrical berries that are typically 3 to 15 cm long, 3 to 10 cm wide and weigh from 200 to 400 g (Fig. 3 and 4). They may be borne singly or in clusters (Fig. 5), which resemble the “hands” of a banana plant (*Musa* spp.). When ripe, skin color ranges from green, to yellow, to brownish black, and flesh color ranges from creamy white through bright yellow to shades of orange (Fig. 3 and 4). The flavor of the pawpaw fruit resembles a combination of banana, mango, and pineapple. However, flavor varies among cultivars, with some fruit displaying more complex flavor profiles. The flavor of a pawpaw fruit can intensify as it over-ripens, as with banana, resulting in pulp that is excellent for use in cooking. The skin should not be eaten. Shelf life of a tree-ripened fruit stored at room temperature is 2–3 days. With refrigeration, fruit can be held up to 3 weeks while maintaining good eating quality.

## COMMERCIAL POTENTIAL OF PAWPAW

In Kentucky and the southeastern United States, alternative and potentially high-value cash crops are being examined for their potential to help supplement the incomes of small farmers who are currently dependent upon growing and selling tobacco. Identifying alternative high-value crops would allow small farmers to diversify to these alternative crops and generate new sources of farm income. This plant is well adapted to the climate of the southeastern United States where tobacco is now commonly grown.

Pawpaw fruit have a unique tropical flavor and powerful aroma. There is commercial potential for use of pawpaw fruit in juices, ice creams, yogurts, and baby food. The fruit are very nutritious, being higher in some vitamins, minerals, and amino acids than apple, grape, and peach (Peterson, et al. 1982). Pawpaw trees are also attractive to the homeowner as an ornamental planting in edible landscapes. Natural compounds (annonaceous acetogenins) in leaf, bark, and twig tissue possess insecticidal and anti-cancer properties (Rupprecht et al. 1986; Zhao et al. 1994; McLaughlin 1997). Harvesting the leaves and twigs for the extraction of these compounds may also represent a lucrative opportunity for small farmers.

There is already a potentially profitable market for those interested in establishing pawpaw orchards. Most fruit for sale are currently collected from wild stands in the forest. Bray Orchards of Bedford, Kentucky has developed a pawpaw ice cream, in cooperation with the pawpaw project at Kentucky State University. The ice cream has been selling for \$10.00 per gallon, and Bray Orchards has been paying up to \$5.00 per lb. for pawpaw pulp. Pawpaws also show potential as fresh market fruit. Pawpaw fruit were sold at the Lexington Farmers Market this year (1998) for \$1 each (or about \$3.00 per pound) and sellers had a difficult time finding enough fruit to market.

Chefs at the Oakroom, a AAA five-diamond restaurant at Louisville's Seelbach Hilton, have developed a menu of Appalachian cuisine, which includes pawpaw. The menu includes a pawpaw and green tomato relish on a French rib pork chop, pawpaw sorbet, and a Pawpaw Foster with pawpaw ice cream (made by Bray Orchards) for dessert. The Pawpaw Foster consists of flambéed pawpaw and banana using ginger liqueur (wild ginger is indigenous to Kentucky) over pawpaw ice cream. An Associated Press article was carried in newspapers across the country in the last week of September 1998 concerning the development of this menu and the use of pawpaws. Hopefully, this media coverage will continue to increase public awareness of the pawpaw fruit and its uses.

**Table 1.** List of pawpaw selections in Regional Variety Trial (RVT).

Clone	Orchard source	Genetic background <sup>z</sup>
1-7	Wye, MD	'Overleese'
1-23	Wye, MD	'Taytwo'
2-54	Wye, MD	GAZ-VA
8-58	Wye, MD	BEF-30
9-47	Wye, MD	BEF-49
9-58	Wye, MD	BEF-50
10-35	Wye, MD	BEF-49
11-5	Wye, MD	BEF-53
11-13	Wye, MD	BEF-53
'Middletown'		From Ohio
'Mitchell'		From Illinois
'NC-1'		'Davis' × 'Overleese'
'Overleese'		From Indiana
'PA-Golden'		From Pennsylvania
'Sunflower'		From Kansas
'Taylor'		From Michigan
'Taytwo'		From Michigan
'Wells'		From Indiana
'Wilson'		From Kentucky
1-7	Keedysville, MD	BEF-30
1-68	Keedysville, MD	'Overleese'
2-10	Keedysville, MD	BEF-30
3-11	Keedysville, MD	BEF-33
3-21	Keedysville, MD	BEF-43
4-2	Keedysville, MD	BEF-53
5-5	Keedysville, MD	BEF-54
7-90	Keedysville, MD	RS-2
8-20	Keedysville, MD	'Sunflower'

<sup>z</sup>BEF = Blandy Experimental Farm Collection, Boyce VA.

GAZ = George A. Zimmerman Collection., Linglestown, PA.

RS = Ray Schlaanstine Collection, West Chester, PA.

