Pawpaw 101:
Just the Basics

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Introduction: What is Pawpaw?

- *Asimina triloba* (L.) Dunal.
- Native tree fruit in the southeastern U.S.
- Fruit can weigh up to 2 lbs.

Botany and Genetic Resources

- *Asimina triloba* is a member of the tropical Custard Apple or Annonaceae family.
  - custard apple (*Annona reticulata* L.)
  - cherimoya (A. *cherimola* Mill.)
  - sweetsop or sugar apple (*A. squamosa* L.)
  - atemoya (A. *squamosa* x *A. cherimola*)
  - soursop (*A. muricata* L.)

The Pawpaw Fruit

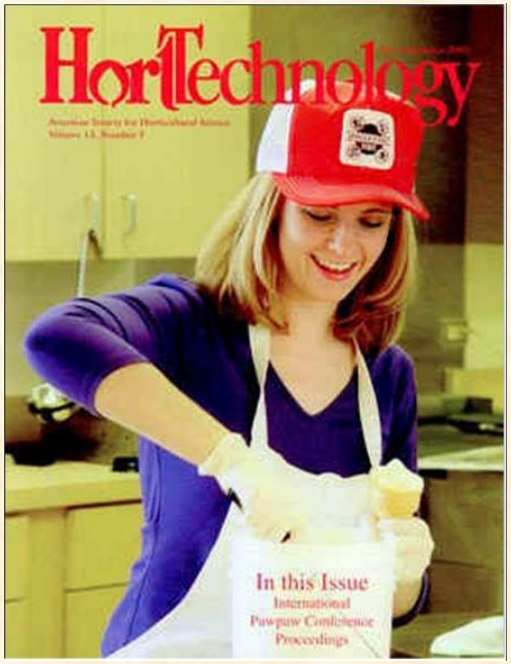
- Tropical-like flavor and aroma resembles mixture of banana, mango, and pineapple.
- Custard-like fruits are berries
- The fruit is very nutritious and high in antioxidant activity.
- Could be used in blended fruit drinks, ice creams, yogurt, etc.

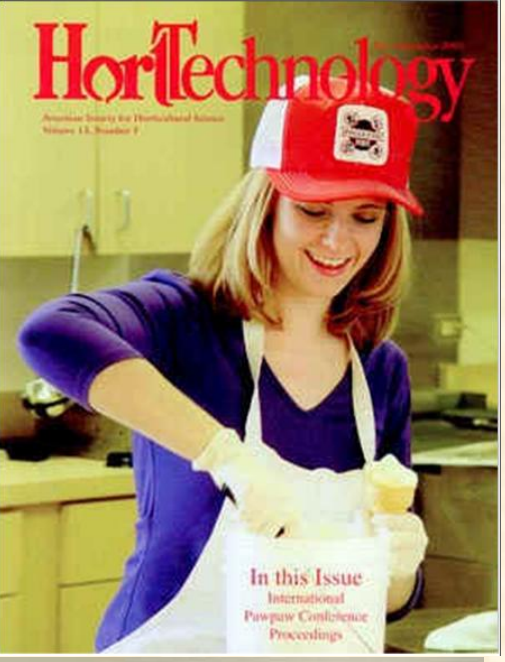
The Potential of Pawpaw

- Fresh market-unique flavor
  - Appearance-not unappealing
  - Post harvest handling issues
    - Potential for bruising after harvest
    - Short shelf life of about 7 days at room temp
    - Storage for 3 wks under refrigeration

The Potential of Pawpaw

- Processing pulp
  - Labor intensive





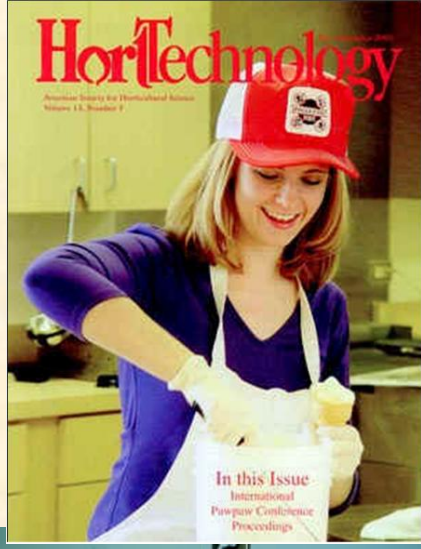
KSU Land Grant Program Pawpaw Ice Cream!

