

Farm Biosecurity Manual for the Banana Industry

Reducing the risk of exotic and damaging pests
becoming established in crops

Version 1.0





Plant Health Australia (PHA) is the peak body for plant biosecurity in Australia. We work in partnership with industry, governments, researchers and others to provide national coordination to improve biosecurity policy and practice across Australia's plant industries and build capacity to respond to plant pest emergencies.
www.planthealthaustralia.com.au



Queensland Primary Industries and Fisheries, a part of the Department of Employment, Economic Development and Innovation is working to promote profitable primary industries for Queensland. This will be achieved by providing its expertise and support to assist the State's food and fibre industries to increase productivity, improve sustainability, grow markets and adapt to change.

Queensland Primary Industries and Fisheries is committed to delivering world-class research and development, providing leadership on industry policy, protecting industries against pests and diseases, maintaining animal welfare standards and managing fisheries sustainably.

www.dpi.qld.gov.au

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Six easy ways to protect your farm

2 You have an important role to play in protecting your farm and industry from biosecurity threats.

Here are six simple things you can do to reduce the risk of pests from entering and establishing on your farm.

1. Be aware of biosecurity threats

Make sure you and your farm workers are familiar with the most important banana pests.

2. Use clean planting material

Ensure all planting material and other farm inputs are pest free. Tissue culture plants are recommended.

3. Keep it clean

Take care to prevent the entry and movement of pests on your farm. Farm hygiene is a very effective preventative measure.

Ensure that workers, visitors, vehicles and equipment are decontaminated before they enter and leave your farm.

4. Check your crop

Checking your crops frequently for pests will help you and your staff to notice anything new or unusual.

5. Report anything unusual

If you suspect a new pest – **report it immediately.**

6. Abide by the law

Be aware of legislative regulations established to protect the banana industry from biosecurity threats.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881

EXOTIC PLANT PEST HOTLINE
1800 084 881



Overview

4 What is biosecurity?

Biosecurity is about the protection of livelihoods and lifestyles that could be harmed by pest incursions. Biosecurity is a national priority and makes good business sense.

Biosecurity ensures that our plant health status is maintained to retain existing trade opportunities and to negotiate access to new markets.

Australia's geographic isolation has meant that we have been relatively free of many pests that have impacted on plant industries overseas. Freedom from these pests is vital for ensuring the future profitability and sustainability of Australia's plant industries. By having freedom from these pests Australia receives a real trade benefit in terms of securing market access domestically and internationally.

The definition of a **pest** used in this manual covers all insects, mites, snails, pathogens (diseases) and weeds that are injurious to plants or plant products

What is farm biosecurity?

Farm biosecurity is a set of measures designed to protect a property from the entry and spread of pests. Biosecurity is the responsibility of you and every person visiting or working on your farm.

This manual is designed to assist you in protecting your banana farm and your industry from invasive pests using simple, yet effective **preventative strategies**.

Employing these techniques in your day-to-day operations could **minimise costs** and **protect your farm** and your livelihood for the long-term.

Farm biosecurity and the Australian banana industry

In Australia, bananas are grown in Queensland, New South Wales, Western Australia and the Northern Territory. The fruit is mainly consumed as fresh product, with Cavendish bananas accounting for about 95% of the market. The remaining 5% is made up of Lady Finger bananas and other cultivars such as Goldfinger, Ducasse, Red Dacca, Sucrier and Pacific Plantain.

The Australian banana industry is at risk from many invasive pests which are present in overseas countries. Freedom from these pests ensures that Australia's banana growers benefit from lower production costs, especially when it comes to the management of pests, and production of a superior quality product.

Prevention is the most cost-effective strategy to protect banana farms and the banana industry from biosecurity threats. Growers can play a vital role by familiarising themselves with key pests of bananas – see the pest fact sheets included in this manual.

Improved awareness and farm biosecurity will increase the chance of early detection of banana pests if they are introduced into Australia. Early detection and response can reduce the impact to your farm and the whole industry, and increase the likelihood of successful eradication.

More information on how to secure your farm and secure your future can be found online at www.farmbiosecurity.com.au, a joint initiative of Animal Health Australia and Plant Health Australia.

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farmbiosecurity 

Pests

The following are high priority pest threats for the Australian banana industry. They have been identified within the *Industry Biosecurity Plan for the Banana Industry* by a group of growers, researchers and field experts. These pests would have serious consequences if they were to become established in Australia. However, these are not the only pests that pose a threat to the banana industry.

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High priority exotic pest threats to the banana industry

Banana bract mosaic disease

ECONOMIC IMPACT – HIGH

- virus: *Banana bract mosaic virus (Potyvirus)*
- found in India, the Philippines and Sri Lanka
- dark red-brown pattern on flower bracts
- green or red streaks on leaf midribs
- severe infection leads to fruit rejection
- can be symptomless
- spread by aphids



John Thomas

Banana freckle – Cavendish strain

ECONOMIC IMPACT – HIGH

- fungus: *Guignardia musae*
- found in South East Asia
- infects leaves and fruit
- numerous minute dark spots
- severe infection causes leaf yellowing
- can lead to wilting and death of the plant
- spread by spores on wet surfaces



Jeff Daniels

Black Sigatoka

ECONOMIC IMPACT – HIGH

- fungus: *Mycosphaerella fijiensis*
- widespread worldwide
- similar to yellow Sigatoka
- narrow streaks, brown lesions
- heavily infected leaves die
- favours hot, wet, windy conditions
- spread by spores on infected plant parts, soil, wind or water



Jeff Daniels

Blood disease

ECONOMIC IMPACT – HIGH

- bacterium: blood disease bacterium
- similar to Moko disease
- found in Indonesia
- affects all plant parts
- internal discolouration
- black, shrivelled flower buds
- wilting of leaves
- spread in infected plant parts, soil, water and by insects



Jeff Daniels

Banana skipper butterfly

ECONOMIC IMPACT – HIGH

- butterfly: *Erionota thrax*
- also known as banana leafroller
- found in South East Asia, Papua New Guinea and Pacific
- brown butterfly with three yellow-white areas on wings
- eggs on lower leaf surfaces
- larvae covered by white powder
- caterpillars eat leaves and cause rolling
- affects bunch size



