

Pawpaw Research at Kentucky State University

Horticulture Research Program

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“Picking up pawpaws, puttin’ ‘em in your pocket,...way down yonder in the pawpaw patch.” We’ve been singing the song and the praises of the pawpaw at Kentucky State University (KSU) for some time now. There has been a comprehensive pawpaw program at KSU since 1990, initiated by Dr. Brett Callaway, directed toward developing pawpaw as a new commercial tree fruit crop for Kentucky and the southeastern United States. Dr. Desmond Layne lead the pawpaw program from 1994 until 1997, before moving to Clemson University to work with peaches. Dr. Kirk Pomper took over the program in 1998 and it has diversified a little. The Pawpaw Program has been renamed this year as “The Fruit and Nut Development Laboratory” to reflect our current research efforts involving pawpaws, gooseberries, and currants, along with demonstration plantings of American persimmon and table and wine grapes, as potential new fruit crops for small farmers in Kentucky and the southeastern United States. However, our bread and butter, so to speak, is still the pawpaw, representing about 80% of our research efforts.

What is a Pawpaw?

The pawpaw [*Asimina triloba* (L.) Dunal] tree produces the largest edible tree fruit native to the United States, reaching over one lb. in size. Pawpaws are hardy to USDA growing zone 5 (-15oF) and grow wild in the 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. In their native setting, pawpaws usually flourish in the deep, rich, fertile soils of river-bottom lands where they grow as understory trees or thicket-shrubs. There are currently more than forty pawpaw cultivars commercially available, either having been selected in the wild or the result of breeding efforts of hobbyists.

The pawpaw flower has a slight fetid odor and flowers are thought to be self-incompatible and require cross-pollination, although some trees may be self-compatible. Flies and beetles are thought to be pollinators of pawpaw flowers. We have noted the presence of many flies and other insects visiting the pawpaw flowers on sunny warm afternoons; we rarely have seen any insects around the flowers on overcast or cool spring days. Dr. David Gordon, an entomologist at KSU, collected insects on a sunny April afternoon and has identified flesh flies, blow flies, and marsh flies that were visiting the pawpaw flowers. We have never placed any meat or road kill, as some have suggested, in our orchards to attract flies, and we have still had excellent fruit set. The large concentration of pawpaw trees at the KSU farm may help attract the many insects we have seen visiting the flowers, hence pollinators are not limiting. In the years to come, we hope to develop recommendations on which cultivars serve as pollinizers for other cultivars. To our knowledge it has never been documented that ‘Sunflower’, often stated to be self-fertile, is really self-compatible. There is much work to be done in the area of pawpaw pollination.

With its uniquely flavored fruit, the pawpaw has great potential as a new high-value fruit crop in regions where tobacco is now commonly grown. The fruit has a powerful aroma and almost tropical flavor, resembling a combination of banana, mango, and pineapple. However, flavor varies among cultivars, with some fruit displaying more complex flavor profiles. Fruit quality of seedlings is quite variable, and fruit often is small and can have bitter or off flavors when compared to named (grafted) cultivars. 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. Drs. Douglas Archbold, Bruce Downie, both at the University of Kentucky, and Kirk Pomper are studying the ripening process of pawpaw fruit; hopefully, we will find ways to store the fruit for longer periods of time. There is commercial processing potential for use of pawpaw fruit in juices, ice creams, yogurts, and baked goods. The fruit is also very nutritious, being higher in some vitamins, minerals, and amino acids than apple, grape, and peach. Pawpaw fruit can also be produced organically (without pesticide). 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. 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 is currently collected from wild stands in the forest. In 1998, Bray Orchards of Bedford, Kentucky developed a pawpaw ice cream, in cooperation with KSU. 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 was sold at the Lexington Farmers Market last year (1999) 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. The Oakroom has also begun serving a pawpaw brandy.

Public interest in the pawpaw has continued to develop. An Associated Press article was carried in newspapers across the country in the last week of September 1998 concerning the development of the Seelbach Hilton Oakroom's menu and use of pawpaws. Hopefully, this media coverage will continue to increase public awareness of the pawpaw fruit and its uses. In addition to recent articles in the popular press, additional public interest in pawpaws is evidenced by KSU web site visits (which has had over 15,000 visitors since 1999; <http://www.pawpaw.kysu.edu>), and strong attendance at the KSU pawpaw field days. In the fall of 1998, KSU initiated its first annual pawpaw field day with 50 people in attendance. In 1999, over 150 people from 16 states attended the annual KSU pawpaw field day, where they learned about growing pawpaws, toured the pawpaw orchards, and sampled pawpaw products. KSU is planning on hosting a National Pawpaw Conference at KSU in the fall of 2001; watch for details over the next year.

Pawpaw Research at KSU

KSU has the only full-time pawpaw research program in the world. Recent pawpaw research efforts have been directed at improving seed and clonal propagation methods, orchard management, regional variety trials, fruit ripening and storage, pollination biology, breeding efforts, and germplasm (i.e. seeds, plants, meristems, etc.) collection and molecular characterization of genetic diversity. An excellent review "Development of Pawpaw as a New Fruit Crop: Research Update from KSU" of the KSU program was

published in Pomona in Fall 1996, which was reprinted again in Winter 1999. Here we will very briefly mention a few of our findings and where we are heading.

