Index | Search | Home

New Crop FactSHEET

Pawpaw

Contributor: Desmond R. Layne

Common Names

Indiana Banana
Hoosier Banana
Poor Man's Banana

Scientific Names

Species: *Asimina triloba* (L.) Dunal
Family: Annonaceae (Custard Apple Family)

Uses

Eaten in-hand as fresh fruit or processed into desserts. Twigs are source of annonaceous acetogenins which are being used in the development of anti-cancer drugs and botanical pesticides.

Origin and Botany

The pawpaw is the only temperate member of the tropical Annonaceae family and is the largest tree fruit native to the United States. Pawpaws grow wild in the rich, mesic hardwood forests of 25 states in the eastern United States ranging from northern Florida to southern Ontario (Canada) and as far west as eastern Nebraska. Pawpaws flourish in the deep, rich fertile soils of river-bottom lands where they grow as understory trees or thicket-shrubs. In addition to the tropical Annona relatives, there are eight members of the *Asimina* genus that are native to the extreme southeastern states of Florida and Georgia. These include *A. incarna* (flag pawpaw), *A. longifolia, A. obovata, A. parviflora* (dwarf pawpaw), *A. pygmaea, A. reticulata, A. tetramera* (opossum pawpaw), and *A. X nashii*.

Description of the Plant

Pawpaw is a small, deciduous tree that may attain 5 to 10 m in height. In the forest understory, trees often exist in clumps or thickets. This may result from root suckering or seedlings developing from fruits that dropped to the ground from an original seedling tree. In sunny locations, trees typically assume a pyramidal habit, straight trunk and lush, dark green, long, drooping leaves that turn gold and brown in color during the fall. Flowers emerge before leaves in mid spring. The blossoms occur singly on previous year's wood and may reach up to 5 cm in diameter. Flowers are strongly protogynous, self-incompatible and require cross pollination although some trees may be self-compatible. Pollination may be by flies and beetles which is consistent with the presentation appearance of the flower: dark, meat-colored petals and a fetid aroma. Fruit set in the wild is usually low and may be pollinator or resource-limited but under cultivation, tremendous fruit loads have been observed. Fruits are oblong-cylindric berries that are typically 3 to 15 cm long, 3 to 10 cm wide and weigh from 200 to 400 g. They may be borne singly or in clusters which resemble the "hands" of a banana plant *(Musa* spp.). This highly aromatic, climacteric fruit has a ripe taste that resembles a creamy mixture of banana, mango, and pineapple. Shelf-life of a tree-ripened fruit stored at room temperature is 2 to 3 days. With refrigeration, fruit can be held up to 3 weeks while maintaining good eating quality. Within the fruit, there are two rows of large, brown, bean shaped, laterally compressed seeds that may be up to 3 cm long. Seeds contain alkaloids in the endosperm that are emetic. If chewed, seed poisons may impair mammalian digestion but if swallowed whole, seeds may pass through the digestive tract intact.

