

Serie XXX

Catalog

Cacao Diseases in Central America

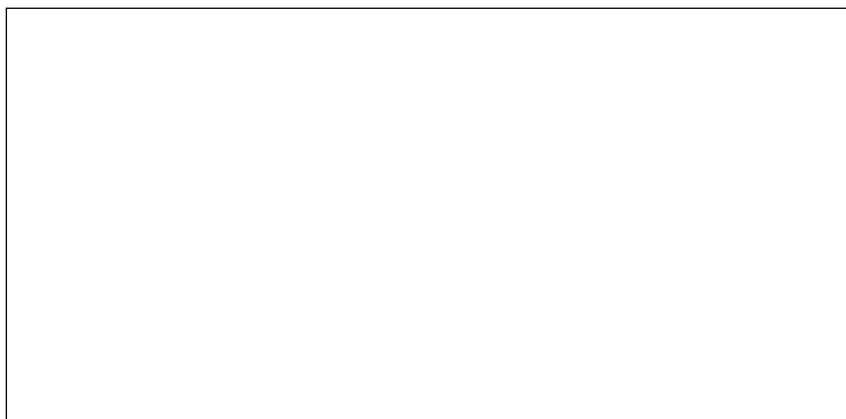
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Introduction

Diseases are the biotic factor with the greatest impact on cacao production in Latin America and the world. In Central America, bacteria, viruses and nematodes do not cause significant problems; instead, fungi and similar organisms are responsible for most of the losses.

Moniliasis (caused by the fungus *Moniliophthora roreri*) is the disease that causes the most damage in this region and it is responsible for up to 80% of losses of cacao fruits or fruits and the abandonment of many cacao plantations. Next in importance is black fruit disease caused by organisms of the genus *Phytophthora*, previously classified as fungi but currently grouped with the Protistas. Black fruit can attack different parts of the plant but, like moniliasis, it mainly damages the fruits that contain the product of commercial interest: the cacao seeds.

After a brief introduction to the factors associated with the incidence of cacao diseases, the first part of this publication focuses on the two main diseases that affect cacao fruits: moniliasis and black fruit. The emphasis is on the identification of these diseases, and this catalog includes photographs of the most characteristic symptoms of the diseases and signs of the fungi. It also provides information about the reproduction and dispersal of their causal agents, life cycles and the measures recommended for controlling them.

The second part of the catalog focuses on diseases that mainly attack parts of the plant other than the fruit, emphasizing their recognition and control. Finally, this publication contains information about witches' broom, a serious disease present in South America, the Antilles and areas to the south of the Panama Canal, which threatens to spread into Central America. Technicians and farmers should learn to recognize the different symptoms and signs of this disease.

The Authors

Factors that favor cacao diseases

Excessive moisture, shade and inadequate ventilation are factors that favor outbreaks of diseases. These conditions occur when:

- Cacao trees are not pruned, which causes too much self-shading by intercrossed branches; as a result, little light can penetrate and humidity increases. The same thing occurs when there are many shade trees that are poorly managed.
- Very tall weeds are present, impeding air circulation and increasing humidity.



When diseased fruits are not cut off in time, the fungi can complete their life cycle, producing millions of spores (the seeds of the fungi), ready to infect the healthy fruits.

In a well-managed, properly pruned cacao plantation as shown in the photographs, more light can enter, humidity is lower and there are fewer attacks by diseases. In addition, the trees flower more readily and this favors the production of fruits.

Moniliasis (frosty pod rot)

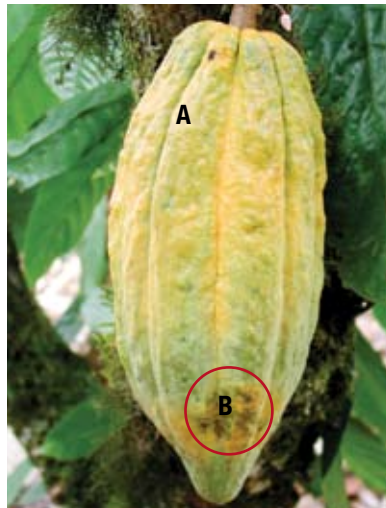
Caused by the fungus *Moniliophthora roreri*

This disease only attacks the fruits or pods of cacao (*Theobroma cacao*) and close relatives such as the pataste (*T. bicolor*) and the cupuaçu (*T. grandiflorum*), causing several types of symptoms that may occur alone or in combination with others. Sporadically, fruits appear that seem to be healthy but they are already damaged internally and can be recognized by their heavier weight.