Seed germination, seed storage techniques, and clonal propagation methods have been examined through the research efforts of Dr. Kirk Pomper, Dr. Desmond Layne, Ms. Cynthia Finneseth, Ms. Snake Jones, Mr. Eddie Reed Jr., and Dr. Robert Geneve (University of Kentucky). We have developed recommendations for the optimal conditions to propagate pawpaws by seed; this information can be found in the extension publication, "Pawpaw Planting Guide: Cultivars and Nursery Sources," which is available from KSU upon request or on the KSU pawpaw web site. We have found that some major points to remember about propagating pawpaws by seed are: 1) Never let the seed dry out; this greatly reduces the germination rate. Keep pawpaw seed in ziplock bags containing moist peat moss, and then store in a refrigerator until you are ready to use it. 2) Pawpaw seed has a chilling requirement that must be satisfied for optimal germination rates. You should store seed for at least 100 days in a refrigerator (in moist peat moss) for optimal germination. 3) Do not let pawpaw seed freeze, it will kill the seed. 4) Start seeds in tall pots (12"), as the seedlings have strong taproots. Since the roots of field dug pawpaw seedlings are easily damaged, we usually recommend starting pawpaws in pots, or buying them from nurseries in pots, and then transplanting them. 5) If you are growing seedlings outside, keep the plants in moderate shade their first year (we use 55% shade cloth) for maximum growth of the plant. Seedlings will grow well in whitewashed or even unshaded greenhouses.

In terms of clonal propagation of pawpaw, budding (specifically chipbudding), and grafting (whip-and-tongue) techniques are most successful on actively growing pencil thick seedling rootstock. Clonal propagation of pawpaw by other methods such as root cuttings or softwood cuttings has been unsuccessful in our laboratory. Attempts to propagate pawpaw via tissue culture have also not yet been entirely successful; however, we have been able to proliferate shoot buds in culture, although most of the buds do not elongate. Research continues on developing a tissue culture propagation system for pawpaw. Mound layering is also currently being investigated as an alternative clonal propagation technique.

Since 1995, KSU has served as the USDA National Clonal Germplasm Repository, or gene bank, for *Asimina* spp. (pawpaw), as a satellite site of the repository at Corvallis, OR. There are over 1,500 accessions (trees) from 16 different states that are planted on 8 acres at the KSU farm. Genetic diversity is a critical component of biodiversity and adjustment to the environment. We are attempting to evaluate the genetic diversity contained in wild pawpaw populations across its native range so that unique material can be added to the KSU repository collection; this rich potential source of useful genetic traits will be used in future breeding efforts. Drs. Hongwen Huang, Desmond Layne, and Donald Riemenschneider (USDA Forest Service, Rhinelander, WI) have used allozyme and isozyme marker systems to examine genetic variation in domesticated pawpaw cultivars and natural populations. These studies suggested that moderate levels of genetic diversity exist in both cultivated as well as wild populations; however, these previous studies included only a limited number of loci. Before leaving KSU, Dr. Layne received a USDA 1890s Capacity Building Grant to establish a molecular genetics laboratory at KSU. We can now extract DNA from pawpaw leaves and use it with techniques involving the polymerase chain reaction (PCR), with methods similar to those used by law enforcement agencies for DNA finger printing of potential suspects, in order to evaluate genetic diversity of the pawpaw populations. Using PCR-DNA based marker systems, higher rates of precision (larger number of loci) are possible in fingerprinting pawpaw cultivars and evaluating genetic diversity in pawpaw across its native range than with allozyme or isozyme methods used previously. Under the direction of Dr. Pomper, Ms. Tera Bonney (KSU graduate student) and Ms. Snake Jones (KSU Research Assistant) have collected over 500 pawpaw leaf samples from trees at a dozen sites in Kentucky and over 25 volunteers collected leaf samples from 270 trees in 17 different states in the pawpaw's native range for use in this study. We are currently processing the samples for use in our studies.

For development of a commercial industry for pawpaw, high quality fruit from cultivars must be marketed to the public, and large numbers of trees of named cultivars will need to be established in orchards. Regional recommendations for pawpaw cultivars need to be developed for growers. In 1993, KSU (at that time Dr. Desmond Layne) and Mr. Neal Peterson and the PawPaw Foundation (PPF) embarked upon an effort to establish a pawpaw Regional Variety Trial (RVT) in which 28 named pawpaw cultivars and PPF's advanced selections were to be evaluated in different regions in the U.S. From 1996 to 1999, 13 universities or private cooperators have established RVT demonstration orchards (Wapello, IA; Frankfort, KY; Princeton, KY; Baton Rouge, LA; Keedysville, MD; Jackson, MI; Lincoln, NE; Ithaca, NY; Raleigh, NC; Piketon, OH; Corvallis, OR; West Lafayette, IN; Clemson, SC). Named cultivars that are secured for testing include: 'Middletown' (selected in OH), 'Mitchell' (IL), 'NC-1' (Ontario, Canada), 'Overleese' (IN), 'PA-Golden' (NY), 'Sunflower' (KS), 'Taylor' (MI), 'Taytwo' (MI), 'Wells' (IN), and 'Wilson' (KY). The other 18 clones to be evaluated were selected from PPF orchards by Mr. Peterson at the University of Maryland Experiment Stations at Wye, MD and Keedysville, MD. 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. Final results of the RVT and regional recommendations will be available on the KSU web site in a few years.

Controlled crosses were preformed this spring signaling the beginning of a pawpaw breeding effort at KSU. Also this spring, pawpaw pollinators are being collected from flowers and cataloged. We will also continue to study the ripening process of the pawpaw fruit in an effort to find ways to store the fruit for longer periods of time. The first steps in developing a commercial pawpaw market are being taken. If you would like more information about growing pawpaws, please check out our web site at <http://www.pawpaw.kysu.edu>, or send an email to kpomper@gwmail.kysu.edu, or write: Dr. Kirk W. Pomper, 129 Atwood Research Facility, Kentucky State University, Frankfort, KY 40601. Watch for details over the next year for the KSU and PPF National Pawpaw Conference in Frankfort, Kentucky in the fall of 2001.

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For Further Reading

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