- 4 cups milk
- 4 cups cream
- 3 cups sugar
- 1-2 cups pawpaw pulp

- Dissolve sugar completely in the milk. Sugar dissolves faster if milk is lukewarm. Stir in cream.
- Stir thawing pawpaw pulp into a small amount of ice cream mix. When smooth, add pawpaw to remaining ice cream mix.
- **For best results:** Mixture should be 10-15% pawpaw pulp, i.e., add 1 cup pulp to 9 cups ice cream mix (10%), or 1.5 c. pulp to 8.5 c. ice cream mix (15%).
- Thaw pulp **gently** – in refrigerator a while, just until it begins to soften. (Or partially thaw ***very*** carefully in a microwave, using short bursts on very low power, turning pulp frequently. **Do not overheat!**) Start stirring pulp into ice cream mix while it is still partially frozen, and stir to break up lumps and finish melting the pulp. Thawed pulp will oxidize and develop a bitter flavor very quickly when exposed to air.

The Potential of Pawpaw

- Gourmet market
  - Fresh market fruit at farmers markets, restaurants, internet sales
  - frozen pulp
- Future markets
  - Grower cooperative, Melissa's, Kroger



Where Are We in Terms of Developing a Pawpaw Industry?

- Orchard (cultivars) vs. wild collected fruit
- Private orchards established AL, CA, KY, NC, MD, MI, MO, OH, and WV.
- Ohio Pawpaw Growers Association
  - Ohio Pawpaw Festival

Pawpaw Products

- Pawpaw ice cream and other menu items are being sold at gourmet restaurants.
- Pawpaw fruit are being sold at farmers markets, such as the Lexington Farmers Market, and on the Internet.
- New pawpaw products will be sold by individuals next year, including:
  - Pawpaw wine and pawpaw hot sauce

Pawpaws in the Wild

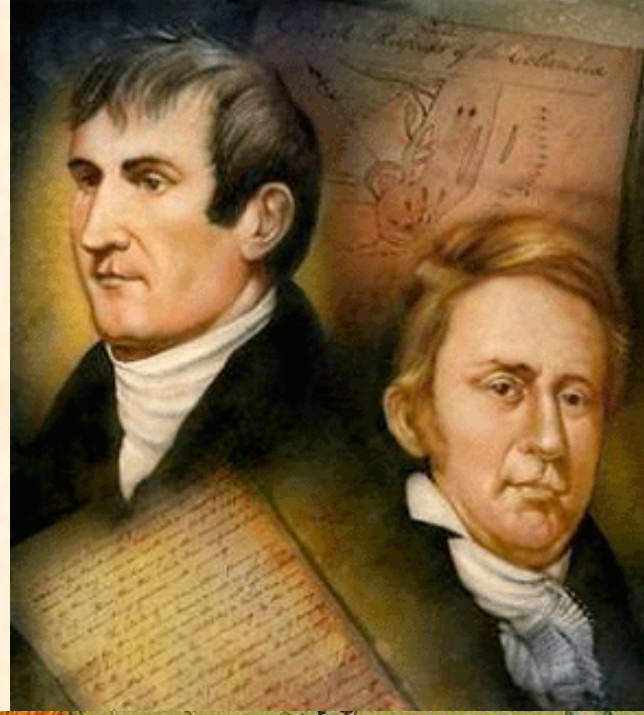
- *A. triloba* is usually found in the forest understory in hardwood forests
- Clonal reproduction by root suckering
- You may not find many fruit (shade, self-incompatibility, lack of pollinators)

History of the Pawpaw

- In 1541 Spanish explorer Hernando de Soto found Native Americans growing and eating pawpaws in the valley of the Mississippi.
- John Filson (1784), an early settler in Kentucky stated: “the pappa-tree does not grow to a great size, is a soft wood, bears a fine fruit much like a cucumber in shape and size, and tastes sweet.”
- Daniel Boone and Mark Twain were pawpaw fans.

History of the Pawpaw

- Lewis and Clark recorded in their journal (18 Sept. 1806) how pawpaws helped save them from starvation.
  - “Our party entirely out of provisions subsisting on poppaws. We divided the buiskit which amounted to nearly one buiskit per man, this in addition to the poppaws is to last us down to the Settlement’s which is 150 miles.”



