



Lecture 31
Papaya



**Papaya,
Puerto Rico**



Papaya: *Carica papaya*, Caricaceae

A tropical fruit, widely grown as a backyard tropical tree but increasingly important as a commercial fruit.

Family consists of two genera, *Carica* and *Jacaratia*.

Genera were so varied that they were hard to place in a family, finally Caricaceae developed to include both genera.

A Venezuelan taxonomist, Bodillo, reduced the species to 57.

All are indigenous to the American tropics.

All dioecious except *C. papaya* which is polygamous (many sexual types).

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Phil Ito and Papaya species, Hawaii

All are single stemmed but *C. goudatiana* is free branching.

Only *C. papaya* is of economic importance but there have been attempts to commercialize *C. pentagona* (babaco) a seedless, fruit from Ecuador with a sweet-tart taste.

Names include papaw (New Zealand), mamão = big breast (Brazil), lechoso = milky (Venezuela), fruta bomba = fruit bomb (Cuba).

The names refer both to the shape of the fruit and the milky exudate from the fruit skin which is the source of papain, a proteolytic enzyme and the source of Adolph's meat tenderizer.



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Papain also used for certain delicate spinal cord surgeries.

While native to tropical America, perhaps the West Indies or Mexico, it spread rapidly to the Moluccas and India in the 19th century and was later imported to Hawaii.

The common Hawaiian cultivar called 'Solo' probably originated in Barbados.

Papaya is now cultivated in all tropical countries up to 32° latitude.

Ecology

A tropical crop.

Moisture is important in papaya.

Total sugars are higher under low irrigation.

Papaya Production (2001)

Continent	1000 tonnes	Chief countries
World	5,444	
Africa	1,017	Nigeria (748), Congo (213), Mozambique (31)
North America	778	Mexico (613), Cuba (40), Costa Rica (35)
South America	1,987	Brazil (1,450), Peru (174), Colombia (114)
Asia	1,642	India (644), Indonesia (470), Thailand (119)
Oceania	20	Samoa (10), Australia (7), Fiji (2)

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Morphology

A large herbaceous, erect single stemmed tree and only occasionally lateral branches.

The main stem is hollow with prominent leaf scars.

The leaves are large, flat palmately lobed or entire.

As the leaves mature they dry off and fall, so the leaves are only found at the top of the tree.

Flowers are produced in the axils of the leaves.

The inflorescence is a modified cyme.

The type of inflorescence depends on the sex of the tree.





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Hermaphroditic types are easily self pollinated but can be also cross pollinated.

Fruit are usually “melon shaped” but may be round, long pyriform or oval and usually has 5 carpels.

The fruit size varies from 0.5 to 15 pounds.

Flesh color ranges from pale orange to bright red.

There are many types of seed cavities, usually star-shaped to round.


The fruits have many hundreds of small seeds.

The crop is one of the few fruit crops planted from seed.

Flower Type

The flower type shows a relationship to fruit shape.


I II III IV V




Papaya flowers, Hawaii

Type I. Pistillate


Has a functional ovary and no stamens.
The petals are separate and fused only at the base.
Fruits with only pistillate flowers (female trees) must be pollinated by an outside source.
The fruit shape from pistillate flowers in 'Solo' is round and is not considered desirable in Hawaii because consumer thinks there is less flesh than a pyriform (pear-shaped) fruit.



Type II. Pentandria bisexual
Contains 5 short stamens that occur in furrows in the pistil.
The fruit is furrowed and considered unacceptable.



Type III. Intermediate or carpelodic bisexual
Produces deformed fruit.



Type IV. Elongata bisexual

Produces pyriform fruit.

Only this produces salable fruit in Hawaii.

The pistil is long and cylindrical.

Pistils have 5 carpels (range 1-10).

Fruit shape changes with the number of carpels.



Type IV. Deviate type

During certain season, type IV fails to develop functional pistil, flower size is reduced.

Appears to be intermediate between type IV and type V (staminate flower).

