

Lecture 18
Tropical Beverage Crops—Cacao



Cacao (*Theobroma cacao*, Sterculiaceae)

Terminology:

Cacao: The specific epithet of *Theobroma cacao* and the name of the tree.

Cocoa: The drink produced from cocoa powder (also cocoa tree).

Cocoa powder: The defatted ground up fermented seed of cacao.

Cocoa butter: The fat expressed from cacao seed.

Coca: The name of the plant producing the stimulant cocaine (*Erythroxylum coca*).

Cocos: The name of the coconut palm (*Cocos nucifera*).

History

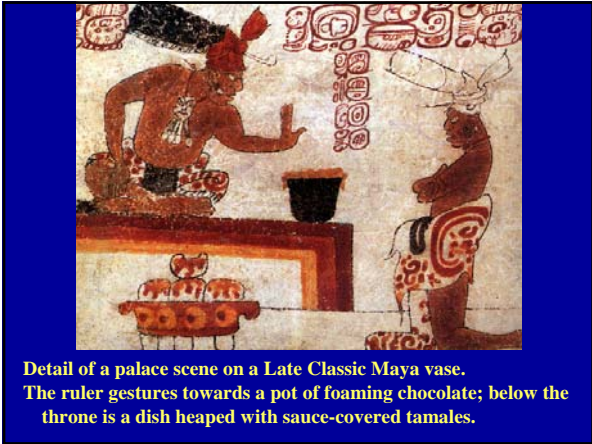
Indigenous to the New World, new evidence dates to 500 BCE in Maya culture.

Indians of Northern South America, Central America, and Mexico consumed a strong bitter, semisolid aromatic beverage made from the seed.

Beans were so valuable they were also used as money (1 slave = 100 beans).

The generic name *Theobroma* means “drink” (*broma*) of the “gods” (*Theo*).

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Remained as a curiosity in Spain until Spanish added sugar, vanilla, and cinnamon to produce the well known beverage cocoa, which became popular in Europe by the middle of the 17th century.
(Featured in Mozart's opera *Così fan Tutti* ca. 1791 as a drink of the upper classes.)
Consumption, however, did not increase rapidly until the latter half of the 19th century.



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In 1848, C.J. van Houten discovered a method for extracting part of the fat (cocoa butter) from the seed in the hot press process.

This produced a new product, cocoa powder, the defatted residue.

Defatted cocoa diluted with starch e.g. corn or arrowroot is popular as a drink in the British navy.

Cocoa butter was then found to a delectable product by adding sugar, cocoa power and molding it into bars—eating chocolate.

Sold by Fry and Sons (1817) and Cadbury (1849).

Milk chocolate produced in 1876 a chocolate suspension in milk, now an important world product (Mars, Hershey, Nestle, Cadbury).

Cacao World Production (2005–2006)

Continent	1000 tonnes	Chief countries
World	3,731	
Africa	2,666	Ivory Coast (1,410), Ghana (591)
Americans	439	Brazil (162), Equador (115)
Asia	626	Indonesia (520), Malaysia (27)

Botany

Related plants include *Cola acuminata* (cola nut, one of the flavorings of Coca Cola), *Sterculia foetida*, a tropical ornamental, *Sterculia urens*, source of karaya gum.

Note the name of the family, Sterculiaceae, refers to the vile smelling flowers of *Sterculia foetida*.

Sterco is the Latin name for dung (manure).

A related species *Theobroma grandiflorum* (cupuaçu) is cultivated for the strongly flavored pulp.

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Ecology

Cultivated in tropical lowlands 20°N to 20°S but main belt is 10°N and S from sea level up to 500 m, best at 200 to 300 m.

Needs constant rain, 1500 to 2000 mm (60–80").

Thrives in diverse soils.

Usually grown under nitrogen fixating leguminous shade trees to provide organic matter.





Cacao

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Traditionally Cacao is Classified into Two Races

Criollo

(cacao dulce, or sweet cacao) native to Central America, considered the best flavored.

Forastero

(cacao amargo or bitter cacao) native to Venezuela and the northern Amazon.

Many types of forasteros.

Trinitarios

hybrids between these types, based on crosses made at the Trinidad Imperial College.

Most of the present cacao seem to be hybrids between these types.

Tree is 5–8 m, (15–40') tall, grown as an understory tree. Small flowers are borne directly on branches (cauliflorous flowering).

Pollination is by insects particularly midges such as *Forcipomyea*.

Pollination is one of the principal problems of cacao.