Hatfield family photo courtesy of McDowell County Historical Society

Pawpaw Tree Incident

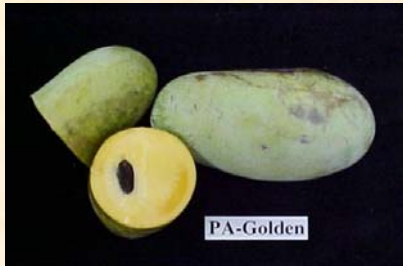
(Marker Number: 2047)

County: Pike
Location: Near Buskirk, KY 1056

Description: This episode is result of August 1882 election-day fight. Tolbert, a son of Randolph McCoy, exchanged heated words with Ellison Hatfield, which started a fight. Tolbert, Pharmer and Randolph McCoy Jr. stabbed Ellison to death. Later the three brothers were captured by Hatfield clan, tied to **pawpaw trees,** and shot in retaliation. Presented by Pikeville-Pike County Tourism.

Efforts to domesticate the pawpaw began early in the 20th century

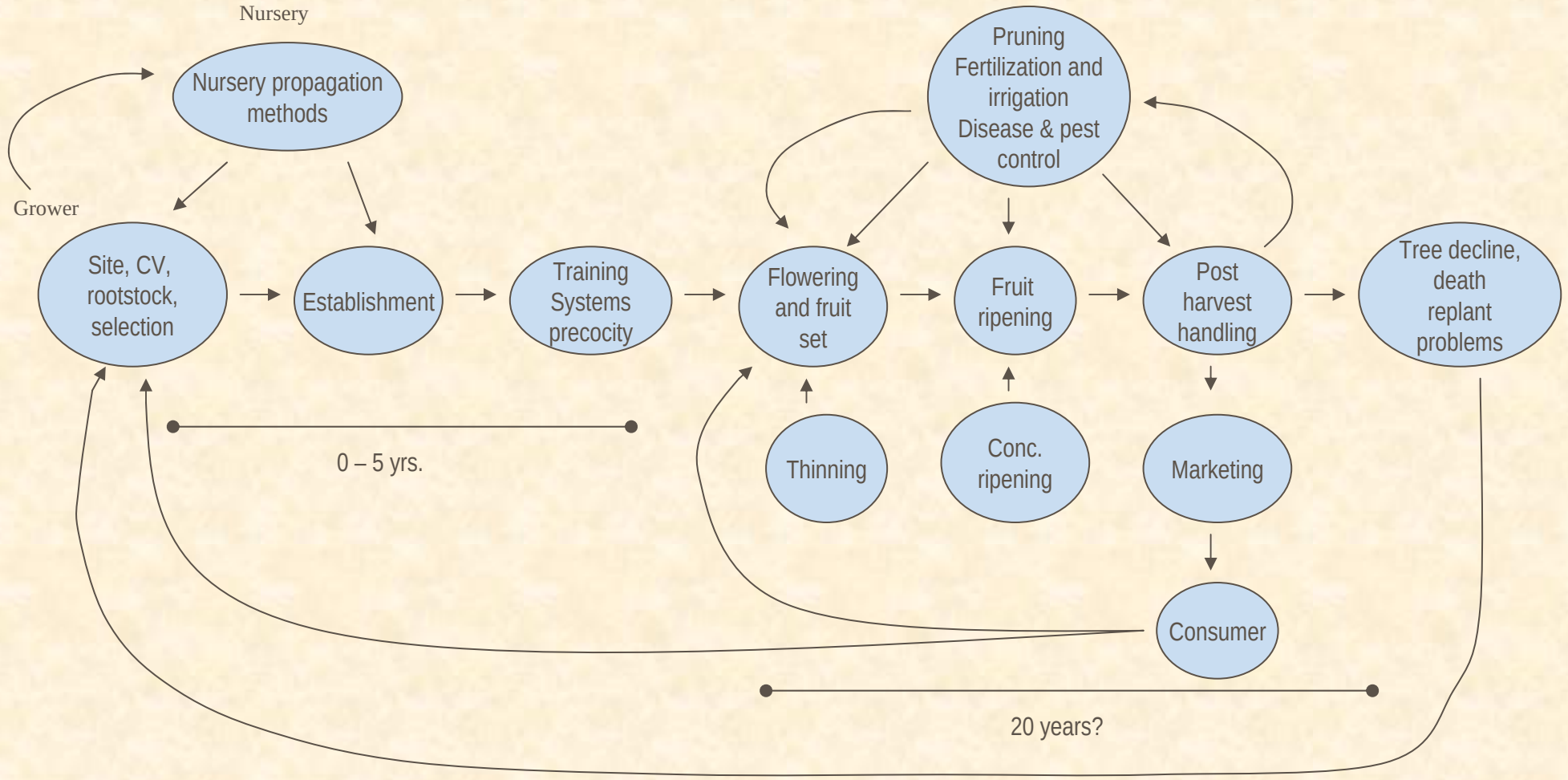
- In 1916, a contest to find the best pawpaw was sponsored by the American Genetics Association.
  - Sponsors thought that “intelligent breeding” would result in commercial quality varieties and an industry would begin (Popenoe 1916, 1917).
- A pawpaw industry did not develop.
- At about this same time, interest in another native fruit, the blueberry was also increasing.
- One reason for the failure of pawpaw to become as popular as blueberry was likely related to rapid perishability of fruit (Popenoe 1916, 1917).



