The Crop of the Day

Papaya (Carica papaya)

© Paul Legis 2011

Sources

- Mark’s Fruit Crops: Papaya: http://www.uga.edu/fruit/papaya.htm
- California Rare Fruit Growers: Papaya: http://www.crfg.org/pubs/ff/papaya.html
- Transgenic papaya: http://www.apsnet.org/online/feature/ringspot/

Papaya, the plant and its origins (I)

- Small, nearly unbranched small tree in tropical America
- Family Caricaceae (related to Passifloraceae)
- Genus Carica:
  - 1 species: from Central America
  - Other related species, from South America, in:
    - genus Vasconcella: 21 species, all from tropical America
    - Genus Jacaratia: 2 species
- $2n = 2x = 18$

Papaya, the plant and its origins (II)

- Related species:
  - Vasconcella x heilbornii (syn. Carica pentagona): babaco
    - seedless fruit, higher elevations
  - Jacaratia spinosa: wild papaya, premontane moist forests in Central America
Papaya, its uses

- Grown in tropics, Hawaii as food:
  - fresh fruit
  - vegetable: cooked fruit (in Peru, also leaves of *C. monoica*)
  - sweet (dulce), cooked in syrup

- Grown in East Africa, Sri Lanka, etc.
  - milky latex in green papaya:
    - papain: proteolytic enzyme active over a broad range of pH
      - meat tenderizer,
      - clearing beer (chill-proof beer),
      - Exfoliative cytology (stomach & intestinal cancer),
      - in the Philippines, meat is wrapped in young leaves to tenderize it

Other uses:
- syrup & silk treatment before dying
- face creams and face lift preparations
- cleaners for contact lenses
- surgery: remove dead or ruptured tissue

Papaya, the harvest

- Propagation mostly by seed, sometimes by cutting:
  - After transplanting the trees will flower about 6 months later and the fruits will mature in about 4 months. Normally a yield of 100 fruits per tree can be expected.
  - The trees can be harvested for about 1 1/2 to 2 years after which they can be topped to produce secondary branches for more fruits.
  - Harvested fruits are packed for export in a single layer in corrugated fibreboard cartons lined with low density polyethylene film, storage period of mature fruits is 3 weeks at 10 C.

Papaya, its reproduction

- All species of Caricaceae, except 3 *Carica* species, are dioecious.
- Exceptions are *C. monoica*, *C. pubescens*, and *C. papaya*.
- *C. papaya*:
  - Pistillate:♀: stable sexual phenotype
  - Staminate:♂: can change into andromonoecious (male + hermaphroditic on the same plant)
- Dioecy:
  - Y chromosome: Male: XY; Female: XX;
  - Hermaphrodite: XY2 (Y2: modified Y chromosome)
Reproduction of papaya

Male flower

Andromonoecious

- Primitive pair of sex chromosomes
- Small male-specific region of Y (8 Mbp)

Papaya, its history and production (I)

- Originated in lowlands of eastern Central America or northwestern South America. Probably was cultivated widely in Mexico and Central America prior to 1492.
- After the conquest of the Americas, distributed by Spanish and became widely grown in all tropics
- Selection for larger fruit, dioecy.
- Plant breeders have produced varieties to match local preferences for fruit size, shape, flesh color, and flavor.

Papaya, its history and production (II)

- Production in Hawaii:
  - Based on cultivar Solo and derivatives, introduced from Barbados in 1911; since 1998, genetically engineered to resist papaya ringspot virus.
  - Pear-shaped fruits of 350-500g
  - Produced by hermaphroditic trees of an inbred gynodioecious strain: seeds of hermaphroditic trees produce 2 hermaphrodites:1 female
- Production in South Africa:
  - Based on cultivar ‘Hortus Gold,’ ‘Honey Gold’: 2x size of ‘Solo’
  - Produced by female plants of dioecious strain: seeds produce 1 female:1 male, 30-45% of all female plants are male or sterile for pollination.
- Note: marker specific to males and hermaphrodites; not amplified in females (Chaves-Bedoya & Nuñez 2007)

Genetic Engineering of Papaya

- Papaya: first genetically engineered fruit crop to be grown commercially
- Resistance to papaya ringspot virus (PRSV):
  - Introduced gene coding for viral coat protein into papaya genome
  - Two varieties: "SunUp" (yellow) and "Rainbow" (orange)
- Potential concerns:
  - Gene flow (outcrossing): contaminates organic production
  - Foreign exports affected
  - 50% of HI production is transgenic: cv. Kapoho Solo is non-transgenic; firm flesh & long shelf life; yellow flesh type
  - Rainbow:

Resistant transgenic Rainbow surrounded by susceptible non-transgenic Sunrise (1995)
Genome Sequence of the Papaya

- Sunup variety, 1st transgenic fruit tree variety
- 3x size of Arabidopsis, but fewer genes, including fewer disease resistance genes. But...
- Amplification of genes:
  - Tree-like habit (intermediate between Arabidopsis & poplar)
  - Deposition & remobilization of starch reserves: leaves, fruits
  - Attraction of seed dispersal agents: volatiles; climacteric fruit
  - Adaptation to tropical daylengths
  - Sex determination
  - Three insertion sites of transgenes (5/6 adjacent sequences are cpDNA insertion sites)

Papaya nutritional qualities

- Fruit is ready to eat when 70-90% yellow and yields slightly when squeezed.
- One papaya (~300g): % DV
  - 313% for Vit. C
  - 30% for folate (vit. B9)
  - 25% potassium and dietary fiber
  - 18% vit. A and E
  - 118 calories
- Antioxidants (Vit. A, C, E): heart disease, diabetes, colon cancer
- Dietary fibers: colon cancer
- Anti-oxidants + papain: Anti-inflammatory (arthritis)

http://www.nutritiondata.com/facts-B00001-01c20W1.html