Crop Status

Pawpaws are not yet a commercially important crop in the U.S. but they have tremendous potential based on the following reasons: 1) adaptation of trees to existing climatic and edaphic conditions; 2) nutritional/cosmetic value of fruit; 3) valuable natural compounds in plant; 4) nursery wholesale and retail tree production; and 5) as a component in residential 'edible' landscapes. Pawpaw is well adapted to the 25 states to which it is native and where it already grows in the wild. It is hardy to zone 5 (-25°C) and requires a minimum of 400 hrs annual chill units, 160 frost-free days, and 80 cm of annual precipitation with most falling during spring and summer. Pawpaw is an excellent food source. It exceeds apple, peach, and grape in most vitamins, minerals, amino acids, and food energy value. Pawpaw fruits are best eaten fresh when fully ripe. The intense tropical flavor and aroma may also be useful for developing processed food products (blended fruit drinks, baby food, ice creams, etc.). The flesh purees easily and freezes nicely. Pawpaws easily substitute in equal part for banana in most recipes. Aromas may be used commercially in cosmetics and skin products. Pawpaw plants produce natural compounds (annonaceous acetogenins) in leaf, bark and twig tissues, that possess both highly anti-tumor and pesticidal properties. Current research by Dr. Jerry McLaughlin at Purdue University (personal communication) suggests that a potentially lucrative industry, based simply on production of plant biomass, could develop for production of anti-cancer drugs (pending F.D.A. approval) and natural (botanical) pesticides. The high level of natural defense compounds in the tree make it highly resistant to insect/disease infestation (R.N. Peterson, The PawPaw Foundation, personal observation). With proper management, organic commercial fruit production may be possible. Currently in the U.S., there are more than 40 commercial nurseries selling pawpaw trees. Seedling and grafted trees in the retail nursery trade are currently selling briskly for as much as $18.50 and $26.50 apiece, respectively, versus $3-4 for a 2-year old, grafted apple tree. Standing orders are currently in excess of 40,000 trees in the wholesale market (Jim Gilbert, manager, Northwoods Wholesale Nursery, Molalla, OR, personal communication). Pawpaws are ideally suited for the residential 'edible' landscape due to their lush, tropical

appearance, attractive growth form, size, fall color, and delicious fruit. In addition, *Asimina* spp. are suitable for butterfly gardens as they attract the zebra swallowtail *(Eurytides marcellus) for* whom they are the exclusive larval host plant.

Crop Culture

Seedling Production

As soon as flesh is soft, fruit should be collected for seed. Seeds are easily extracted following maceration of fruit in water and floating off of pulp. The seed can be sterilized by shaking seeds with a 10-20% Chlorox solution for 1-2 minutes followed by several rinses of distilled water. This aids in reducing fungal and bacterial contamination during storage. Seeds should not be allowed to dry out. Once cleaned, they should be stored refrigerated in Ziplock-type polyethylene bags with slightly moist sphagnum (or peat) moss. Seeds have a dormant immature embryo and require stratification. Storage under refrigerated conditions (5°C) for 100 days is recommended to overcome embryo dormancy. Provided that desiccation and microbial contamination do not occur, seeds may be stored for several years under refrigerated conditions with little loss in viability.

Stratified or afterripened seeds are planted either in a prepared seedbed or in containers. Scarification of the seed coat is not necessary. Pawpaw seed germination is hypogeal. Seeds should be sown to a 3 cm depth in a moist, well drained soil or other medium that has good aeration in containers that are 20-25 cm deep. Following radicle emergence, tap root growth proceeds to the bottom of the container and lateral roots begin to develop. Typically, under soil temperatures of 24°-29°C, the shoot does not emerge from the soil until 9 weeks following sowing. Shoot emergence is hastened 10 days by elevating soil temperature to 29°-32°C from sowing date thereafter. The optimal conditions for greenhouse production of robust, container-grown seedlings include the following: average day and night temperatures of 27° and 24°C, respectively, max. light intensity 1000 $\mu mol \bullet m^{-2}\ s^{-1}$ photosynthetic photon flux density (greenhouse whitewashing recommended during summer months, especially), 16 h photoperiod (extended by high pressure sodium lamps), fertilization 2x/wk to runoff during shoot growth phase, and soil temperature of 29°-32°C. For seedlings with 2-12 unfolded leaves grown in 740 cu. cm containers, 250 ppm 20N-20P-20K water soluble fertilizer plus trace elements is recommended. After 12 or more unfolded leaves are attained, seedlings require transplanting to a larger container. Seedlings will continue actively growing once 'potted-on' if transplanted before they exhaust the existing soil volume; otherwise, they will set a terminal bud and stop shoot growth. We transplant into 40 cm deep 2 gallon pots and then boost the fertilization rate to 500 ppm 20N-20P-20K water soluble fertilizer plus trace elements. If root spiraling in containers is a problem, containers can be coated with a latex paint mixture containing copper compounds of low solubility. By utilizing photoperiod extension, light intensities not exceeding 50% of full sunlight, temperature regulation, soil warming and fertilization, we have produced pawpaw seedlings with up to 1.5 m of top growth in one season in the greenhouse. Trees of this size are ideal for field transplanting and have sufficient caliper for chip-budding.