New Interest in Pawpaw

- From 1950 and 1985, interest grew nurtured by the enthusiasm of individuals in the Northern Nut Growers Association (Peterson 2003).
- The PawPaw Foundation was founded in 1988, by R. Neal Peterson.
- In 1990, a full-time pawpaw research program was initiated at Kentucky State University by Brett Callaway (Callaway 1992) and was expanded by Desmond Layne from 1993 to 1997 (Layne 1996) and has been under the direction of Kirk Pomper since 1998 (Pomper et al. 1999).

Pawpaw Production



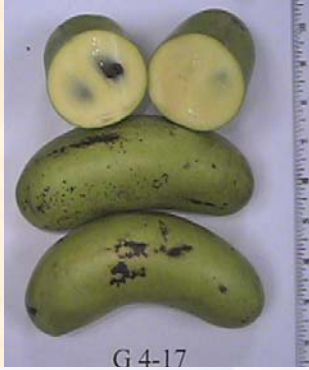
KSU Pawpaw Objectives

- 1) conduct a variety trial at KSU in cooperation with other sites across the nation
- 2) examine flowering, fruit set, and ripening
- 3) improve clonal and seedling/rootstock propagation methods
- 4) characterize the morphological and molecular variation in the germplasm collection
- 5) develop organic production methods

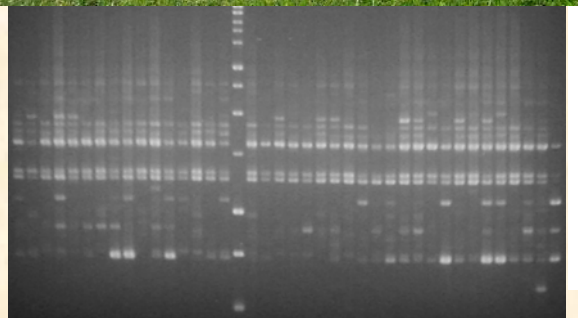
Pawpaw Acetogenin Compounds

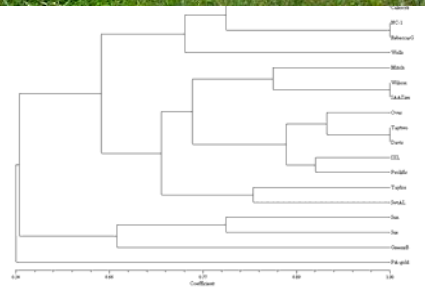
- Annonaceous acetogenins
  - Long unbranched fatty acid chain
- Present in twig tissues and recently found in fruit tissue
- Potential anti-cancer activity
- Unknown if potential health problem
  - Atypical parkinsonism?

USDA National Clonal Germplasm Repository for *Asimina spp*. at KSU



- In 1994, KSU was approved as the USDA National Clonal Germplasm Repository for Pawpaw (*Asimina* species), or gene bank
- The orchards at KSU contain more than 2000 accessions sampled from native stands from 17 different states in the papaw's native range.





Pomper et al., 2003. J. Amer. Soc. Hort. Sci. 128:521-525.

What cultivars should I plant?

Pawpaw Regional Variety Trial Cooperators and Cooperating Institutions

- Conceived by R. Neal Peterson (PawPaw Foundation) and Desmond Layne (then KSU)
- Contains 10 cultivars and 18 selections from R. Neal Peterson.

Materials and methods

- 28 selections, 10 named varieties, 224 total grafted trees on PPF seedling rootstock (half-sib seed)
- Established in March 1998 at the KSU Research and Demonstration Farm in Frankfort, Kentucky in a Lowell silt loam soil (pH 6.9)
- Spacing 2 m (6.5 ft) between trees, 5.5 m (18 ft) between rows

Some Desirable Pawpaw Tree characteristics

- Small tree size, easier harvest
- Precocious bearing, 4 years or less
- Vigorous growth with low to medium inputs
- Open branching with strong crotch angles
- High flower density
- High fruit set under natural pollination
- Consistently high fruit yields
- Cold hardiness and drought tolerance

Some Desirable Pawpaw Fruit Characteristics

FRUITFULNESS
over 40 fruit per tree

FLAVOR
sweet, firm texture, delicate blend of flavors, rich but not cloying, no bitter aftertaste

FLESHINESS
visually: mostly flesh. by weight: less than 5% of the fruit is seed

FRUIT SIZE
over 10 ounces

SEEDS
over 45 seeds per oz., av. seeds as small as 3/4" (2 cm) long

APPEARANCE
bright clear colors, no brown mottling (ripe); even, symmetrical

PECULIARITIES

SKIN: waxy/ fuzzy/ thick and hard/ yellow/ bluish.