Type V. Staminate flower

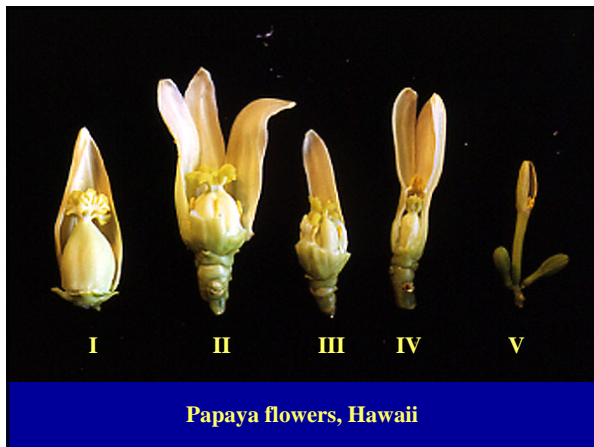
Corolla tube is slender and long.

Flowers are borne on long cymes.

No fruit is produced.

Trees with all staminate flowers are considered male.





Genetics of Sex Determination

Pistillate = m
Hermaphroditic = M_2
Staminate = M_1
Pistillate tree = $mm = ♀$
Hermaphroditic tree = $M_2m = ♂$
Staminate tree = $M_1m = ♂$

Note: M_1M_1 , M_1M_2 , and M_2M_2 are lethal combinations.

Pistillate tree (mm). Produces type I flower.
This is a stable type and requires pollination.
Staminate (or male) tree (M_1m). A counterpart of the pistillate tree.
Continually fertile hermaphroditic tree (M_2m).
From July to December type IV flower is produced in terminal position to produce pyriform fruit.
In some seasons type II and III flowers are produced.
Thus abnormal fruit may be produced in some seasons.
The hermaphroditic types of sex expression shifts with temperature.
Low temperature gives a shift to femaleness, high temperature gives a shift to maleness.

Sex Determination Inheritance

Dioecious Types

$mm ♀ \times M_1m ♂ \rightarrow 1 mm ♀ : 1 M_1m ♂$

Thus, when seed is planted half the plants are pistillate and half are staminate.
But of course only pistillate types bear fruit.
Approximately 5 to 10% of trees should be staminate to insure adequate pollination.
This is usually controlled by planting three seeds per hole and, if possible, leaving only one pistillate tree, determined when the trees flower.

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One eighth of holes with 3 plants will be all staminate ($1/2 \times 1/2 \times 1/2 = 1/8$) (Note: This is the same probability of a couple having three sons.)
Eliminating two trees will leave one staminate tree.
Seven eighths of holes will have at least one pistillate tree.

Thus a field planted with 3 seed from a dioecious cross and thinned to obtain at least one pistillate plant will contain 12.5% staminate trees or 87.5 % pistillate trees.

If 4 plants are left per hole, 6.5% will have four staminate plants; if 5 plants are left the number of holes with all staminate plants will be 3.125%.

Hermaphroditic Type

In this case seed from intercrossed M_2m types are planted; plants can self or cross pollinate.

M_2m selfed ($M_2m \times M_2m$) \rightarrow

1 M_2M_2 (lethal) : 2 M_2m ♂ : 1 mm ♀

	M_2	m
M_2	M_2M_2	M_2m
m	M_2m	mm

The M_2M_2 seeds abort so the effective ratio is 2 hermaphroditic to 1 pistillate.

Now in the case of 'Solo' the mm pistillate type has unacceptable round fruit so these types are eliminated.

If there is one plant per hole 2/3 or 66.7% of the plants will be hermaphroditic and 1/3 or 33.3% will be the undesirable pistillate types.

If there are two plants per hole which are thinned to obtain one hermaphroditic plant, $1/3 \times 1/3 = 1/9$ or 11.1% of the holes will have two undesirable pistillate plants.

With three seeds only 1/27 ($1/3 \times 1/3 \times 1/3$) or 3.7% will be all pistillate and so forth.

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Proportion of at least one desired sex type with thinning

No. plants per hole	% pistillate (dioecious types)	% hermaphrodites (hermaphroditic types)
1	50.0	66.7
2	75.0	88.9
3	87.2	96.3
4	93.8	98.7
5	96.9	99.9

At the present time there is no way to pre-select seedlings for sex.
A technique using molecular markers should be possible but has not been reported.

Spacing

Usually papaya is planted 10 × 10 or 8 × 10 feet; 10 feet minimum between rows is usually maintained to accommodate tractors.

Trees get too crowded if planted too close.

‘Solo’ usually requires 50 nodes for first flower, but some strains flower after 25 nodes.