**Table 2.** Regional Variety Trial cooperators and cooperating institutions by location.

State	Cooperator	Institution	Location
Indiana	Bruce Bordelon	Purdue University	West Lafayette, IN
Iowa	Tom Wahl	Iowa State University	Wapello, IA
Kentucky	Kirk Pomper	Kentucky State Univ.	Frankfort, KY
Kentucky	Jerry Brown	Univ. of Kentucky	Princeton, KY
Maryland	Chris Walsh	Univ. of Maryland	Keedysville, MD
Michigan	Dennis Fulbright	Michigan State Univ.	Jackson, MI
Nebraska	Bill Gustafson & Stan Matzke	Univ. of Nebraska	Lincoln, NE
New York	Ian Merwin	Cornell University	Ithaca, NY
North Carolina	Mike Parker	N.C. State University	Raleigh, NC
Ohio	Tom Wall	Ohio State University	Piketon, OH
Oregon <sup>z</sup>	Kim Hummer	USDA-NCGR	Corvallis, OR
	Anita Azarenko	Oregon State University	Corvallis, OR
South Carolina	Greg Reighard	Clemson University	Clemson, SC
Country			
China <sup>z</sup>	Xi Sheng-Ke	Chinese Academy of Forestry	Beijing, China
China <sup>z</sup>	Hongwen Huang	Chinese Academy of Sciences	Wuhan, Hubei, China
Chile <sup>z</sup>	Luis Luchsinger	University of Chile	Santiago, Chile

<sup>z</sup> Outside pawpaw native range.

## PAWPAW RESEARCH AT KYSU

Kentucky State University (KYSU) has had a comprehensive pawpaw research program since 1990 directed toward developing pawpaw as a new commercial tree fruit crop for Kentucky and the United States. Current research efforts at KYSU have been directed at developing cultural recommendations (Layne 1996), improving propagation methods (Finneseth et al. 1998), culinary development (see the Commercial Potential of Pawpaw section above), and germplasm collection and molecular characterization of genetic diversity in existing cultivars (Huang et al. 1997, 1998). Germplasm collection and characterization is an important continuing mission for the pawpaw program, since KYSU is also the site of the USDA National Clonal Germplasm Repository for *Asimina* spp.

There is a great deal of public interest in pawpaw. KYSU usually receives hundreds of inquiries each year, from the US and around the world, from interested individuals concerning pawpaw. To help meet public interest in pawpaw, two extension bulletins have been developed and are now available from KYSU: “*Cooking With Pawpaws*” by Jones and Layne (1997), and “*Pawpaw Planting Guide: Cultivars and Nursery Sources*” by Jones et al. (1998). A web site (<http://www.pawpaw.kysu.edu>) has been developed to disseminate pawpaw information and it contains the above extension bulletins, updates on pawpaw research at KYSU, pawpaw photographs, a bibliography, and information on the PawPaw Foundation. This site will also serve as a medium for the delivery of new information concerning orchard culture and available genetic resources.

## THE REGIONAL VARIETY TRIAL (RVT)

In 1993, the PawPaw Foundation (PPF) and Desmond Layne, former Principal Investigator of Horticulture at KYSU, embarked on a joint venture to test within pawpaw’s native range many of the commercially available, named pawpaw cultivars and PPF’s advanced selections. Orchards for the Regional Variety Trial (RVT) were planted in 15 different locations from Fall 1995 through Spring 1999, each consisting of 300 trees. At each RVT site, 8 replicate trees of each of the 28 grafted scion varieties will be tested in a randomized complete block design. Named cultivars that are secured for testing include: ‘Middletown’, ‘Mitchell’, ‘NC-1’, ‘Overleese’, ‘PA-Golden’, ‘Sunflower’, ‘Taylor’, ‘Taytwo’, ‘Wells’, and ‘Wilson’. The other 18 clones

to be evaluated were selected from PPF orchards at the University of Maryland Experiment Stations at Wye, MD and Keedysville, MD (Table 1). These “advanced selections” were selected based on superior horticultural traits including fruit size and taste, flesh-to-seed ratio, resistance to pests and diseases, and overall productivity on a year-to-year basis. Seedling trees from local native sources were planted around the perimeter as a buffer against edge effects and to allow comparisons with local germplasm. Identical orchards will be or have been planted at the institutions and locations presented in Table 2.

## THE FUTURE OF THE RVT

Orchard performance to be examined at each RVT site will include climatic factors, culture, pests, growth, flowering, yield, and fruit characteristics. Trees will be evaluated for several years for such characteristics as yield, year-to-year consistency, and regional suitability. At the end of several fruiting seasons, regional recommendations will be made. Each site will serve as a regional demonstration for growers and nursery operators, and they will serve public education/extension purposes. Kirk Pomper will serve as the coordinator of all RVT plantings. Once trees begin fruiting, annual RVT cooperator meetings will rotate from site to site for research updates and plot evaluations/tours. Final results of the RVT and regional recommendations will be available on the KYSU web site (<http://www.pawpaw.kysu.edu>). At KYSU, the RVT was planted in late March of 1998. By July, only 6 trees had failed to survive. Approximately 40 trees have initiated flower buds during the summer. These trees will be starting their third growth cycle next spring, and with the presence of flower buds, there is at least the potential that some fruit may be produced next year.

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