FLESH (ripe): white/ pink/ red.

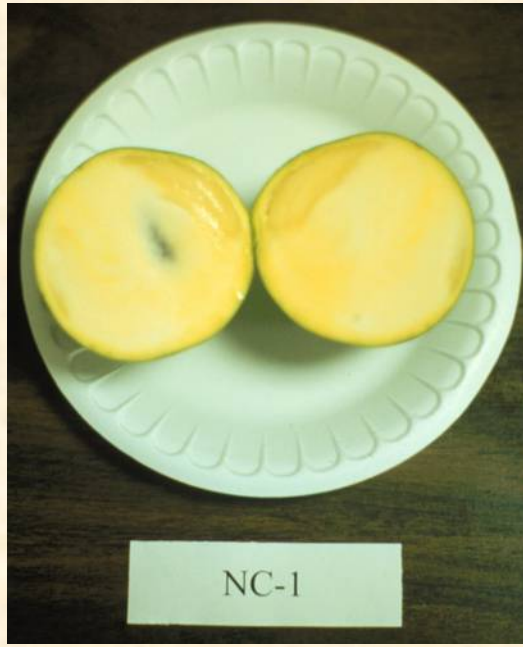
SEEDS: in a single row.

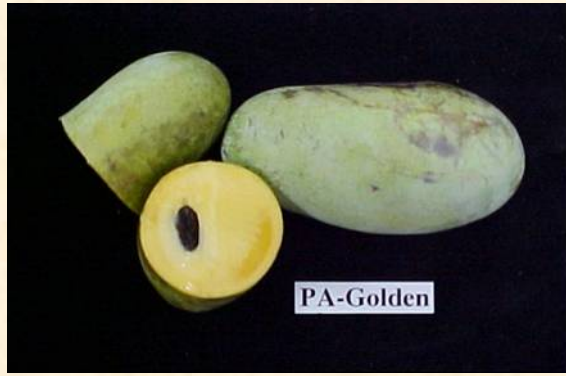
RIPENING TIME: early / late

KEEPING ABILITY: 2+ in refrig.

Commercially Available Cultivars

Clone	Genetic background
‘Middletown’	Wild seedling from Middletown, Ohio
‘Mitchell’	Wild seedling from Iuka, Ill.
‘NC-1’	‘Davis’ female × ‘Overleese’ male
‘Overleese’	Cultivated (open-pollinated) seedling from Rushville, Ind.
‘PA-Golden’	Second-generation seedling from G.A. Zimmerman collection
‘Sunflower’	Wild seedling from Chanute, Kans.
‘Taylor’	Wild seedling from Eaton Rapids, Mich.
‘Taytwo’	Wild seedling from Eaton Rapids, Mich.
‘Wells’	Cultivated (open-pollinated) seedlings from Salem, Ind.
‘Wilson’	Wild seedling from Cumberland, Ky.





Seedlings from Collections

Clone	Open-pollinated seedling of
1-7-2	BEF-30
2-10	BEF-30
2-54	GAZ-VA
3-11	BEF-33
3-21	BEF-43
4-2	BEF-53
5-5	BEF-54
7-90	RS-2
8-58 Rappahannock	BEF-30
9-47	BEF-49
9-58	BEF-50
10-35	BEF-49
11-5 Susquehanna	BEF-53
11-13	BEF-53

BEF = Blandy Experimental Farm Collection, Boyce Va.

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

RS = Ray Schlaanstine Collection, West Chester, Pa.