A number of crosses are incompatible, typically due to embryo abortion.

Cauliferous Flowering in Cacao



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Morphology

Tree shows dimorphic branching.

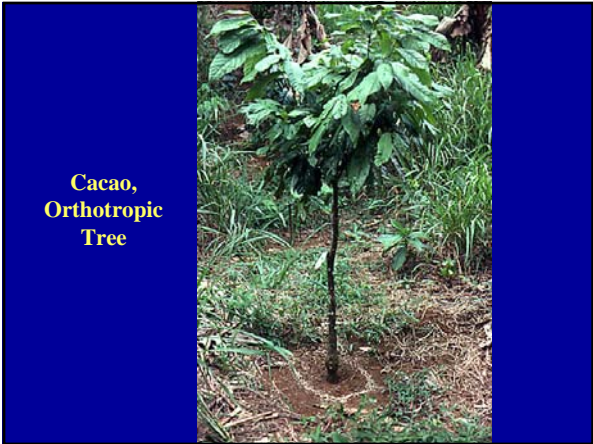
Seedlings form an orthotropic single main stem or chupon from 1 to 1.5 m high at 14 months.

The terminal bud breaks into 3-5 lateral branches called a jorquette.

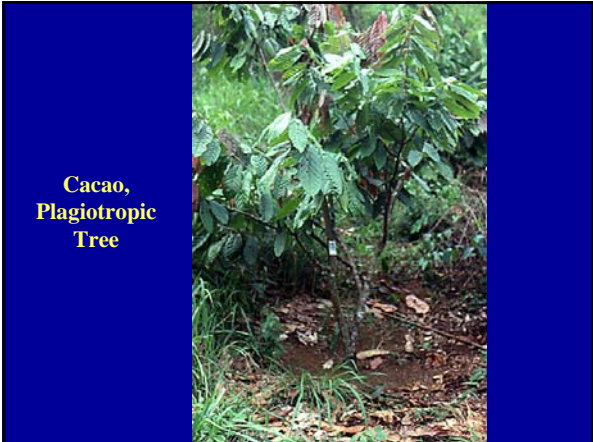
Buds from jorquette are plagiotropic and trees propagated with their buds will have an undesirable spreading growth.

These two types of growth are associated with changes in phyllotaxy, arrangement of leaves around the stem.





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Fruits are pods, usually 10–32 cm long, usually football shaped and furrowed, warty, green yellow or red in color.

There are 20 to 60 seeds (called beans) surrounded by a sweet delicious pulp that is sometimes collected as a source of jelly or frozen as a flavoring for yogurts or ice-cream.

Seeds usually constitute 25% by weight of the mature fruit; there are 250–450 dry fermented beans per lb.

Fruits are harvested with a knife blade at the end of a long pole.

Harvesting is carried out continuously throughout the year.

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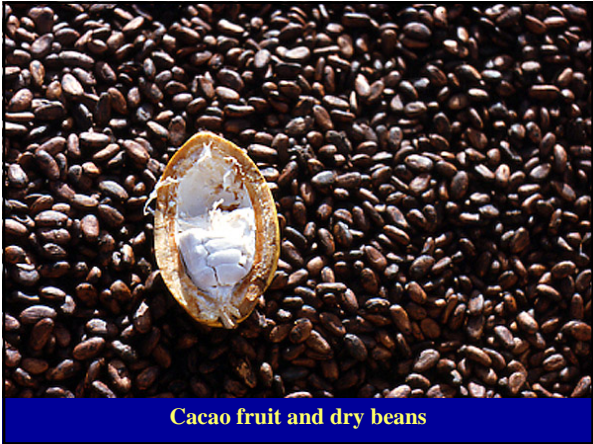