Field Planting

Field planting should be done when trees are not actively growing. Trees can be planted in fall or spring. Spring-planted trees should have had their chilling requirement met at or before planting. Ideally, a dormant tree is planted in early Spring, although similar considerations as noted below should be adhered to for Fall planting of a dormant tree. Planting holes should match the existing containerized root system. For 2 gal. containers, a hand-held power auger works nicely for hole drilling. Care should be taken not to plant trees when soil is too dry or wet. Hole drilling in wet, clayish soils will result in glazing of the hole walls which may impede root penetration into the soil. Soil should be well drained, deep, fertile and slightly acid (ie. pH 5.5-7). Preplant soil tests are desirable in order to make necessary amendments. Spring planting should be done during the local pawpaw budbreak period (April in Kentucky). Trees should be planted such that the soil line of the pot is even with the soil line of the field. It is essential that seedlings receive adequate water in the year of establishment. Pawpaw trees establish and grow best when they are given shelter the first year in the field. This is reliably accomplished by utilizing tree shelters that are used in reforestation. Weed control is necessary especially in the establishment

year. Fertilizer application can be accomplished by broadcasting granular fertilizer in spring. Fertigation with liquid fertilizer can be useful if drip irrigation is installed in the orchard. We do not currently have recommendations for feeding field planted trees but we fertigate with 500 ppm 20N-20P-20K water soluble fertilizer plus trace elements once a month in May, June, and July during the active growth phase. Fertilizer recommendations based on foliar and soil analyses will be developed in the future. Recommended tree spacing at present is 5.5 m between rows and 2 m apart in the row. Row orientation should be North-South.

Transplanting trees from the wild is usually unsuccessful. Young trees dug from a thicket or grove are often root suckers with few, brittle roots that have very few root hairs. Due to the poorly developed root system and frequent absence of shelter following transplanting, transplanting shock is usually severe resulting in the death of the root sucker. Transplanting of seedlings from the wild is most successful when done in the Spring during budbreak. If many roots are lost in the digging process, it is desirable to prune the shoot to bring it into balance with the existing root system. Unlike transplanting seedlings collected from the wild, containerized seedlings transplant with high success if the guidelines described above are adhered to.

Vegetative Propagation

Pawpaws are easily propagated by several grafting and budding techniques. These include whip-and-tongue, cleft, bark inlay, and chip budding. Chip budding is most successful when the seedling rootstock is pencil thick or greater in diameter and actively growing. Winter collected, dormant scion budwood should have had its chilling requirement fulfilled. When performing chip budding, it is desirable to try to match the diameter of the budwood with that of the stock plant. It is recommended to wrap the graft with parafilm laboratory film using strips cut to 2 cm x 15 cm. Parafilm is flexible, moldable, self sealing and moisture resistant. When stretched, it applies adequate pressure to stimulate callus production and it maintains good humidity for union formation. Within 2 weeks, buds will begin expanding and may penetrate the parafilm or just enlarge under it. In the latter case, parafilm is easily removed by using a sharp budding knife and making a shallow incision along the length of the wrap on the side opposite the bud. Care must be taken not to damage the scion bud in the process of removing parafilm. Once scion growth commences, we recommend cutting back the top of the stock to 30-60 cm in height leaving 6 or more functional lower leaves and rubbing off all competing buds on the rootstock. We have found that cutting the stock back to just above the bud reduces scion growth. Once the scion is 30 cm or more in length, the lower leaves on the stock can be removed and the stock can be cut back to a height of 20-25 cm above the union. Under greenhouse conditions, we have also found that leaving the stock as described above is extremely helpful because the stub of the stock projecting above the union then provides a `stake' to secure the growing scion. Some scion varieties appear to grow more horizontally from the graft union than others and using this technique ensures uniform habit and development of a strong union and vertically oriented scion. We use masking tape to tie up the scion as it grows. Once the scion becomes woody, this tape is no longer needed. Starting with a large, healthy rootstock, up to 1.5 m of scion growth can be attained in as few as 3 months under optimal greenhouse conditions described above. Whip grafting is successful on seedling rootstock material that is as small as 3-4 mm in diameter, provided the scion is of similar diameter (Jim Gilbert, Northwoods Wholesale Nursery, Molalla, OR, personal communication).