Fruit Production on Mature Trees

Clone	*fruit weight (g)*	
	2004	***2005***
4--2	276.9 a	225.7 a
7--90	207.8 b	155.7 cdefgh
NC-1	187.6 bc	188.9 abc
10--35	184.8 bcd	152.3 cdefghi
Susquehannah	184.1 bcde	205.4 ab
1--7--2	180.2 bcdef	170.2 bcdef
5--5	177.4 bcdef	212.1 ab
3--11	173.3 bcdefg	138.6 efghij
11--13	165.4 cdefg	143.4 efghij
2--10	163.5 cdefgh	170.1 bcdefg
8--20	161.7 cdefgh	187.7 abcd
Shenendoah	151.4 defgh	179.7 bcde
Sunflower	147.4 efghi	155.8 cdefgh
3--21	145.4 efghi	115.2 ijkl

Fruit Production on Mature Trees

Clone	*fruit weight (g)*	
	2004	***2005***
1--68	141.7 fghi	153.2 cdefghi
9--47	136.7 ghij	126.5 ghijk
PA-Golden	129.8 hij	115.5 ijkl
Overleese	126.9 hijk	180.1 bcde
9--58	113.2 ijkl	148.9 defghi
2--54	112.4 ijkl	116.6 ijkl
Mitchell	108.2 ijklm	118.0 hijkl
Taylor	105.5 ijklm	115.3 ijkl
1--23	104.9 jklm	156.6 cdefg
Taytwo	102.7 jklm	133.5 fghijk
Rappahannock	93.7 jklm	98.2 kl
Wells	88.5 klm	105.4 jkl
Middletown	80.4 lm	84.7 l
Wilson	73.4 m	84.1 l

Fruit Production on Mature Trees

Clone	*Yield (kg/tree)*	
	2004	**2005**
10-35	19.7 a	9.6 a
Shenendoah	17.0 ab	4.3 efghij
8-20	16.3 abc	2.9 ij
11-13	14.5 abcd	7.1 abcde
PA-Golden	14.4 abcde	8.8 ab
1-68	14.4 abcd	5.6 cdefghi
Rappahannock	14.0 abcdef	4.3 fghij
1-23	13.3 abcdef	4.1 ghij
4-2	12.8 bcdef	5.7 cdefghi
7-90	12.4 bcdef	7.8 abcd
Sunflower	11.8 bcdef	3.8 ghij
9-47	11.1 bcdef	5.8 cdefgh
1-7-2	11.0 bcdef	8.0 abc
3-11	10.7 bcdef	2.5 j
Wilson	10.5 bcdef	6.0 bcdefgh

Fruit Production on Mature Trees

Clone	*Yield (kg/tree)*	
	2004	**2005**
Taylor	9.6 cdef	3.5 ghij
5-5	9.5 cdef	6.6 bcdefg
Taytwo	9.1 def	6.7 bcdef
2-10	8.4 def	6.4 bcdefg
NC-1	8.3 def	3.7 ghij
Susquehannah	8.2 def	5.1 defgh
Mitchell	8.1 def	2.9 ij
9-58	7.9 ef	4.7 efghij
Wells	7.9 def	4.9 defghij
2-54	7.5 ef	3.1 hij
Middletown	7.1 f	3.5 ghij
Overleese	6.6 f	4.9 defghij
3-21	6.1 f	4.7 efghij

Establishing A Pawpaw Orchard

- "Pawpaw Planting Guide"
- Site
  - air drainage (frost)
  - deep, fertile, well-drained soil, pH 5.5-7.0
  - water source for irrigation

Pawpaw Propagation and Nursery Sources

- Historically, pawpaws have been a difficult tree species to propagate
  - Seed requires stratification and is desiccation sensitive
- Commercial clonal propagation of cultivars is via chip budding onto seedling rootstock
- Many nurseries grow pawpaw seedlings in containers
- High prices for seedling and grafted trees are limiting the development of an industry
  - Seedlings $5.00-$10.00
  - Grafted trees $15.00-$25.00