Jeff Daniels

Eumusae leaf spot

ECONOMIC IMPACT – HIGH

- fungus: *Mycosphaerella eumusae*
- found in South East Asia, India and Africa
- symptoms similar to yellow and black Sigatoka
- streaks and dark spotting on leaves
- favours hot, wet and humid conditions
- spread by spores on infected plant parts, soil, wind or water
- laboratory testing for diagnosis essential



Juliane Henderson

Moko

ECONOMIC IMPACT – MEDIUM-HIGH

- bacterium: *Ralstonia solanacearum* race 2
- found in Central and South America, Jamaica and the Philippines
- similar to blood disease
- internal discolouration of fruit
- yellowing, wilting of leaves
- black, shrivelled flower buds
- spread in infected plant parts, soil, water and by insects



PaDIL

Banana spider mite

ECONOMIC IMPACT – MEDIUM

- mite: *Tetranychus piercei*
- attacks tropical fruit crops overseas
- closely related to two-spotted spider mite
- nymphs and adults spin webs
- yellow spots on leaves
- all parts of plant affected
- fruit ripening delayed, yield reduced



Jeff Daniels

Banana *Xanthomonas* wilt

ECONOMIC IMPACT – UNKNOWN

- bacterium: *Xanthomonas vasicola* pv. *musacearum*
- found in Central Africa
- yellowish ooze from cut tissue
- pink discolouration of internal tissue
- wilting of leaves
- can kill whole plants within a month
- spread in infected plant parts, soil, water and by insects



Anthony Young

Pest threats under active control in Australia

Panama disease (*Fusarium* wilt, tropical race 4)

ECONOMIC IMPACT – EXTREME

- fungus: *Fusarium oxysporum* f. sp. *cubense* (tropical race 4)
- attacks Cavendish in tropical regions
- marginal yellowing of leaves
- leaves turn brown, dry and collapse
- skirt of dead leaves around plant
- discolouration of cut stem and corm
- spread in plant parts, suckers, soil or water
- persists in soil for many years



Jeff Daniells

Bunchy top disease

ECONOMIC IMPACT – HIGH

- virus: *Banana bunchy top virus* (*Babuvirus*)
- found in southern Queensland, New South Wales, West Papua and widespread in South East Asia
- dark green dot-dash flecks along leaf veins
- emerging leaves become bunched
- plants stunted
- spread in infected plant parts and by aphids



Tony Heidrich

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More information on these pests is contained in the fact sheets in this manual. The fact sheets were completed with expert comment from the following individuals:

- Anthony Young (Primary Industries and Fisheries, Indooroopilly)
- Chris Hayward (private consultant, formerly of University of Queensland, St Lucia)
- Don Wilkers (University A&M, Texas)
- Jeff Daniells (Primary Industries and Fisheries, South Johnstone)
- John Thomas (Primary Industries and Fisheries, Indooroopilly)
- Juliane Henderson (Tree Pathology Centre, Indooroopilly)
- Kathy Grice (Primary Industries and Fisheries, Mareeba)
- Ken Walker (Museum Victoria)
- Natalie Moore (NSW Department of Primary Industries, Grafton)
- Suzy Perry (Biosecurity Queensland, Primary Industries and Fisheries, Brisbane)
- Tony Heidrich (Australian Banana Growers' Council)
- Wayne O'Neill (Primary Industries and Fisheries, Indooroopilly)

Crop monitoring

Crop monitoring or surveillance involves looking for, recording and managing plant pests. Conducting regular surveys of your crop gives you the best chance of identifying a new pest before it becomes established. This can be incorporated into existing Integrated Pest Management (IPM) work or as part of routine crop management activities.

Active crop monitoring is necessary because:

- Depending on the type of pest and seasonal conditions, many pests can quickly build up to high levels. For general management of established pests, regular inspections should be undertaken to determine their presence and levels. IPM should be a fundamental part of your farm management practices.
- On-farm surveillance helps build knowledge of the presence or absence of a particular pest in Australia.

- Early detection of exotic pests improves the chance of eradication or containment within a region. If eradication or containment is not feasible early detection, in conjunction with contingency planning and preparedness (e.g. emergency chemical registrations, selection or breeding and pre-emptive management), assists with more rapid and effective response to new pests.

Report suspect pests

Any unusual plant pest should be reported immediately via the Exotic Plant Pest Hotline on 1800 084 881. Early detection and reporting of unusual pests enhances the chance of implementing effective pest control measures and/or mounting an effective eradication program, and will also prevent or minimise the long-term damage to the individual grower and the banana industry.

Calls to the Exotic Plant Pest Hotline will be forwarded to an experienced person in the department of primary industries from the state of origin of the call, who will ask some questions about what you have seen and may arrange to collect a sample.

In some states, this number operates only during business hours. Outside these hours, leave your contact details and a brief description of the issue and your call will be followed up as soon as possible. Every report will be taken seriously, checked out and treated confidentially.

If you suspect you have found an exotic plant pest, the following general precautions should be taken:

- **Do not allow movement** of people and equipment near the affected area as this can spread pests very rapidly through regions and communities.
- **Wash hands and clothes** that have been in contact with affected plant material or soil.
- **Do not touch, move or transport** affected plant material. Contact your state department of primary industries and they will assist with the correct protocols for sampling, handling and transport of samples. Incorrect handling could further spread the pest or render the samples unfit for diagnosis.



If you find anything unusual on your farm call the Exotic Plant Pest Hotline 1800 084 881

The Emergency Plant Pest Response Deed (EPPRD) and the Banana Industry

The EPPRD is a formal legally binding document between Plant Health Australia, Australian and state/territory governments and plant industry signatories. As a signatory to the EPPRD, the Australian Banana Growers' Council (ABGC) has a seat at the decision making table and also contributes to funding if an approved Response Plan is implemented to eradicate a pest incursion.