How do we recognize the disease?



Presence of deformations called gibas (conspicuous bumpy swellings)



Premature ripening (A)
+ oily spots (B)



Irregular brown or
chocolate-colored spots



Incipient mycelium in a brown spot



Fungal mycelia on the brown spots.
The most contagious stage



Mummified fruit



Different symptoms caused by moniliasis

How does the fungus reproduce?

A white “fuzzy” layer formed by minuscule interlaced threads of mycelia appears on the brown spots. This layer darkens as millions of tiny spores are produced and mature. The spores, which are the seeds of the fungus, detach when they are dry, forming a floury dust.

How does the disease spread?

The spores are carried to healthy fruits by the wind or by splashing raindrops, or they are spread by being stuck to animals or humans. When the surface of the fruit is damp, the spores germinate and infect it. The damage is visible several weeks later. Young fruits under three months old are most commonly attacked.

The most contagious stage of moniliasis is when the fungus produces its spores. It is essential to remove the fruits before the mycelia fungi form!

Black pod or phytophthora

Caused by *Phytophthora palmivora* and also by *P. capsici* in some countries of the region

This disease attacks several parts of the plant (see the following section) but the most severe damage occurs on the fruits, particularly on those that are nearly ripe. It produces a brown spot with an regular edge that spreads rapidly, covering the entire fruit within a few days. Internally it causes a brown rot.

How do we recognize the disease?



Brown spots usually begin to appear at one of the ends of the fruit



The spot covers the fruit within a few days



Mycelia fungi form on the spots



Internal rotting partially or completely damages the seeds

How does the organism reproduce?

Minuscule interlaced threads of mycelia appear on the brown spots, taking on the appearance of a small, sparse. This produces the spores and other reproductive structures that act like the seeds of the organism.

How does the disease spread?