Establishing a Pawpaw Orchard

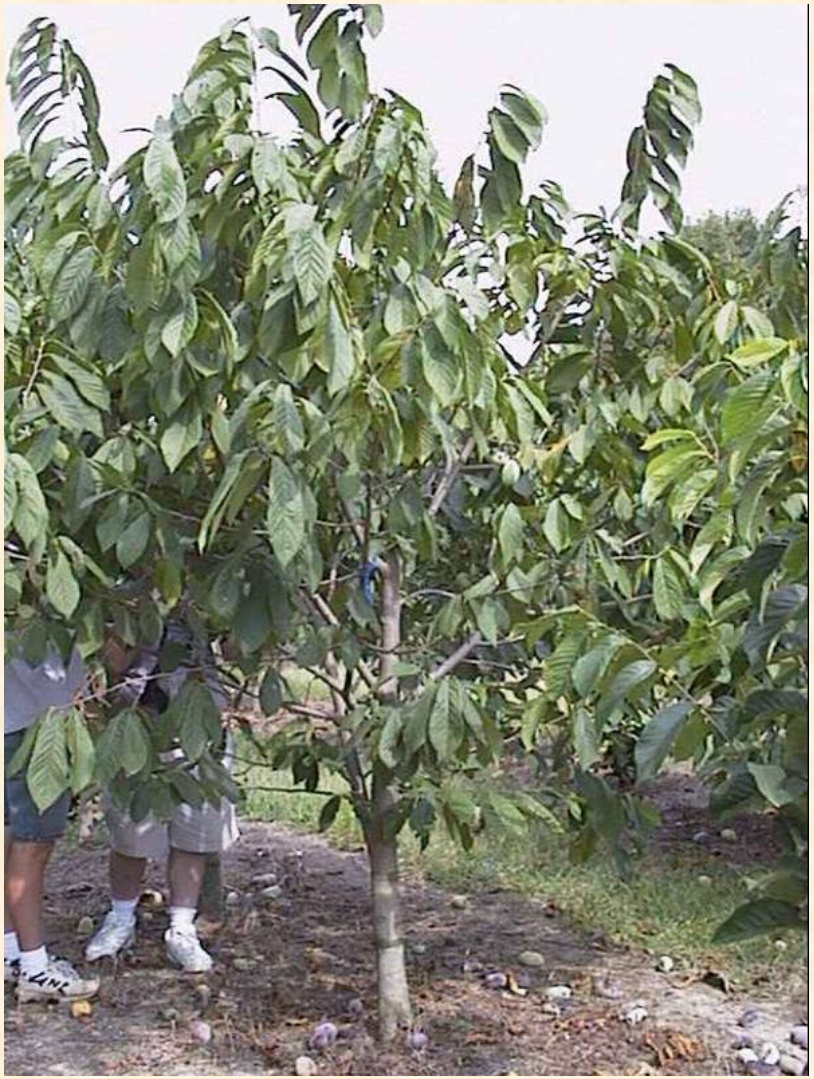
- Pawpaw will fruit in the shade, optimum yields are obtained in open exposure
- Shading recommended the first year
- Irrigation should be provided at least the first two years

Pawpaw Pruning

Field Planting Pawpaw

- 8’ between trees, 18’ between rows
- 295 trees/ac
- Tree seldom grow taller than 25 feet

Fertilization and Irrigation of Pawpaw



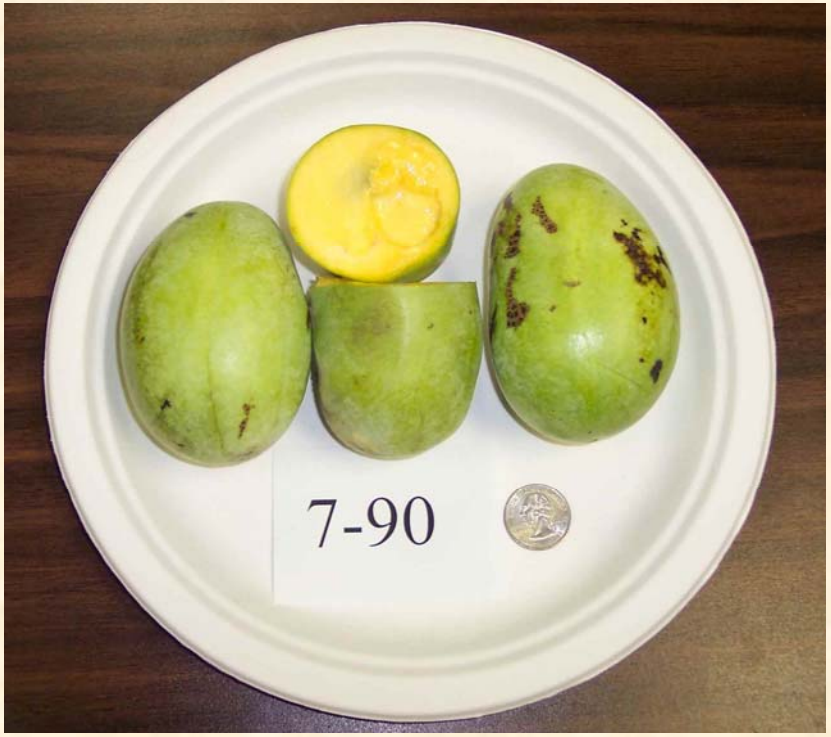
- Trickle Irrigation:
  - emitters (1 gal/hr) with 2 emitters/tree
  - about 240 gal/tree/yr.
- Fertigation: Peters 20-20-20 (3 times each yr.)
  - 0.6 oz N/tree/yr.
- Granular (10-10-10)
  - 1 oz N/tree/yr., 2 oz N/tree/yr. after two years