Under the EPPRD, ABGC members have a responsibility to report suspect pests. The earlier a new pest is detected, the greater the chance an eradication response will be mounted and the greater the chance it will be successful.

Within an approved Response Plan, grower reimbursement payments for direct costs they incur as a result of eradication of a pest incursion are included.

Product movement

10 Planting and propagation material

Obtain clean planting and propagation material from reputable sources to reduce the risk of introducing new pests and diseases.

You cannot accurately assess planting material quality just by looking at it. Plants may appear clean and healthy but could contain pests. Many pests can be spread by infected planting material (e.g. Panama disease, bacterial wilts and skipper).

Ask questions about where the plants or propagation material originally came from and always try to purchase certified or quality assured planting material. Make sure you adhere to banana movement regulations in your state or territory.

Using clean or certified planting and propagation material reduces the incidence of pests and provides a useful safeguard for growers. Use of tissue culture plants from a Quality Banana Approved Nursery (QBAN) is ideal (see opposite).

To minimise the risk:

- Use planting material that is free of pests and regularly check crops, especially new plantings, for signs of the presence of pests.
- Seek out pest free stock as this will help ensure that your planting material is clean.
- Maintain a register of your farm's propagation material. Information recorded should include the source of planting material and contact details, certification type, banana cultivar, number of plants obtained, and the areas where the material was planted (block number, date, etc.).

Never use poor quality or diseased planting material, as it has the potential to infect your entire farm and threaten your livelihood.

Tissue culture

Almost a quarter of the total production of banana plants in Australia is propagated through tissue culture. Tissue culture is a process whereby plants are produced under sterile conditions and grown in pots before planting. This is the safest way to obtain new planting material for your farm. The next best option is to produce nursery material on-farm for the production of suckers and bits so that you are not introducing plants from outside your farm.

The Quality Banana Approved Nursery (QBAN) scheme

This national banana industry supported scheme was established in 1994 and aims to reduce the risk of pest spread by providing access to clean planting material.

Freedom from targeted pests is assured through propagation of tissue cultured plants from individually virus indexed banana suckers. Businesses approved under QBAN must meet audited quality standards for tissue culture and nursery production. QBAN businesses monitor and record all components of the banana propagation process, from selection of initial mother planting material, including propagation after viral indexing and assignment of the tissue culture clone registration number, to processes for growth and propagation that minimise contamination.

The QBAN scheme aims to ensure that banana plants produced from these accredited laboratories and nurseries live up to their claim: traceable clean planting material that is free of targeted pests.

Fruit and fruit by-products

Maintaining good farm hygiene when dealing with fruit and fruit by-products can minimise cross-contamination and breeding environments for pests.

To ensure good hygiene:

- Maintain an effective monitoring/pest management program (a 'spray diary' record should be kept for each block).
- Collect and dispose of fallen or waste fruit and stalks away from bananas and irrigation water sources.
- Use disposable banana bags or thoroughly clean bags of all soil and plant debris, and store in a clean, dry place when not in use.
- Load fruit onto trucks on a concrete or bitumen pad outside the production areas.
- Ensure that no soil, plant material or insects are left adhering to, or in, the container where fruit has been packed in the field.

Biosecurity and quality assurance

If your farm uses any of the quality assurance schemes, such as Freshcare or the Woolworths Quality Assurance Scheme, it is likely that you are also applying fundamental techniques of farm biosecurity best practice. This includes practices relating to product identification for traceability and recall, as well as IPM and surveillance.

Membership to these quality assurance schemes improves access to domestic and international markets and provides an assurance to customers that fresh produce is safe to eat and has been prepared to meet customer specifications. It also provides the foundation for good farm hygiene practices and on-farm biosecurity best practice.

People movement

12 Farm signage

Well designed signage informs visitors that biosecurity on your farm is a high priority. The signs should request visitors to respect your biosecurity arrangements without making them feel unwelcome.

Signs also demonstrate your commitment to cleanliness and safety and alert people to the potential impacts of their visit.

A farm biosecurity sign at the house or near the sheds will ensure visitors contact you before entering any production areas or packing sheds where there is a greater risk of spreading pests.

The sign should include the home telephone number, mobile number and two-way channel so visitors can contact you if nobody is home.



Biosecurity signage can be placed at the main gate, external entrances, visitor parking areas and wash-down facilities.

Contact Plant Health Australia for further information on obtaining biosecurity signs for your property.

Managing people movement

People moving between farms and regions can spread pests on boots and clothing. The most obvious risk is from mud, soil and plant material containing pests or weed seeds.

The following measures will reduce the risk of introduction of new pests by movement of people:

- Let family members, employees and visitors know their footwear and clothing should be free of soil and plant material before entering or leaving the farm.
- Ensure that your staff are well informed of, and involved in, your biosecurity measures.
- Brief all employees, itinerant workers, contractors and visitors on your farm hygiene measures.
- Undertake biosecurity training for farm personnel, and devise a simple induction based on the information contained in this manual.



- Provide rubber boots and protective clothing such as disposable overalls and boot covers where appropriate. Provide scrubbing brushes and footbaths, as an extra precaution, for people entering or leaving your farm, or moving from contaminated to clean areas of the farm.
- Keep a record of people that come on to your farm by getting them to sign a Visitor Register. If a new pest has been introduced, this information will be invaluable in helping work out where the pest may have come from or spread to.



Natalie Moore

Overseas travellers

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People returning from overseas can pose a high risk, especially if they visited a plantation, farm or market where plant material was sold.

Check that family members, employees, itinerant workers and visitors recently returned from overseas have washed their clothes, cleaned their footwear and have not brought in any plant material.

Clothes, footwear, hair and even watchbands can carry fungal spores or bacteria, and weed seeds can easily lodge in clothes and pant cuffs. Great care should be taken to prevent the accidental introduction of overseas plant pests into Australia. Be aware that plant pests are only a few hours away by air travel.

Itinerant workers

Itinerant workers (overseas workers, backpackers and retirees) are often employed to assist with fruit picking, packing, deleafing, desuckering and other farm tasks. While the contribution of this workforce is significant, they can contribute to increased biosecurity risk. Working from farm to farm, itinerant workers can unknowingly carry and spread pests on their clothing, footwear and tools.