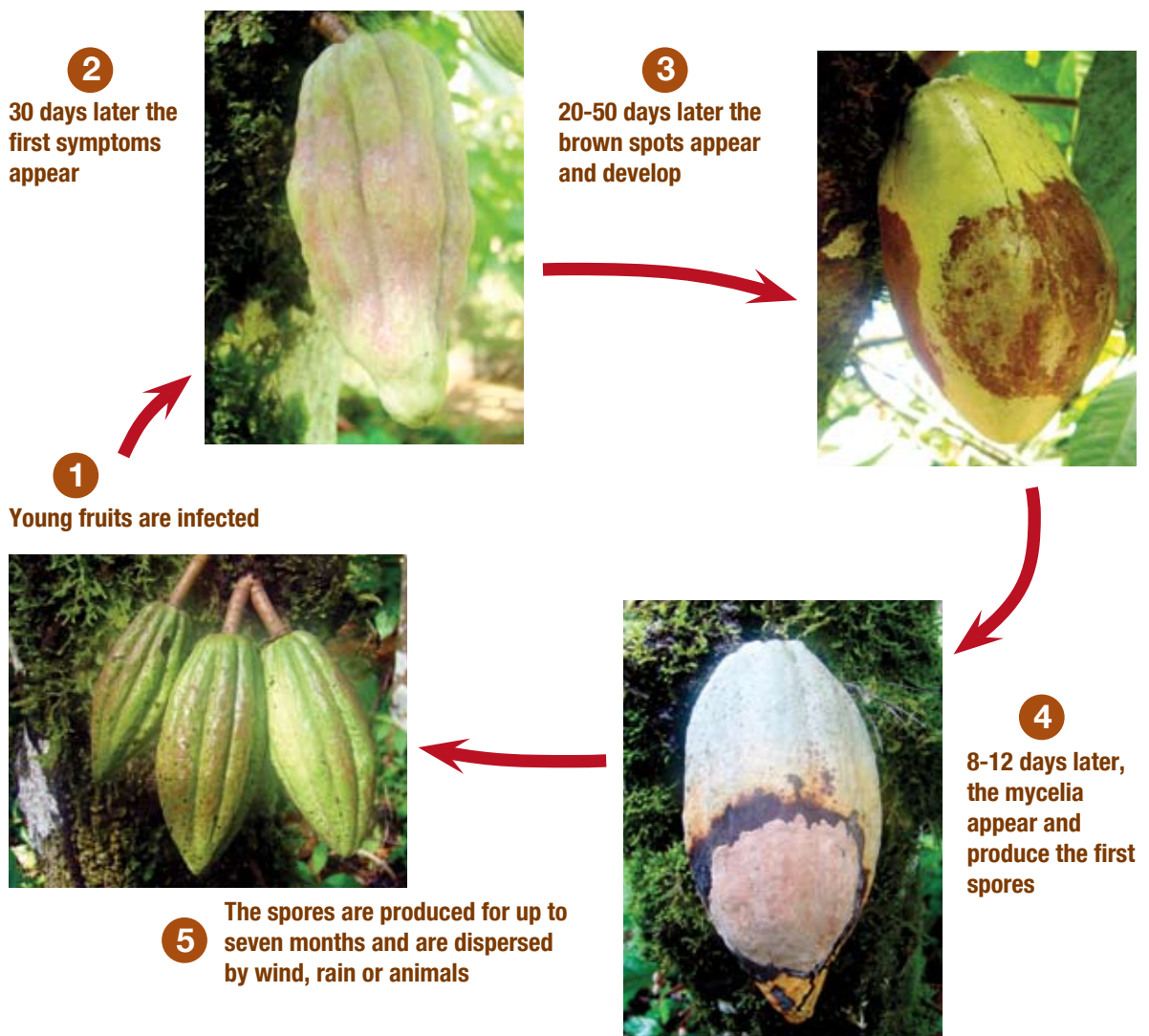
The most common route of infection is via spores that have the capacity to swim; these become active in very humid conditions and when a period of low temperature alternates with a warm period. The spores are transported by splashing rain, water currents, wind, ants, etc. Direct contact between diseased and healthy fruits is another major source of infection.

The appearance of mycelia is the most contagious stage of black fruit and we must avoid it by eliminating diseased fruits before they produce spores!

Life cycle of moniliasis

Learning about the life cycle of the organisms that cause these diseases will help us to better understand when and how to control them. The duration of the life cycle depends on the cacao variety and environmental conditions: it is shorter in warm, moist climates and longer in cooler climates.

Life cycle of moniliasis (about 85 days)



Life cycle of black pod

Life cycle of black pod (11 days)

1

Fruits of different ages become infected



2

Five days later, brown spots appear and develop



5

Water, ants and other insects disperse the spores



3



After three days, brown spots cover the entire fruit





4

After three days, mycelia cover the entire fruit

Recommended practices for controlling cacao fruit diseases

Practice	When?	What to do?
Rehabilitation pruning of cacao trees	At the end of the main harvest season	 <p>When the plantation is very tall, very old or has been abandoned, heavy pruning is recommended to reduce the height of the cacao trees to 3 meters, eliminating low-growing and tangled branches.</p>
Shade regulation	At the end of the main harvest season	Regulate the level of shade to 30% or 50% by pruning and thinning nearby fruit or timber trees associated with the cacao
Maintenance pruning	At the end of the main harvest season	 <p>Cut cacao branches that are misshapen, very low or tangled with other trees to allow light to penetrate, improve ventilation and reduce humidity.</p>
Sucker removal	Simultaneous with harvests	Cut off suckers (chupons) when they are still young.