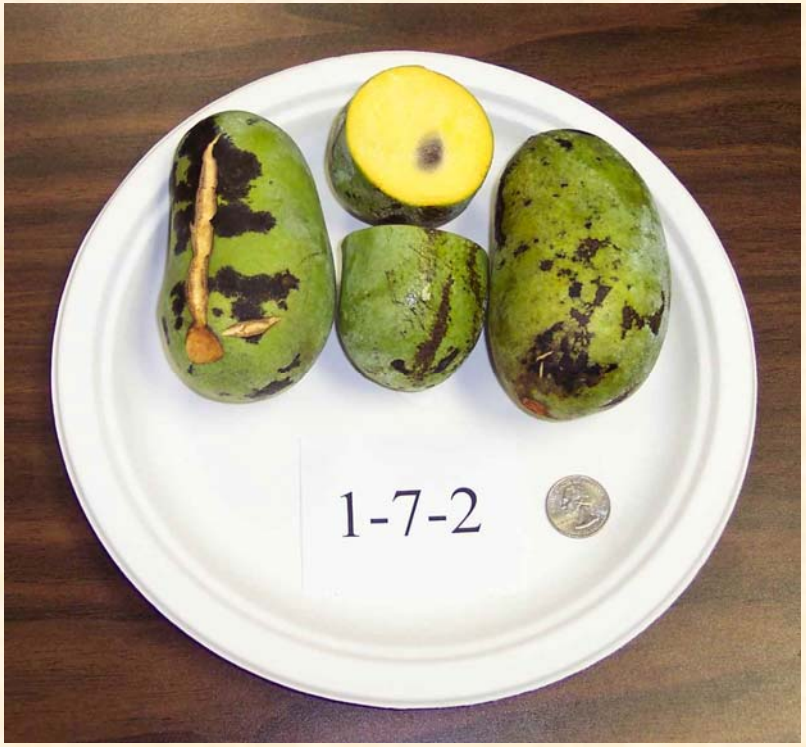
Pawpaw Pests

- Organic production possible?
- Some Past Problems
  - Japanese beetles
  - Zebra swallowtail butterfly-not necessarily a pest
  - *Talponia plummeriana* - pawpaw peduncle borer

New Pawpaw Pests?

- Leaf and fruit spot (Phyllosticta)





New Pawpaw Pests?

Asian Ambrosia Beetle *Xylosandrus crassiusculus*

New Pawpaw Pests?

- Asian Ambrosia Beetle *Xylosandrus crassiusculus*

Flowering Time and Harvest

- The North American Pawpaw, *Asimina triloba*:
  - Cross-pollinate
  - Pollinated by flies and beetles
  - Ripe fruit should yield when squeezed and give way with a gentle tug
  - Color change not a reliable indicator of ripeness
  - Fruit may be harvested from the same tree over several weeks

Pawpaw RVT Overview

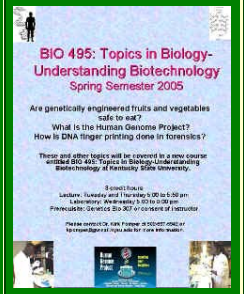
- There is great variation in fruit size, yield, and quality among the pawpaw selections examined
- About 4 to 5 years to come into production
- A number of pawpaw selections in the trial show promise for production in Kentucky [Shenandoah, Sunflower, Overleese, NC-1]
- Availability of some PawPaw Foundation selections a problem (4-2, 1-7-2, 10-35)

Pawpaw Information Web Site

Frankfort, Kentucky

Pawpaw Links

- Personnel
- Kentucky Nut Growers Spring Meeting NEW



- New Biotechnology course offered! NEW
- Pawpaw in the News NEW
- Pawpaw Commercial and Video
- Pawpaw Research at Kentucky State University
- Reports and Publications
- PowerPoint Presentations
- Pawpaw FAQ
- Planting Guide
- Cultivars NEW
- Nurseries
- Description of Fruit and

Pawpaw Program

Kentucky State University has the only full-time pawpaw [*Asimina triloba* (L.) Dunal] research program in the world as part of the KSU Land Grant Program. Pawpaw research efforts are directed at improving seed and clonal propagation methods, developing orchard management recommendations, conducting regional variety trials, understanding fruit ripening processes, developing fruit storage techniques, and germplasm collection and characterization of genetic diversity. KSU also is the home of the PawPaw Foundation, a nonprofit organization dedicated to the research and development of pawpaw as a new fruit crop.

- Over 150,000 visitors since the website was placed on the internet!

http://www.pawpaw.kysu.edu/