Equipment and vehicles

14 Movement of vehicles and machinery

Vehicles and farm equipment such as sprayers, tractors, bagging machines and hand tools can carry pests attached to soil and plant material (especially in wet conditions). Pests could then be transported to other parts of the farm, or to other properties. While it is impractical to stop all traffic movement on and off the farm, washing down machinery, or denying access of dirty machinery, can reduce the spread of pests.

Contractors and service providers such as delivery trucks and earth moving equipment can, and should, be requested to clean their vehicles and equipment before entering your farm.

Measures to consider:

- Keep farm vehicles clean by clearing the vehicle floor of soil, weed seeds and insects, especially after visiting other properties.
- Where possible, use your own vehicle to carry visitors around your farm.
- In farm production areas, keep vehicle movement to a minimum, especially on wet soil. Stick to regular pathways through each block to minimise the risk of spreading pests.
- Hose off and disinfect machinery in a designated wash-down area before moving between properties.
- Use high pressure water or air to remove plant material and soil from larger equipment and machinery.

Ensure that waste water and debris don't enter production or storage areas.

- Always make sure that borrowed and second-hand equipment and machinery is cleaned of all plant material and soil before moving them onto your farm.
- Regularly clean all tools and equipment, including deleafing blades, cane knives, bell injection equipment, and desuckering bars, preferably with a disinfectant solution and as often as possible from row to row or block to block.

Inspecting and cleaning machinery is more time and cost effective than managing a new pest introduced on to your farm.

Designated parking areas

A well sign-posted, designated parking area provides visitors with clear directions where to park.

A parking area allows the farm manager to contain the possible entry of new pests to an area away from bananas and farm facilities. It also allows inspection of tyres, equipment, floor mats and boots for soil and plant material which may carry unwanted pests.

A sign, situated in the parking area, will remind visitors of the risk of spreading pests between properties and acts as a prompt for them to consider their movements.

Do not allow the movement of farm machinery through the parking area.



Wash-down facilities

A wash-down facility allows farm employees and contractors to clean their vehicle and equipment and allows you to contain any potential pest introductions in one easily managed area.

Providing a high-pressure wash-down facility and cleaning equipment will assist you and your visitors to clean down vehicles and equipment. For additional protection you can add a detergent-based degreaser or disinfectant (for example, Septone Truckwash®, Castrol Farmcleanse® or Virkon®) to disinfect the equipment. Seek advice from your local department of primary industries or chemical reseller on the use of disinfectants and availability of other cleaning products for your farm. For best results, remove as much soil and plant material as possible from the equipment before using cleaning products.

The wash-down area should have a sump or water collection area. The sump and area surrounding the wash-down facility should be checked regularly for the presence of new pests or weeds. Any new pests should be managed as soon as possible.

Wash-down areas should:

- Be readily accessible and located between the driveway and farm roads.
- Be well away from crops.
- Have access to power and water.
- Have a sealed (concrete or bitumen) or packed gravel surface.
- Not drain into a waterway or crop.
- Have a sump or collection area for easy inspection.

The wash-down area may be the same as that used for chemical wash-down of vehicles and equipment. If so, all occupational health and safety issues associated with chemical wash-down areas must be taken into account.

Farm biosecurity checklist

Farm name:

Date of biosecurity check:

RECOMMENDED PRACTICES	YES	NO	Comments
Pests			
Crops regularly inspected for pests			
Farm staff know how/where to report pests			
Are you familiar with the high priority pest threats for the banana industry?			
Active crop monitoring is regularly conducted			
Survey activities are recorded, even when nothing is found			
Product movement			
Planting material is free from pests and crops regularly checked for pests			
Certified planting or propagation material comes from a reputable supplier			
Mother plants used for selecting suckers or bits for propagation inspected to ensure they are healthy and pest-free			
Register of planting material and its source maintained			
Can you identify the symptoms of banana pests that can spread in banana planting material?			
An effective monitoring/pest management program maintained			
No soil, leaf-material or insects are left adhering to, or are left in, the container where fruit has been packed in the field			
Fruit loaded onto trucks on a concrete or bitumen pad outside the production area			

RECOMMENDED PRACTICES	YES	NO	Comments
People movement			
Biosecurity signs at main entrances with contact details of house phone, mobile and UHF channel			
All visitors sign a Visitor Register book on arrival to track on-farm movements			
All visitors clothing, footwear and tools are free of loose soil and plant matter before entering or leaving the farm			
All people recently returned from overseas have clean footwear and clothes before entering the farm			
Footbaths and scrubbing brushes provided for people entering and leaving, or moving from contaminated to clean areas of the farm			
Farm vehicles used to transport visitors around the farm			
Farm staff are aware of biosecurity procedures in place on the farm			
Equipment and vehicles			
Designated parking area for visiting vehicles and contractor equipment			
Cleaning and wash-down facilities, preferably concrete, provided for people, machinery and equipment			
Sump installed in wash-down facility to catch unwanted pests, weeds and stop excess run-off			
Farm vehicles kept clean by regularly clearing the vehicle floor of soil, weed seeds and insects			
Vehicle movement kept to a minimum in production areas of the farm			
Vehicle movement limited to regular pathways through each block			
High pressure water or air used to remove plant material and soil from equipment and machinery			
Borrowed and second-hand machinery and equipment is cleaned of all plant material and soil before use			
Tools and equipment are cleaned regularly, particularly between blocks, preferably with a disinfectant solution			
Machinery cleaned down before being moved off the property			

Further Information

Quarantine regulations for bananas

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There are restrictions on the growth and movement of banana plants and propagation material within Australia, which are intended to protect commercial banana farms from pests and refer to both *Musa* and *Ensete* species.