To keep orchards low, growers start plants in cans to produce short internodes but of course as plant grows fruit appears higher and higher on the plant.



Papaya, Hawaii

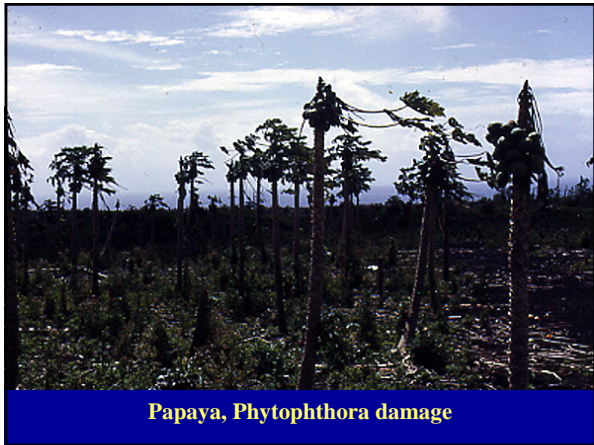
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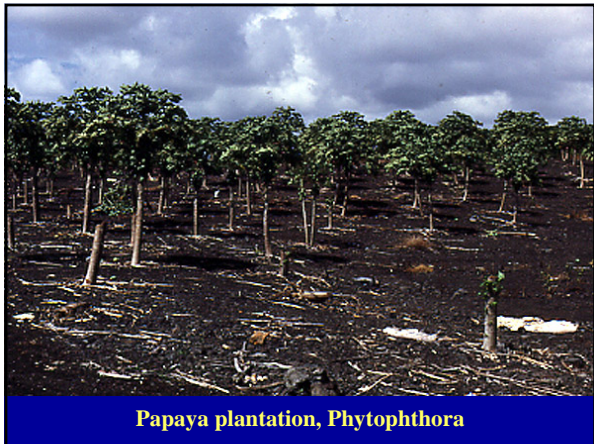
Diseases

The greatest problem in papaya is tomato ringspot virus.

At the present time Florida cannot successfully produce papaya because of the virus problem.

Genetic transformation to induce virus resistance has been successful in Hawaii.





Commercialization

The 'Solo' papaya is becoming the major world cultivar because the size is suitable and the quality is high.

'Solo' papaya is often available in most supermarkets in the United States.

Red-fleshed mutants are available which are very attractive.

'Solo' is now very popular in Brazil.

However in Mexico many high quality, large-fruited types from dioecious cultivars are produced and recently these have also been imported into the United States.

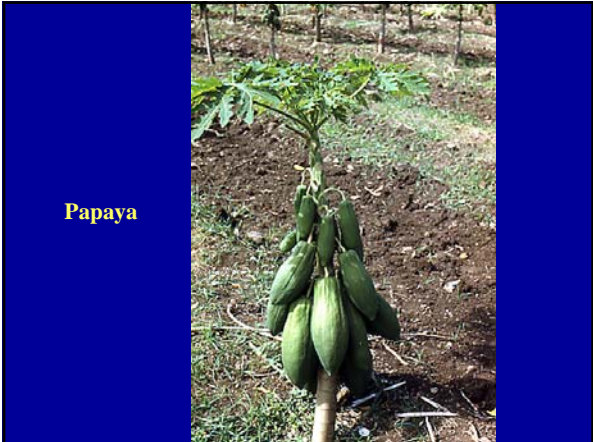


Papaya cavity types

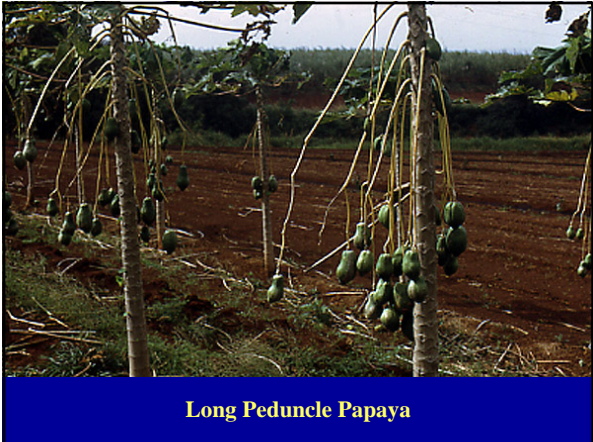


Packing Papaya

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