Cacao fruit, Ceylon



Cacao

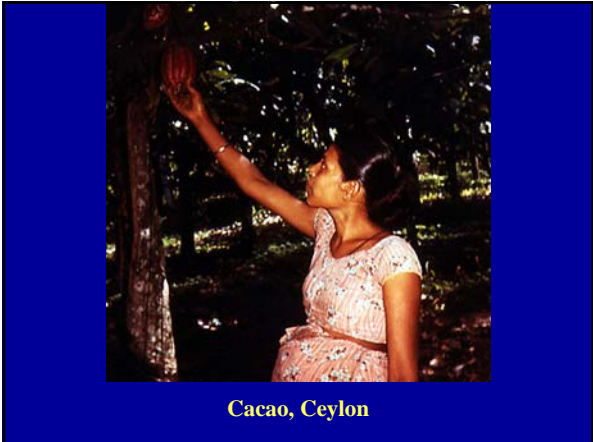
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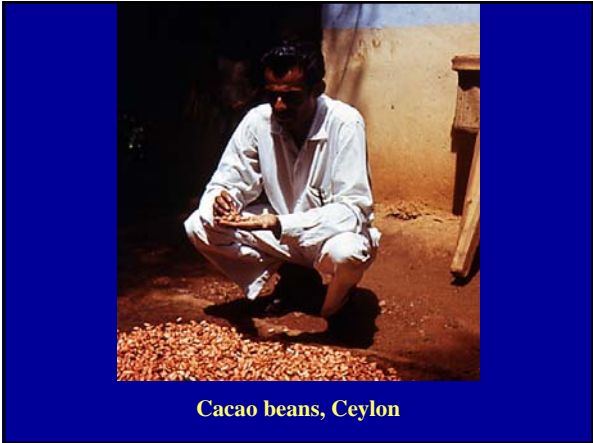






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Culture

Most cacao plantations are planted with seedlings, often from hybrids between different clones (clonal hybrids).

Problem with vegetative propagation by cuttings or grafting is the plagiotropic growth obtained which requires special pruning to make suitable trees.

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Planting system is usually 3 to 6 m (9 to 18' apart).
Usually bananas are interplanted for temporary shade until shade trees mature.
Cacao will stand full sunlight but the critical factor is humus in the soil.
Pruning is controversial and little done except to establish plantings from vegetative trees.
Shade trees are often thinned.

Cacao Diseases

Two serious diseases

Blackpod (*Phytophthora palmivora*) is serious in Africa.

Witches broom (*Marasmiium perniciosuses*) is now destroying the Brazilian industry.

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Field Processing

Fermentation

After harvest, seeds and pulp are scooped out of the fruit by hand and left to ferment into heaps (often in wooden boxes) for about 36 hr at 40–50°C.

Two processes are involved.

1. Decomposition of sugars in the mucilaginous pulp around the beans to alcohol and CO₂ by yeast and from alcohol to acetic acid by bacteria.

Pulp liquefies and drains away.

Thus, one of the reasons for fermentation is to get rid of the pulp (which could be utilized as a byproduct).

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2. Internal changes.

Aeration is necessary for these changes thus piles of beans are transferred from box to box for aeration.

Embryo dies and seed coat changes color.

Bitter seed substances are converted to milder flavored components and chocolate aroma is developed.

The aroma is produced by cacaool, 23 ml/ton.

Thus, fermentation is critical for high quality.

Over fermentation leads to offensive flavor; under fermentation leads to bitter taste.

3. In some cases seeds are washed but this stage is usually omitted.

4. Seed drying for 36 hr, moisture is reduced from 33 to 8%.

Slow and even drying is important.

Thus, the seeds are often shaded in the warmest part of the day and raked.

100 kg of wet seed reduces to 45 kg of dry seed because of loss of moisture and changes that occur during the process.

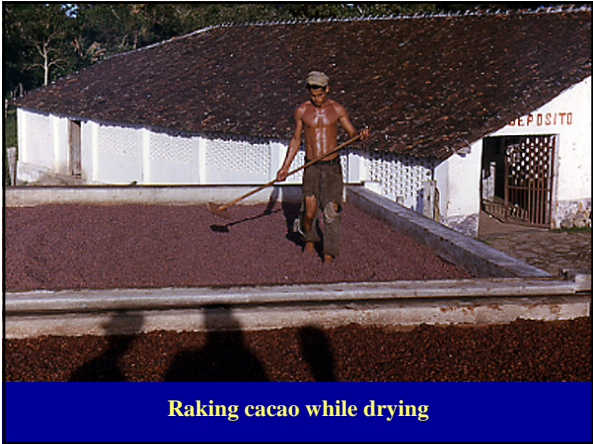
5. Sorting, grading, bagging, and storing.