Queensland

The movement, planting and cultivation of banana plants is prohibited without an Inspector's Approval. Applications to move and to plant bananas must include the source of material so that checks can be made in the event of a pest incursion.

www.dpi.qld.gov.au/cps/rde/dpi/

New South Wales

Before planting or moving banana planting material into and within the state, growers must obtain a permit. Restrictions on the movement of banana plants and planting material are applied through the *Plant Diseases Act 1924*.

www.dpi.nsw.gov.au/agriculture/

Western Australia

Normal restrictions apply to the movement of plant material from other parts of Australia. It is recommended that planting materials should only be purchased if they have been grown and prepared with the aim of minimising the risk of spread of pests to the area. Soil and banana plants (except fruit) may not be moved from within 50km of the Carnarvon or Kununurra Post Offices unless in accordance with approved conditions.

www.agric.wa.gov.au/content/pw/q/

Northern Territory

A permit is required before importing banana planting material into the Northern Territory and can only come from an accredited tissue culture facility. Movement restrictions on some planting material is in place within the Northern Territory to prevent the spread of pests and a prohibition exists on replanting susceptible varieties into areas affected by Panama disease.

www.nt.gov.au/d/Primary_Industry/

A banana grower's guide to Queensland's plant health legislation

Queensland's plant health legislation provides a framework to protect growers from the impact of serious plant pests and diseases. As well as helping to maintain sustainable production, the legislation also plays an important role in facilitating trade of Queensland produce with interstate and international markets by demonstrating a clean, safe plant health status and freedom from plant pests and diseases of concern. Much of the legislation was developed in consultation with the banana industry and is aimed specifically at protecting the banana industry from unwanted pests and diseases.

The legislative powers to protect plants in Queensland are provided for under the Plant Protection Act 1989 and the Plant Protection Regulation 2002. The banana quarantine regulation lists pests affecting banana, to which legislative provisions apply, and defines six pest quarantine areas within Queensland.

The purpose of quarantine for these pest quarantine areas is to:

- prevent the introduction of banana pests into Queensland
- prevent the spread of banana pests in Queensland and
- prevent, control or remove pest infestations of banana plants in the pest quarantine area.

By law, the movement, planting and cultivation of banana plants is prohibited without an Inspector's Approval. To prevent banana pests and diseases being spread throughout production areas, landowners are also required to treat pest infestations or diseased banana plants. The movement of soil, appliances and other things that have been in contact with infested or diseased banana plants is also prohibited without approval.

The regulation was developed following extensive industry and community consultation and is in place to protect the Queensland banana industry from pests and diseases, such as bunchy top and Panama, which are considered to be major threats to the industry unless they are controlled.

Banana farm biosecurity: what is Biosecurity Queensland doing for you?

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Biosecurity Queensland is a business group within the Department of Employment, Economic Development and Innovation whose purpose is to help protect Queensland's primary industries and environment from exotic pests.

Biosecurity Queensland works to protect the banana industry through ongoing prevention, surveillance, control and containment programs, and emergency response capability.

This plant biosecurity system helps safeguard banana production and maintain market access for Queensland banana growers by:

- Enhancing biosecurity risk analysis, scientific support, prevention, surveillance, diagnostics and response systems.
- Early warning surveillance for exotic pests such as banana skipper and black Sigatoka.
- Implementing control and containment strategies for endemic pests such as banana bunchy top virus and Panama disease.
- Issuing Inspector's Approvals for movement, planting and cultivation of banana plants, to limit the spread of pests in banana growing regions.
- Implementing quality assurance systems, such as Interstate Certification Assurance, to ensure compliance with market access requirements for product traceability and certification.
- Leading responses to contain or eradicate incursions of emergency plant pests.
- Working with industry to enhance biosecurity education and awareness and contributing to industry biosecurity planning.



21

Visitor register

Please enter your details to assist us with our farm biosecurity records

Date	Name	Reason for visit	Vehicle registration or mobile phone	Time arrived	Details of last contact with fruit or plants

If you see anything unusual on your farm call the Exotic Plant Pest Hotline on 1800 084 881.

EXOTIC PLANT PEST HOTLINE
1800 084 881

Pest record/surveillance data sheet

Property Name:
GPS (optional):

Date	Name of person inspecting	Location description (e.g. row number, farm block)	Pest/symptom observed (or being looked for)	Estimated pest level (e.g. high/medium/low/nil or number/% plants affected)	Action taken (e.g. sample sent for diagnosis, pest treatments)

If you see anything unusual on your farm call the Exotic Plant pest Hotline on 1800 084 881



Banana bract mosaic disease

What is banana bract mosaic disease?

Banana bract mosaic (BBrMV), also known as Kokkan, was first detected in the Philippines in 1979 and has subsequently been detected in India and Sri Lanka. This pathogen spreads very quickly and causes significant economic losses and can infect all varieties of banana.

BBrMV causes reduced bunch weights with fruit rejection in severe cases. In addition, a significant proportion of fruit are made unmarketable by the production of malformed bunches and underdeveloped fingers.

As the most distinctive symptom of this pest is the dark reddish-brown mosaic pattern seen on the flower bracts, it can be difficult to see in non-bunching field plants. Leaf and stem symptoms may be present and the virus has also been detected in symptomless plants.

What do the symptoms look like?

- Dark red-brown mosaic pattern on flower bracts.
- Green or red streaks or spindle-shaped lesions on leaf petioles and midribs of new leaves.
- Reddish-brown spindle-like streaks can also be seen on the stem when the dead outer leaves are removed.
- Chlorotic streaks may appear on bunch stems and fingers.
- Severe infection leads to fruit rejection.





Dark red-brown mosaic pattern on flower bracts

John Thomas

How is it spread?

BBrMV is transmitted non-persistently by at least three species of aphid, which acquire the virus during feeding on infected plants. The pest can also be transferred through planting material (e.g. using infected plants as a source of new planting material or for tissue culture). Rigorous testing of planting material is essential as BBrMV can be detected in symptomless plants.

There have been no reports of transmission of BBrMV on cutting tools or other equipment, and it is not known to be soil-borne.

Where is it now?

BBrMV has been recorded in the Philippines, India and Sri Lanka. There are additional records of BBrMV from Western Samoa and Vietnam, but these were from plants displaying atypical symptoms and its presence in these countries requires further investigation.

How can I protect my farm from banana bract mosaic virus?

