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New pests and invasive diseases

Mango bacterial disease

1

Mango bacterial disease caused by *Xanthomonas citri* pv. *mangiferaeindicae*

PIP is funded by the European Union

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

Document produced by PIP, with the technical assistance of:
Delhove, Rey, Vannière, proofreading Pruvost

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PIP is a European cooperation programme managed by COLEACP. COLEACP is an international network promoting sustainable horticultural trade. PIP is financed by the European Union and implemented at the request of the ACP (Africa, Caribbean and Pacific) Group of States. In accordance with the Millennium Development Goals, the global objective is to: «Maintain and, if possible, increase the contribution made by export horticulture to the reduction of poverty in ACP countries».

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of PIP and COLEACP and can in no way be taken to reflect the views of the European Union.

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PIP
FOR SUSTAINABLE DEVELOPMENT OF
THE ACP HORTICULTURAL INDUSTRY

Mango bacterial disease caused by *Xanthomonas citri* pv. *mangiferaeindicae*

Causal agent

Mango bacteriosis (mango bacterial canker or mango bacterial black spot, the subject of this sheet) is caused by a phytopathogenic bacterium belonging to the *Xanthomonas citri* species. This species has a very high degree of host specialisation, meaning that these bacteria are only pathogenic in a restricted range of plants. To translate the high specificity of their pathogenic power, scientists have created a pathovar subdivision (abbreviated to pv.) that provides information on the host plant being attacked. Thus, *X. citri* pv. *mangiferaeindicae* is a pathogen of Mangifera indica, the mango tree.

Several of these pathovars are enemies of fruit trees, especially *X. citri* pv. *citri*, responsible for Asiatic citrus canker and *X. citri pv. anacardii,* responsible for cashew bacterial spot in Latin America.

Geographical distribution

Black spot is widespread throughout the world, especially in Asia (Japan, India, Malaysia, Thailand, the Philippines, etc.), Australia, the United Arab Emirates, islands in the Indian Ocean (the Comoros, Réunion, etc.), and East and Southern Africa (Kenya, South Africa, etc.).

Until recently, West Africa seemed to have been spared. However, the disease has been identified in Ghana, Burkina Faso and Mali since 2010. Symptoms have also been observed recently in Côte d'Ivoire but no formal laboratory identification of the causal agent has yet been made. It was probably introduced about ten years ago, at least, but it is now spreading more rapidly. The fear is that it exists in other countries in the sub-region.

Symptoms and damage

Mango bacterial disease produces several types of symptom.

On the leaves: the damage starts with small oily spots that turn into necrotic, black, angular, raised spots, often bound by the veins on the leaf. These black spots are surrounded by a clearer, oily-looking halo on the underside and a yellow halo on the upper side. Cankers can be seen on the petioles and the main vein. The strongly-attacked leaves fall, leaving long defoliated branches behind.

Spots on the underside of a leaf. The black spots are surrounded by a paler, oily halo.

Damage on the upper side of a leaf. The centre of the aged spots turns grey. They are surrounded by a yellow halo. It can be seen on both sides that the spots are bound by the veins, which gives them an angular appearance.

Necrosis at the base of the leaf and cankers on the petiole.

Cankers on branches with gummy flow (gummosis).

Apical necrosis. The apical buds are destroyed and cannot produce new shoots or inflorescences.

Developed necroses, and cankers on a branch that has lost most of its active leaves.

Cankers with flowing gum on an older branch than in Photo 4.

Craters in a branch. The gum containing bacteria flows from these wounds especially when the rains return.

Fruit damage

On the branches and the peduncles: the bacterium causes cracks, raised spots and cankers. Having penetrated the young stems, it survives inside these organs during the dry season. Gum containing bacteria exudes from cankers (gummosis), mainly in the rainy season. The cankers can weaken the scaffold branches and make them vulnerable to strong winds.

Mango bacterial disease

On the fruit: the small raised spots are black, often like teardrops. These spots tear into a star shape as they develop. Gum oozes out of these craters.

The disease is highly dangerous for several reasons that can vary according to climate areas.