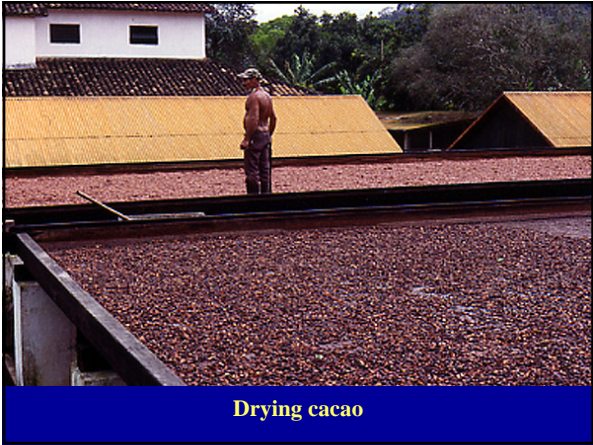
The bagged seed are exported to chocolate processing facilities, usually in the temperate world.

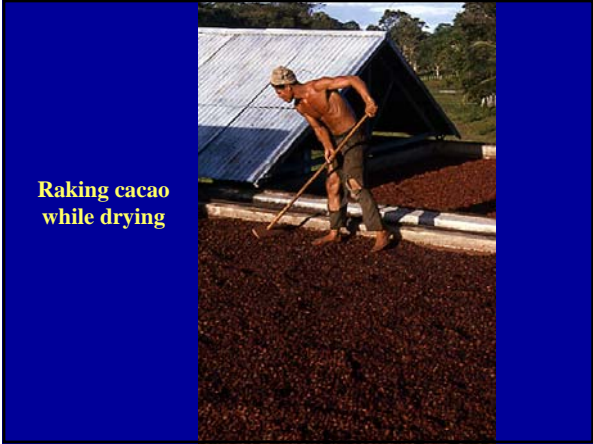


Drying cacao

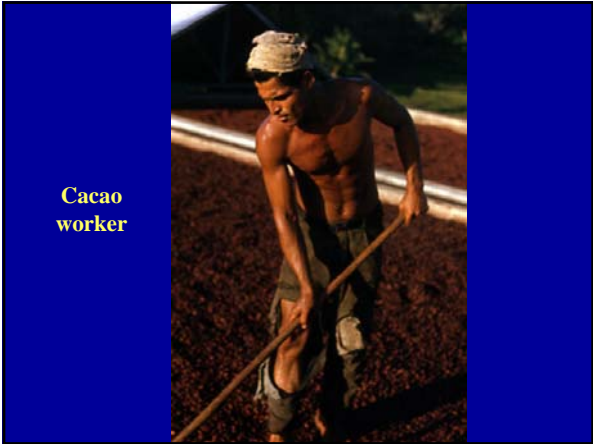
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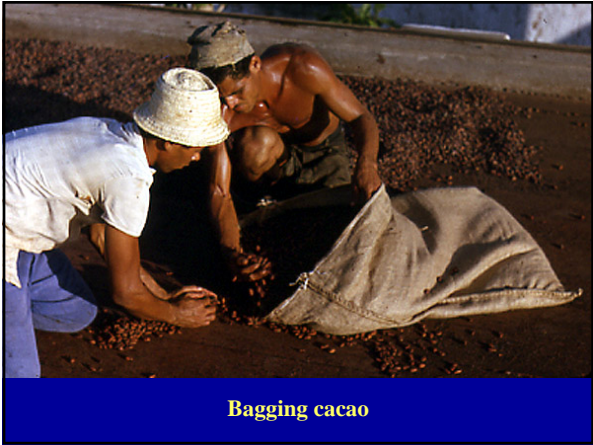


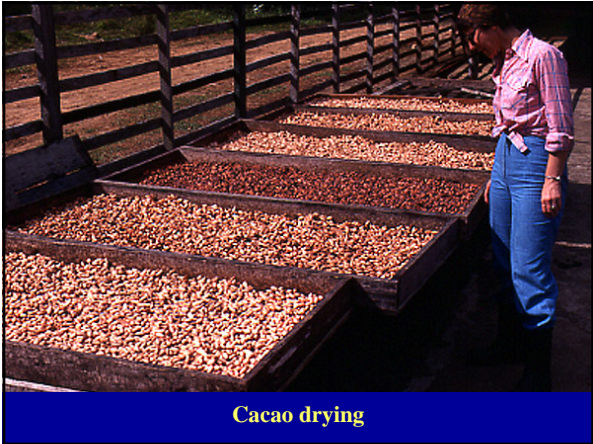




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Cacao Processing

Three steps: cleaning, roasting, and winnowing to remove the shell from the "nibs" or embryos.
The byproducts of cacao harvest are the pods which can be ground into meal.
However, the alkaloid content (theobromine) makes them unsuitable unless diluted with other feeds.
The seed coat or shell (from cacao processing) makes an excellent horticultural mulch.
The mucilage is a wasted resource and could be a valuable food product.
There are also mucilaginous compounds in the shell which could be a source of gums similar to karaya gum.