Only use pest-free, tissue culture planting material.

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.



Reddish-brown spindle-like streaks can be seen on the stem when the dead outer leaves are removed

John Thomas

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Banana freckle (Cavendish strain)

What is banana freckle?

Banana freckle is a disease of banana leaves and fruit. It is caused by the fungus *Guignardia musae*. A strain of this fungus that infects Lady Finger and Bluggoe bananas occurs in Australia, but the strain that infects Cavendish bananas (Cavendish strain) does not currently occur on mainland Australia.



Sharon Van Brunschot

Typical freckle symptoms on Lady Finger banana leaf



Kathy Girice

Spread of freckle on a leaf, roughly concentrated on leaf veins

What do the symptoms look like?

The most characteristic symptom of freckle is a sandpaper feel to infected (spotted) leaves and fruit. This is caused by the fungal spore structures protruding through the surface of the leaf tissue or fruit peel.



Kathy Grice

Freckle spots concentrated on leaf veins



Jeff Daniells

Freckle on dwarf Cavendish



Juliane Henderson

Freckle on Pisang Abu Nipah bunch in Malaysia

What can it be confused with?

Banana freckle of Lady Finger and Bluggoe, which already occur in Australia.

How do I distinguish Cavendish strain of banana freckle from the banana freckle already present in Australia?

The strain of banana freckle already present in Australia does not infect Cavendish bananas. If you see any freckle like symptoms on Cavendish bananas report it immediately.

How is it spread?

The pest is spread by the movement of fungal spores on wet leaf surfaces. It can also be spread by contaminated fruit shipments.

Where is it now?

Cavendish strain of banana freckle has been reported from the Philippines and Taiwan. There are unconfirmed reports from India, Borneo and Java.

Freckle disease has been reported on Cavendish bananas in the Ord River production area of Western Australia but it has not been seen there for many years.

How can I protect my farm from banana freckle?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Black Sigatoka

What is black Sigatoka?

Black Sigatoka (sometimes referred to as black leaf streak) is caused by the fungus *Mycosphaerella fijiensis* and is one of the most devastating leaf diseases of banana around the world. Severely infected leaves die, significantly reducing fruit yield and causing mixed and premature ripening of bunches.

Leaf symptoms of black Sigatoka are very similar to those produced by yellow Sigatoka (present in Australia) and Eumusae leaf spot (not present in Australia).



Advanced stage of black Sigatoka on banana leaf



Black Sigatoka-infected banana plant

What do the symptoms look like?

Black Sigatoka leaf spots begin as minute (1mm) reddish-brown flecks on the lower leaf surface that gradually increase in size to form dark linear streaks (4–12mm) parallel to the leaf veins that are visible on both leaf surfaces. As the streaks mature they expand, becoming oval spots often with a distinctive yellow halo. As the lesions mature further they become sunken and the centre turns grey. In susceptible cultivars, high levels of disease can cause large areas of the leaf surface to die.

What should I look for?

- Narrow streaks parallel to the leaf veins.
- Early lesions that are reddish-rusty brown and most easily seen on the underside of leaves.
- Developing lesions becoming dark brown to black, with lesion centres eventually turning grey and becoming sunken.
- Heavy infection levels causing large areas of leaf to die, eventually leading to total leaf collapse.
- Leaf death reducing fruit yield and causing uneven ripening.

What can it be confused with?

Yellow Sigatoka (caused by *M. musicola*) or Eumusae leaf spot (caused by *M. eumusae*).

How do I distinguish black from yellow Sigatoka?

In black Sigatoka, early leaf streaks are reddish to rusty-brown, longer and broader than yellow Sigatoka and most evident on the lower leaf surface. In comparison, early streaks of yellow Sigatoka are yellow-green, narrower and shorter, and more prominent on the upper leaf surface. Both pathogens can be present on the one plant.

Laboratory testing is required to reliably distinguish these pests.

How is it spread?

Infection is favoured by hot, wet and windy weather. The pest can be spread by the movement of infected plant material, or by fungal spores produced on leaf lesions and within dead leaf material on the plant or in the trash. Black Sigatoka spores can be dispersed by wind or by water splash.

The unfurling and youngest fully expanded leaves on large plants and suckers are the most susceptible and as the leaves mature they become resistant to infection. The pest can also be spread by contaminated fruit shipments.

Where is it now?

Black Sigatoka is present in all major banana exporting countries, including in South East Asia, India, China, the Pacific islands, East and West Africa, Hawaii, Grenada, Trinidad, Central and South America. It also occurs in Papua New Guinea and on several islands in Torres Strait.

There have been several outbreaks of black Sigatoka on the Cape York Peninsula during the 1980s and 90s. The only outbreak in an Australian commercial production area occurred in Tully, North Queensland in 2001 – the successful eradication of the disease was a world first. Reinstatement of mainland Australia's pest-free status for black Sigatoka occurred in 2005.

How can I protect my farm from black Sigatoka?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Blood disease

What is blood disease?

Blood disease is a serious bacterial wilt pest of banana caused by the blood disease bacterium (BDB). BDB is closely related to, but distinct from, the bacterium that causes Moko and bugtok, and produces very similar symptoms.

Blood disease results in reduced numbers of marketable bunches and causes significant wilting, generally reducing the vigour of the tree and killing whole plants in severe cases.

What do the symptoms look like?

Initial symptoms of blood disease are yellowing and wilting of leaves, which die and can form a skirt of dead leaves around the plant stem. Younger leaves may turn yellow before dying. Eventually the whole plant takes on a wilted appearance.

Fruit can ripen prematurely or split and sometimes fruit may appear unaffected but is internally discoloured reddish-brown and is often dry or rotted. Stem internal tissue may be reddish-brown and this discolouration can extend from the corm up to the fruit branches.

Blackened or shrivelled flower buds and peduncles are also common. Cut stems or peduncles exude bacterial ooze that may vary in colour from milky to yellow to reddish-brown to black.

Symptoms change depending on the type of banana and the age of the plants.