- The damage caused to the branches and foliage (cankers that act as a way in for other diseases, falling leaves, etc.) weaken the tree and hinder the flowering and development of the fruit.
- It causes infested unripe fruit to fall.
- Cankers on fruit that is nearly ripe means harvest losses than can be more than 80% in the wet season.

10

Large spots superinfected by other diseases and pitting by flies, and small, raised spots in the shape of teardrops.

12

Principal necrosis and raised spots like teardrops

11

Wide spot with the centre opening into a star, in which the fruit flies have laid their eggs. Small spots form star-shaped wounds around the main spot.

How is bacterial disease distinguished from fungal diseases?

The spots on the leaves are angular, whereas those caused by anthracnose or cercosporiosis are more rounded. The slightly raised appearance of the symptoms caused by *Xanthomonas* can also distinguish them from fungal afflictions. But all these symptoms (angular, raised black spots with a halo, cankers on leaves and stems, raised spots on fruit, craters in fruit, etc.) come together for a visual diagnosis.

A visual diagnosis can be made by the local research institutes, but it is not 100% reliable, even for someone with a little experience. It is strongly recommended to carry out laboratory tests, at least to confirm new cases in a new country or a new province. Laboratory tests can take place in the Réunion laboratory referred to in the annex. Fast shipment (express courier, for example) is essential to ensure that the samples are of sufficiently high quality on arrival and the analyses can be performed correctly. Ideally, small quantities of dry, diseased leaves should be packed in closed paper envelopes. Unripe fruit can also be sent in dry newspaper. Avoid using plastic bags. This laboratory diagnosis usually involves molecular biology tests and inoculations on mango trees.

Contamination

In healthy areas – as previously in West Africa – the initial contamination is brought in by infested plant material. The same applies inside a country between regions that are far apart. Inoculum movement may be made by infected fruit, but the likelihood of diseased fruit (intended for consumption or processing) passing it on to a healthy tree is much lower than transmission via propagation material (or movements of young diseased plants). Human factors are therefore virtually always behind initial contaminations.

The disease is then disseminated in an area by the transport of infested plant material and by natural elements. The rains play a major role, but only disseminate the disease inside a tree or between neighbouring trees if the foliage is in contact. The bacteria survive mainly in the necroses and cankers of leaves, stems and fruit on the tree and are disseminated under the effect of the rain.

Harvesters often protect the mangos in crates by layers of leaves, normally mango leaves; this practice is a method of transmission and should be banned.

Dissemination is amplified when the rains are combined with strong winds (≥ 8 m/s) and the dissemination distances then depend on the wind speeds. It has been shown that a modest storm with average hourly winds of 10 to 15 m/s disseminated the pathogen over at least 250 m.

The risks are especially high at the beginning and end of the rainy season, when the storms feature gusts of wind. The effect of heavy rain combined with strong winds is twofold: (i) it causes tissue injuries that encourage the penetration of the bacterium and (ii) it has an aerosol effect that disseminates the bacteria a long way away. The damage increases as the rainy season advances.

In the islands of the Indian Ocean where the disease is present, cyclonic events often reactivate the disease, especially in the driest areas. In the following years, if there is no real cyclone, in these dry areas that receive about 500 mm rainfall, everything seems to return to normal and the trees regain their fine appearance. But the potential for recontamination is still there, although subdued, to take off again during the next favourable event for diseases.

Protecting mango trees and mangos from bacterial disease

Several factors must be taken into account:

- The pathogen is a bacterium, not a fungus, and the fungicides currently used in arboriculture have no effect.
- The bacteria survive in the cankers, which are a source of permanent contamination.
- A healthy area is basically contaminated by the transport of infested plant material and by natural elements (bacteria transported by the wind).

Preventive control

Preventive control should be encouraged.

- Avoid all transport of contaminated plant material from infested areas to healthy areas.
- Inside an infested area, never transfer infested seedlings or grafts to a healthy orchard.
- Eradicate the diseased trees when the disease is not widespread. At country scale, the decision should be taken by the National Plant Protection Services.
- Take account of this risk when installing new orchards and ‘aerate’ the existing orchards.
- Promote the installation of effective windbreak hedges and ban spray irrigation (prefer drip irrigation using micro-sprayers that wet the bottom tree sections). Ban all cultivation activity when the foliage is wet.