The cocoa butter is more valuable than the cocoa power because when chocolate is made cocoa powder is left over and is thus in surplus compared to the fat.
The fat has very peculiar properties melting at body temperature and giving a creamy texture.
It is composed of almost equal parts of palmitic acid (C16:0), stearic acid (C18:0), and oleic acid (C18:1) with only small amount of linoleic acid (C18:2).
Cocoa butter substitutes are being produced but the chocolate must be labeled as artificial chocolate.

Production of Cocoa Powder

Liquor process.
The seed or nib is ground to a dark fluid brown liquor which can be molded and sold as unsweetened chocolate.
The liquor is pressed to extrude the fat or cocoa butter.
The press cake is sieved and is known as natural chocolate.
In the alkalization or Dutch process, the nib is soaked in alkali, dried, and pressed again.

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The cocoa power with about 6% fat is known as breakfast cocoa.

In the manufacture of chocolate, cocoa butter and cocoa powder are recombined with the addition of sugar and flavorings such as vanilla.

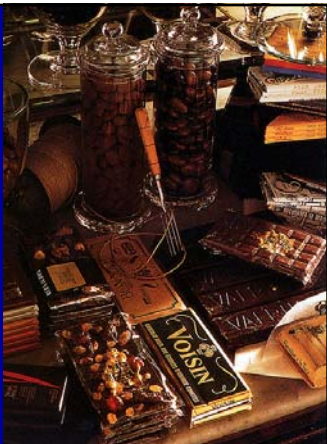
The European preference is for dark, bittersweet chocolate; the US preference is for sweet, milk chocolate.

Through fermentation and drying, the cacao pod's pulp-surrounded seeds are converted into nibs ready for roasting and grinding into chocolate liquor.



The end of the 20th century has seen a revival of luxury high-quality chocolate with a high content of cocoa solids and cacao butter.

These premier confections on display come from all over Europe.



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Economy

Chocolate represents about 1/2 of the production of coffee.

The product is delicious and almost “addicting.”

The two most popular flavors for Americans are vanilla and chocolate; we associate vanilla with a cream color and chocolate with a dark brown color.

However, vanilla which is a brown bean is often used to flavor chocolate.

White chocolate is merely cocoa butter which still has some chocolate flavor.

The future of the world industry depends on the extent to which Asians can be induced to consume chocolate.

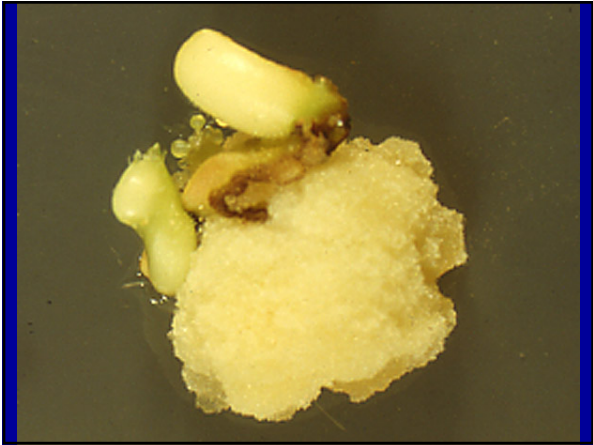
The problem is that chocolate is fairly expensive.

At the present time Brazil is under severe stress due to witches broom; Ivory Coast and Ghana are the major producers but Malaysia is moving up very fast as a major world producer.



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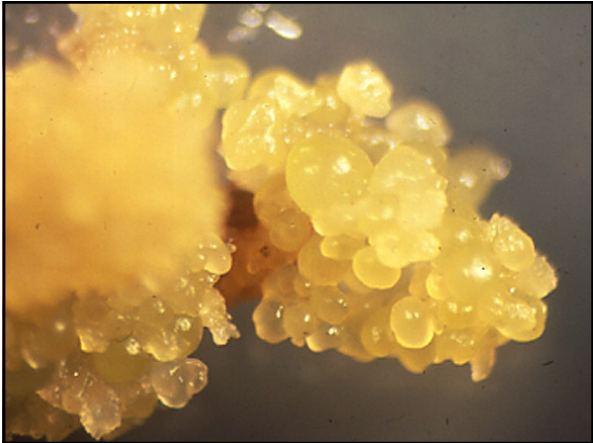