Jeff Daniells

Blood disease symptoms on banana in Sulawesi



Jeff Daniells

Skirts of dead leaves can form around the bottom of infected plants



Jeff Daniells

Discolouration of vascular tissues can occur throughout the plant, including bunch stems

What can it be confused with?

Moko (caused by *Ralstonia solanacearum* race 2) and Panama disease (caused by *Fusarium oxysporum* f. sp. *cubense*) also cause general wilting of banana plants. Moko and bugtok (also caused by *R. solanacearum* race 2) can also cause internal fruit discolouration.

What distinguishes blood disease from Panama, bugtok or Moko?

Panama disease does not cause internal fruit discolouration or produce bacterial ooze. Bugtok causes internal fruit discolouration but does not cause wilting of the whole plant.

Laboratory testing is required to distinguish between Moko and blood disease.

How is it spread?

BDB persists all year round and can be spread by infected plant parts, by insects and in soil or water. Insect transmission can occur from infected male buds to distant flowers. BDB can survive for one year in soil contaminated with infected plant residue. Root to root infection is also possible.

Where is it now?

Blood disease occurs in Indonesia. It is of particular concern due to its presence in West Papua, with its close proximity to Australia's northern banana production zones.

How can I protect my farm from blood disease?

Only use pest-free planting material.

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

Bacterial oozing from any banana plant or heliconias should be reported immediately.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

EXOTIC PLANT PEST HOTLINE
1800 084 881

Banana skipper butterfly

What is banana skipper?

Banana skipper (*Erionota thrax*) butterfly is from South East Asia, where the caterpillars (larvae) cause the major damage to infested plants. This pest is also known as the banana leaf roller. After hatching, the caterpillars move towards the outer edge of the leaf where they feed and roll the leaf to make a shelter. Within the roll the larva secretes a protective, white, waxy covering. The feeding and rolling destroys the leaves, significantly reducing the plant's leaf area and leading to reduced fruit production, as well as preventing the use of the leaves for traditional purposes.

Banana skipper was particularly devastating to banana crops in Papua New Guinea in the 1980s. However, the release of a biological control agent (larval parasitoid) in 1990 has significantly reduced the effects of this pest.

The close proximity of this pest to northern Australia makes it a real concern for the Australian banana industry.

What do the symptoms look like?

Rolled up leaf sections are the most distinctive symptom of banana skipper. Leaf rolls can extend to 15cm in length. Caterpillars also consume the leaves and can quickly cause significant amounts of defoliation.





Jeff Daniells

Leaf damage as a result of banana skipper butterfly infestation



Jeff Daniells

Rolled banana leaves are key indicators of the presence of banana skipper butterfly



Jeff Daniells

The caterpillars curl themselves up in the leaf pieces as they feed and exude a fine, white powdery material. Leaf rolls must be uncurled to see the larvae



Ken Walker

Adult butterflies are brown with large red eyes. They have a wingspan of around 7cm

What does banana skipper look like?

The adult female lays small yellow eggs in batches of 12–25 on lower leaf sides, from which the caterpillars emerge. Caterpillars roll up banana leaf sections and eat the leaves as they grow. They also exude a fine white powdery material over their body. Adult butterflies are brown with three yellow-white areas at the front of their wings. They have a wingspan of around 7cm.

What should I look for?

Look for the presence of rolled-up sections of leaves. Unroll the leaf curls and check for the presence of the caterpillars and/or their white powdery covering.

The adult butterflies are most active in the early evening and are not commonly seen.

How is it spread?

Banana skipper is spread over large distances by the movement of banana planting materials with eggs attached to the leaves. Butterflies can fly within a localised region.

Where is it now?

Banana skipper is currently widespread in South East Asia, and is also found in Papua New Guinea, Mauritius, Guam and Hawaii.

How can I protect my farm from banana skipper?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Eumusae leaf spot

What is Eumusae leaf spot?

Eumusae leaf spot (caused by the fungus *Mycosphaerella eumusae*) is one of three closely related fungi that cause a devastating leaf spot disease on banana. Symptoms are very similar to black Sigatoka (caused by *M. fijiensis*) and yellow Sigatoka (caused by *M. musicola*). All three pests can cause significant reductions in banana production.

Eumusae leaf spot and black Sigatoka are exotic to Australia, while yellow Sigatoka (sometimes referred to as 'leaf spot') is present in all banana growing regions of Australia.

Eumusae leaf spot is the newest member of the *Mycosphaerella* group of fungi to be identified on banana and consequently has not been studied to the same extent as yellow and black Sigatoka. Importantly, Eumusae leaf spot is known to infect cultivars of banana in Sri Lanka and Thailand that have shown high resistance levels to both black and yellow Sigatoka.

What does it look like?

Symptoms of this disease are very similar to black and yellow Sigatoka. The first obvious symptom is a brown streak that expands into a circular spot and eventually darkens. The spot develops a dark brown margin and the centre turns grey. When infection levels are low, individual spots are oval or elliptical when mature. The size and shape of this type of spot distinguishes it from the mature symptoms of black and yellow Sigatoka. When infection density is high the spots join together and cause large areas of leaf tissue to die. The symptoms are still visible in the dead leaf area as grey spots.



Eumusae leaf spots on banana leaf

Juliane Henderson



Advanced Eumusae leaf spot symptoms

Kathy Grice

What can it be confused with?

Symptoms of Eumusae leaf spot can be confused with black Sigatoka or yellow Sigatoka.

What distinguishes Eumusae from other leaf spots?

Reliable diagnosis can only be made using specialist laboratory methods.

How is it spread?

Research into infection and spread of Eumusae leaf spot has not yet been conducted. However, it is assumed that they would be similar to that of black and yellow Sigatoka (i.e. new infections occur when spores are dislodged by wind or water from leaf lesions or trash onto young leaves). Another mode of pest spread is through the movement of infected plant material.

Where is it now?

It has been reported in South and South East Asia, southern India, western Malaysia, Mauritius, Nigeria, Sri Lanka, Thailand and Vietnam.

How can I protect my farm from Eumusae leaf spot?

Only use pest-free planting material.

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Moko

What is Moko?