Other vegetative propagation techniques such as root cuttings, hard and softwood cuttings, and tissue culture have met with poor or marginal success. Propagation by hardwood cutting techniques has never been attempted for pawpaw indicating a need for research to evaluate the commercial potential thereof. However, pawpaw propagation by softwood cuttings has been successful although at a low percentage. Micropropagation techniques have been developed for many Annonaceous relatives of pawpaw indicating potential promise of this technology for pawpaw.

Germplasm

Collections

Kentucky State University, Frankfort, KY (USDA National Clonal Germplasm Repository for *Asimina* spp., satellite site of Corvallis, OR repository).

The PawPaw Foundation (University of Maryland property).

Commercial Seed Sources

F.W. Schumacher Seed Co., 36 Spring Hill Rd., Sandwich, MA 02563.

Sheffield Seed Co., 273 Auburn Rd., Locke, NY 13092.

Commercial Seedling Sources

Edible Landscaping, P.O. Box 77, Afton, VA 22920.

Oikos Tree Crops, P.O. Box 19425, Kalamazoo, MI 49019.

Commercial Named Variety Sources

Sherwood Greenhouses, P.O. Box 6, Sibley, LA 71073.

Northwoods Retail Nursery, 27635 S. Oglesby Rd., Canby, OR 97013.

Hidden Springs Nursery, Route 14, Box 159, Cookville, TN 38501.

Key References

- Kral, R. 1960. A revision of *Asimina* and *Deeringothamnus* (Annonaceae). Brittonia 12:233-278.
- Layne, D.R. 1996. The pawpaw *[Asimina triloba* (L.) Dunal]: A new fruit crop for Kentucky and the United States. HortScience (in press).
- McGrath, M.J. and C. Karahadian. 1994. Evaluation of physical, chemical, and sensory properties of pawpaw fruit (Asimina triloba) as indicators of ripeness. J. Agric. Food. Chem. 42:968-974.
- McLaughlin, J.L. and Y.-H. Hui. 1993. Chemotherapeutically active acetogenins. U.S. Patent No. 5,229,419.
- Peterson, R.N., J.P. Cherry, and J.G. Simmons. 1982. Composition of pawpaw *(Asimina triloba)* fruit. Ann. Rpt. N. Nut Growers Assoc. 77:97-106.
- Peterson, R.N. 1991. Pawpaw *(Asimina).* In: J.N. Moore and J.R. Ballington (eds.) Genetic resources of temperate fruit and nut trees. Acta Hort. 290:567-600.
- Ratanyake, S., J.K. Rupprecht, W.M. Potter, and J.L. McLaughlin. 1992. Evaluation of various parts of the paw paw tree, *Asimina triloba* (Annonaceae), as commercial sources of the pesticidal annonaceous acetogenins. J. Econ. Entomol. 85:2353-2356.

Selected Experts

Desmond R. Layne, Assistant Professor of Horticulture, Department of Horticulture, Poole Agriculture Center, Box 340375, Clemson University, Clemson, SC 29634-0375
FAX: (864)-656-4960, phone: (864)-656-4964

Contributor: Desmond R. Layne, Community Research Service, Kentucky State University (8/25/1995)

Last update Tuesday, February 24, 1998 by aw