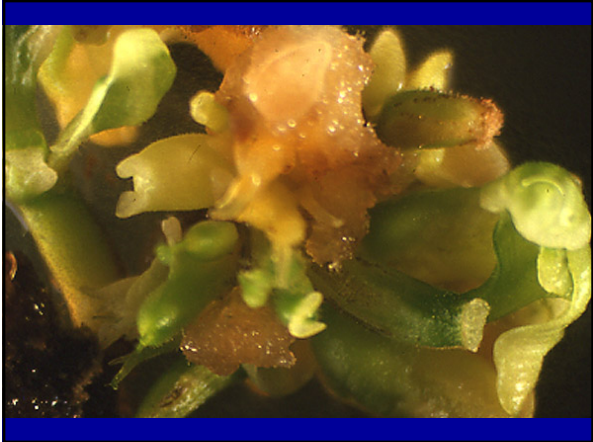




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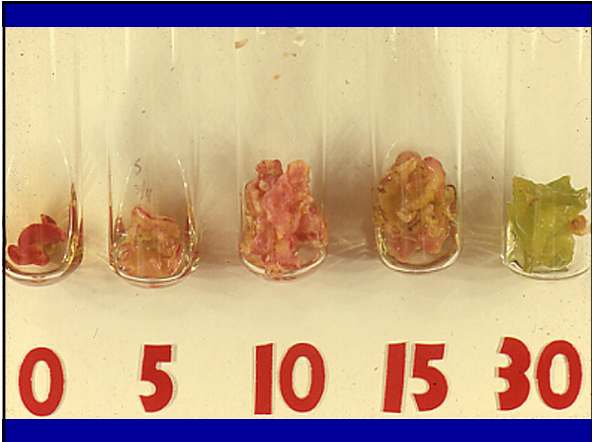
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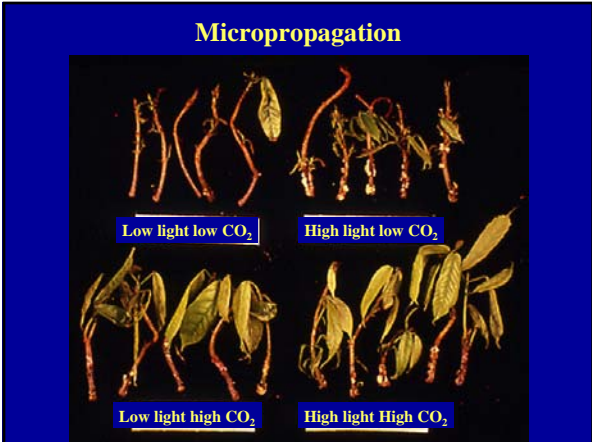




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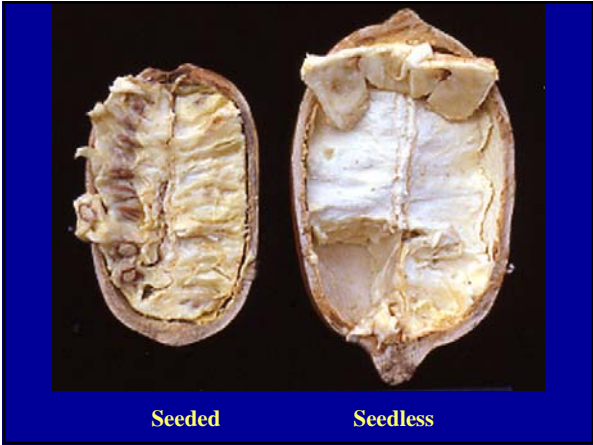


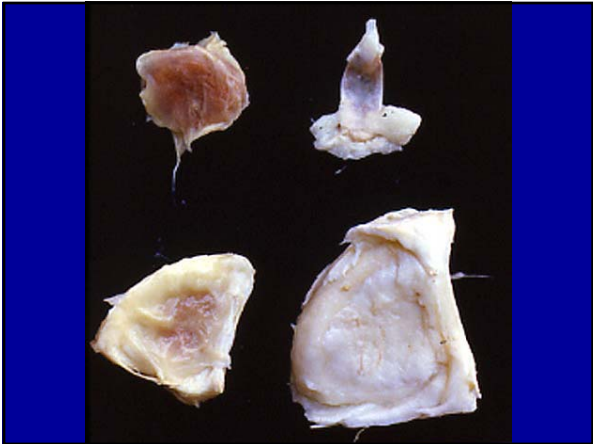




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