Practice	When?	What to do?
Drainage management	During the dry season	Build drains and keep them clean to avoid water-logging.
Weeding	At least four times per year	Eliminate weeds, particularly large-leaved and tall ones. Also control weeds around the edges of the cacao plantation.
Timely harvesting	Every 15 days	 <p>Harvest ripe fruits with a knife or scissors to avoid damaging floral cushions. Do not allow fruits to overripen in the cacao plantation, as these will be attacked by <i>Phytophthora</i> or eaten by animals.</p>
Complete removal of fruits	At the end of the main harvest season	Before the rains begin and new fruits form, remove all diseased and healthy fruits left over from the previous production cycle. Gather them together in an open site and sprinkle them with lime or products high in nitrogen (e.g., up to 15% urea*) so that they will decompose more rapidly.
Removal of diseased fruits (sanitary pruning)	Every eight days during the period of fruit formation and growth. Every 15 days the rest of the time.	 <p>Cut all diseased fruits or fruits during the early morning hours so that the spores do not dry off and detach. The cut fruits should be covered with leaf litter or piled up in open sites in the cacao plantation, sprinkled with lime or a solution of 15% urea in water and covered with plantain leaves.</p>
Rational application of fungicides	During the first two months of fruit formation	Make two monthly applications of copper oxide (e.g. Cobre Sandoz*) with up to 1% of the active ingredient + up to 0.1% Pegafix* with a motorized pump. Use 200-300 ml per tree, applying the product both to the fruits and the foliage.

*Remember that if your cacao plantation is organic, you should consult the technician before applying these products.

Phytophthora disease and trunk canker

These diseases are caused by the same organisms that cause black pod
(*Phytophthora palmivora* or *P. capsici*)

How do we recognize the disease?



Infected suckers (chupons)



Descending dieback in
nursery plants



Nursery plant affected
by Phytophthora



Trunk canker: lesions before and after bark removal

How does phytophthora affect the plant?

a) It produces dieback (death) from the top to the bottom of the young shoots (suckers or chupons) of adult plants and nursery seedlings. b) It causes canker on the trunk of adult trees, characterized by the appearance of circular lesions that are red in color when the bark is removed, and can eventually cause the death of the tree. Reddish-brown lesions appear on the roots and water and nutrient absorption are disrupted, which can also kill the tree.

How does it spread and what factors favor the disease?

The factors that favor the spread of the foliage damages are the same as those described for black fruit rot in cacao. Trunk canker usually occurs in water-logged areas or during prolonged flooding.

How do we combat the disease?

In the nursery: reducing the level of moisture in the nursery and building raised beds covered by a layer of sand helps to mitigate the effects of the disease. During cool weather the seedlings can be protected by applying a copper-based fungicide weekly during periods of high humidity. Dead seedlings should be carefully eliminated.

In the field: suckers (chupons) should be eliminated periodically to prevent them from becoming infected and thereby becoming a source of contagion for other organs. Proper construction and maintenance of the drainage ditches on the plantation helps prevent the appearance of trunk canker. When damage occurs, cut off all affected tissues and apply a tree wound dressing to the cuts.

Rosellinia or black root rot

Caused by the fungus *Rosellinia pepo*

How do we recognize the disease?



The disease affects groups of trees which usually show different levels of damage



Roots are infected with the fungus; consequently, leaves dry and fall down and the tree dies



Typical fan-shaped mycelia present beneath the bark of a root

How does the disease affect cacao?

It severely damages the root system and the base of the trunk, producing the yellowing, drying and progressive shedding of the leaves, the drying of branches and finally, the death of the tree. The disease occurs in patches that rapidly spread, killing the cacao plants and certain other species used as shade or crops associated with cacao.

How does it spread and what factors favor the disease?

This fungus occurs naturally in the soil and is common in areas where the original vegetation has been removed and the residues are left to decompose. The presence of materials with high organic content in decomposition, high humidity and little aeration create favorable conditions for the disease. New infections occur mainly through contact between healthy and diseased roots. Weak, malnourished trees are generally the most susceptible to the disease.