Curative control

- Ban all cultivation activity when the foliage is wet.
- Prune and burn all infested organs that represent sources of re-inoculation.
- Destroy the infested fruit on the ground.
- Two types of treatment are possible:
  - It is strongly recommended not to use antibiotics in agriculture as their dispersion in Nature leads to resistance to antibiotics used in human and veterinary medicine. They are also inactive in cankers as they do not penetrate the dead tissues.
  - Copper-based products (750 g active ingredient per hectare per treatment for the most effective formulations) are ultimately the only possible options against bacterial disease. These products are not systemic and act by contact. The trees and fruit must therefore be protected throughout at-risk periods. Copper is approved in organic cultivation, provided the annual limit is respected.
- Making control easier in orchards to be treated: limit the height of trees, make it easy for machinery to move through, limit the densities, etc.

Adoption of new crop management protocols

Varietal resistance

There are huge differences in sensitivity between varieties. Most of the Floridian varieties are sensitive. This is true of the main export varieties: Kent and Keitt (very sensitive).

On the other hand, less sensitive, late varieties may be evaluated for the national and sub-regional markets. The varieties Sensation and Heidi have shown good levels of partial resistance.

Staggering production

Staggering production means that the at-risk periods can be avoided (rainy season).

Note that many of these recommendations are in line with those proposed for the control of fruit flies, mainly B. invadens that proliferates during the same period as bacterial disease.

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Annex

Proposals: preliminary draft of national control strategies based on the extent of the disease

Stage 1: creation of national observatories for bacterial diseases caused by *Xanthomonas citri*

Objective:

- Determine whether or not the disease exists in the country; if so, to what extent is it dispersed in the national territory and what is its intensity in the various regions affected? (Ideally these surveys on bacterial diseases of mango trees and citrus trees should be carried out simultaneously).
- Map out the affected areas, by identifying the strains, so that the progress can be monitored and the origins of the strain identified.
- Monitor changes in these diseases over time.

The ideal solution would be to create a West African observatory for bacterial diseases or, failing that, to develop a network of observatories in as many countries as possible, to have an inventory as accurate as possible available.

Stage 2: prophylactic measures

Prophylactic measures aim to prevent the introduction of the disease and, if it is present, to prevent it from spreading further, or even better, to eradicate it before it can spread.

To achieve this:

- Supervise strictly all introductions of plant materials; raise the awareness of travellers and the players in the sectors in question.
- If the disease is just starting, eradicate the contaminated trees and those surrounding them. Burn the uprooted trees and their leaves.
- Monitor all the nurseries and destroy all seedlings in nurseries with at least one diseased seedling. Nurseries are the main source of dissemination of diseases.
- Ban the transport of plant material from contaminated areas to healthy areas. Only plant healthy seedlings, even in contaminated areas.

Stage 3: curative measures

The curative measures apply to the infested orchards, when the disease is already widespread and the socio-economic constraints do not allow it to be eradicated.

They aim to limit the damage caused by bacterial disease and limit its propagation.

- Organise the treatments with copper-based products.
- Lay out the orchards so that the ambience does not encourage the disease (aeration, windbreaks, limited densities, etc.).
- Encourage the effectiveness of treatments: Copper-based products have a contact effect. The entire tree, both inside and out, must be treated. The orchards must therefore be suitable for these treatments: room for machinery to pass through, limitation of the height of mango trees, etc.

Stage 4: by-pass methods

The so-called by-pass methods aim to live with the disease rather than fight it.

They include the following options:

- Staggering production, meaning that production takes place outside the at-risk periods (before the rainy season). This is possible either by advancing the flowering or by using early varieties.
- The selection of varieties which are resistant, tolerant or less-sensitive to bacterial diseases than the current varieties.

Research bodies have a major role to play in this breeding work.

Annex 2

References in West Africa and reference laboratory

Reference laboratory

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1 Mango bacterial disease

2 Tuta absoluta (Meyrick)

3 Papaya mealybug

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PIP is funded by the European Union

FOR SUSTAINABLE DEVELOPMENT OF THE ACP HORTICULTURAL INDUSTRY

Printed on FSC-certified paper with environmentally friendly solvent-free inks.
Publication date : February 2013