How do we combat the disease?

For prevention purposes, old and diseased trees should be promptly eliminated, preferably by injecting herbicide into the trunk. Girdling the trees should be avoided because this delays their death and increases the possibilities of infection. A good fertilization program and ecological management of the plantation prevents the disease. When an attack occurs, a 30 x 30 cm ditch should be dug around the affected trees and at least one healthy plant in each direction; eliminate all parts of the diseased trees and their roots, burning the residues in the same site; pile up the organic material and expose the soil to the sun; sprinkle lime and plant narrow-leaved species for a period of at least 6 months. All tools used in the process should be disinfected with up to 10% formalin or formol solutions, sodium hypochlorite or another similar product.

Ceratocystis wilt (machete disease)

Caused by the fungus *Ceratocystis cacaofunesta*

How do we recognize the disease?



Sudden death of the tree with the leaves drooping down



Reddish lesions visible on the stem

Remember to use resistant rootstocks when planting grafted trees

How does the disease affect cacao trees?

The fungus grows in the internal conducting tissues of the trunk and branches, blocking the flow of water and nutrients. The tree wilts and dies as a result. The disease occurs in a sporadic and dispersed manner on the plantation, but it can become a very serious problem when the planted materials are genetically uniform or when they are grafted onto rootstocks that are not resistant to soil-borne diseases.



Xyleborus beetles associated with the disease



Perforations of the trunk and wood dust caused by the beetle

How does it spread and what factors favor the disease?

The fungus produces most of its spores within the tree, especially in the galleries or tunnels made by barely visible *Xyleborus* beetles. The spores are disseminated by these beetles when they move from one tree to another, or by the wind, along with the wood dust and the feces of these and other perforating insects.

For an infection to occur there must be wounds in the trunk and/or on the branches that are caused naturally or by the action of insects or tools such as machetes, shovels, pruning shears, etc.

How do we combat the disease?

A number of useful measures for preventing the appearance and spread of this disease include: disinfecting all work tools with a suitable product before using them; applying tree wound dressing to the cuts and wounds on pruned trees; and avoid planting uniform material and grafting onto susceptible rootstocks. Sick trees should be eliminated by burning or burying the residues. If a patch of affected trees is detected, follow the procedure indicated for controlling rosellinia (black root rot).

Anthracnosis

Caused by the fungus *Colletotrichum gloeosporioides*

How do we recognize the disease?



Dry, brown spots with yellow edges that spread over the leaves and dry them



Anthracnosis infection in the veins



Diseased fruits show signs of the fungus



Diseased leaves on a nursery plant

How does anthracnosis affect the cacao tree?

It attacks the young shoots, leaves and stems that are most exposed to the sun, particularly those in the crown of the tree, which limits the development and production of the plants. It causes dry lesions with yellow edges that normally spread from the edge to the center of the leaves, eventually damaging them completely, and then the leaves fall off leaving the branches bare. This stimulates the growth of new branches that are also infected, which finally take on the appearance of small brooms. In the nursery it causes similar lesions and defoliation, as well as deep lesions on the stem. The damage to the fruits is not economically significant and can be identified by the appearance of deep brown lesions on fruits of a certain age. White mycelia appear on the lesions that turn pink when the fungus produces spores. The diseased fruits turn black and die.

How does it spread and what factors favor the disease?

The spores are produced on the stem and fruit lesions when conditions are humid. They are disseminated by the wind, rain water or irrigation, insects and tools. Infection of the foliage occurs during the rainy season and is propitiated by wounds caused by insects.

How do we combat the disease?

Adequate amounts of shade in the field (30%-50%) and shade in the nursery (50%-70%) prevents damage by anthracnosis. Infections in the nursery can be reduced by building raised beds covered with a thick layer of sand or mulch* to avoid the splashing of rain water. Diseased seedlings should be carefully eliminated and a copper-containing fungicide should be applied to the rest of the seedlings at the recommended dose and frequency. In adult plants diseased tissues should be pruned 10 cm below the affected area, applying tree wound dressing to the thick stems and disinfecting the tools properly.

* Layer of decomposing vegetal residues

Other cacao diseases



◀ Thread blight

The fungus *Pellicularia koleroga* produces whitish mycelia threads that spread over the stems and leaves. The thickest threads branch out on the underside of the leaves, resembling a sort of spider web. The leaves dry out and detach but remain suspended on the branches by the mycelia. The disease seldom causes major damage, but in extreme conditions it can kill the branches. Thread blight occurs in abandoned plantations or in excessively shaded plantations. It is spread via direct contact, insects and work tools. Good plantation management prevents and controls the disease. An effective way to combat it is by cutting and eliminating diseased branches and then disinfecting the tools used.

Pink disease ▶

The fungus *Corticium salmonicolor* attacks the branches, twigs and trunk of the cacao tree, covering them with a white crust that later turns pink. It causes defoliation, drying of the branches and, in very few cases, the death of the tree. It usually occurs in young, dispersed trees in the plantation, which means that its economic impact is limited. The fungus is spread by wind-borne spores and survives in old lesions. This disease can be combated using a similar method to that for thread blight.



Green point gall

◀ Galls or warts

These are growth abnormalities that occur on the trunk and branches of cacao and are known as green-point galls, flowery galls, fan galls, knob galls and lobed galls. The most studied is the green-point gall caused by *Albonectria rigidiuscula*. This fungus produces a large number of very small shoots that do not develop and affect the growth and fruiting of the plant. The propagation of these diseased plants should be avoided. Highly damaged plants should be completely eliminated.

Warning!

Witches' broom is a threat

This is one of the most damaging cacao diseases and is caused by the fungus *Moniliophthora perniciosa* (formerly *Crinipellis perniciosa*). It attacks all cacao plants causing abnormal growths and lesions on the shoots, branches, floral cushions and fruits. It also attacks nursery seedlings. Some of the symptoms on the fruits can be confused with moniliasis. Witches' broom is present in South America, some Caribbean countries and areas south of the Panama Canal, which means it is a permanent threat to Central American cacao plantations. The early identification of witches' broom is essential in order to alert the appropriate authorities and prevent the spread of this disease in the region. The fungus can propagate in any kind of tissue such as seeds, whole plants, twigs, fruits, etc.

How do we recognize witches' broom?



Brooms on the floral cushions



Brooms and dry fruits



Small pink umbrellas appear on dead tissues and then turn brown as they form millions of spores underneath



Green brooms on shoots





Green witches broom



a) Dried witches broom and b) green witches broom



Strawberry-shaped fruits



Gibas



False ripening



Brown spots



Black spot with irregular edges



Internal rotting caused by the fungus

Do not put your plantation or your country at risk. Do not introduce cacao plants or any plant parts (fruits, seeds, twigs or buds) from South America or any other affected country.

If you see any symptoms of witches' broom on your plantation, do not move any vegetative material and immediately contact officials of the Ministry of Agriculture, the National Plant Protection Office, or other related institution.

Bibliography

Capriles, L. Enfermedades del cacao en Venezuela. Fondo Nacional de cacao, Venezuela. 79 p.

Hill, D.S. and Waller, J.M. 1988. Pests and diseases of tropical crops. Singapore, Longman. Vol. 1: 175 p.; Vol.2: 432 p.

Porras U., V.H. 1988. Enfermedades del cacao. La Lima, Honduras. FHIA: Serie Tecnología Comunicación y Desarrollo Fascículo no.5. 32 p.

Rossmann, A.Y.; Palm M.E. and Spielman, L.J. 1990. A literature guide for the identification of plant pathogenic fungi. APS press, Minnesota, USA. 252 p.

Wellman, F.L. 1977. Dictionary of tropical crops and their diseases. New York, Scarecrow. 495 p.

Wood, G.A.R. 1982. Cacao. Translation from English by Antonio Marino, México, Continental. pp. 161-207.