Moko is a devastating bacterial disease caused by *Ralstonia solanacearum* race 2. This bacterium also causes bugtok of banana, and is closely related to the blood disease bacterium which causes blood disease. Moko is currently the most widely dispersed of the three pests. Moko symptoms have also been confused with those caused by Panama disease (caused by *Fusarium oxysporum* f. sp. *cubense*).

Moko has caused severe losses in banana crops in Central and South America, the Caribbean and the Philippines. Yield reductions of 70% due to Moko have been reported in Guyana.

What do the symptoms look like?

The symptoms produced by Moko may vary depending on the strain of bacterium, and are similar for both banana and heliconia species.

Moko causes yellowing and wilting of leaves that eventually die and collapse. Younger leaves may develop pale green or whitish panels, before dying. Suckers may wilt.

The internal part of the stem becomes progressively discoloured, cream to yellow, eventually turning brown to black. This discolouration can extend into the fruit stems and bases of younger leaves. When cut, the stem will exude bacterial ooze. Bacterial ooze may also be seen on diseased peduncle cushions.

Fruit develop prematurely or split. Prematurely ripened fingers appear amongst otherwise green fingers in hands and bunches of Cavendish bananas. Internally fruit become discoloured yellow, then brown or grey, developing a firm rot. Infected flower buds and peduncles are blackened and shrivelled.



PaDIL

Externally unaffected looking fruit can have significant internal browning and rotting

What can it be confused with?

Moko is most commonly confused with blood disease or bugtok. Moko has also been confused with Panama disease.

What distinguishes Moko from Panama, bugtok or blood disease?

Panama disease does not cause internal fruit discolouration, produce bacterial ooze, or cause premature ripening of some fingers in otherwise green hands or bunches.

Bugtok causes internal fruit discolouration, but does not cause wilting of the whole plant. Bugtok only affects cooking banana fruit in the Philippines.

Laboratory testing is required to distinguish between Moko and blood disease.

How is it spread?

Moko bacteria persist all year round and can be spread by infected plant parts, with roots, stems, bunches, fruit, peel, suckers or leaf material all being suitable sources of infection. Root to root infection is also possible.

Moko bacteria exist in the soil where infected plants are growing, and can survive for over 18 months. Infected soil can be spread on hands, tools, machinery, shoes, by animals and in water run-off. Pruning can also spread the pest. Insect transmission can occur from infected male buds to distant flowers. It can also be spread by contaminated fruit shipments.

Where is it now?

Moko is endemic to Central and South America, Jamaica, the Philippines and Guam.

Moko was detected in Cairns (1989) on heliconia plants imported from Hawaii, and was eradicated.

How can I protect my farm from Moko?

Only use pest-free planting material.

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

Bacterial oozing from any banana plant or heliconias should be reported immediately.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

EXOTIC PLANT PEST HOTLINE
1800 084 881

Banana spider mite

What is banana spider mite?

Banana spider mite (*Tetranychus piercei*) is an exotic spider mite that attacks a range of tropical fruit crops overseas, including banana. It is also known as banana leaf mite or banana red mite.

The banana spider mite is one of many spider mites commonly found on tropical plants throughout Asia. Spider mites are tiny insects, almost microscopic – about the same size as the full-stop at the end of this sentence. Although tiny, these mites can cause devastating damage to banana plants. Banana spider mites mainly attack banana leaves, delaying fruit ripening and reducing yields.

Banana spider mite is closely related to the two-spotted mite (*Tetranychus urticae*), which is already present in Australia. Banana spider mites produce silky, white webbing similar to a spider's web, while two-spotted spider does not.

What do the symptoms look like?

Banana spider mite feeding produces small brown spots, initially on the under-surface, of mature banana leaves. As mite populations increase, damaged portions of the leaf enlarge and finally the whole underside of the leaf becomes reddish-brown, the upper surface turns yellow and the entire leaf becomes necrotic and dry. Serious infestations result in arrested plant growth, reduced quality and yield, as well as a delayed harvest.

Banana spider mites spin webs that resemble spiders' webs.



Don Wilkers

Close up of an adult spider mite



Jeff Daniells

Spider mite damage on banana leaves

What does the banana spider mite look like?

It is very difficult to see individual spider mites, even with a hand lens and almost impossible to distinguish by physical characters from two-spotted mites. Under a microscope adults are dark red in colour and range in length from 0.3–0.5mm. The eggs are creamy white.

What do I look for?

Silky threads, that look similar to a spider's web, associated with reddish-brown mite damage on the underside of leaves. Check carefully to make sure it's not actually a web belonging to a spider.

What can it be confused with?

Two-spotted spider mite is sometimes called banana spider mite when it attacks bananas in Australia.

What distinguishes banana and two-spotted spider mites?

Only banana spider mite produces webbing.

How is it spread?

Adults and nymphs are capable of crawling short distances, but can be carried much greater distances by humans, wind, insects or birds.

Where is it now?

This pest is present throughout Asia, Indonesia, Malaysia and Papua New Guinea.

Banana spider mite has not established in any mainland production areas of Australia. However, its presence in nearby Papua New Guinea puts Australia at high risk, as the pest could potentially move into the northern parts of Australia, either carried by people on plant material across Torres Strait, or blown on the wind.

This mite is capable of surviving and reproducing across a wide range of temperatures. All commercial banana growing areas in Australia fall within the banana spider mites' natural climatic range.

Establishment would most likely occur in tropical or subtropical conditions.

How can I protect my farm from banana spider mites?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Banana *Xanthomonas* wilt

What is banana *Xanthomonas* wilt?

Banana *Xanthomonas* wilt (caused by *Xanthomonas vasicola* pv. *musacearum*) is a devastating bacterial disease of banana in East and Central Africa. It has caused significant reductions in banana and enset production in Ethiopia since its discovery in 1968 and is now causing massive losses in other parts of Africa. The recent rapid spread is thought to be due to the suitability of environmental conditions and an abundance of vectors, as well as the relative increase in banana production.

Banana *Xanthomonas* wilt is so severe that it can kill whole plants within a month of the first appearance of symptoms. The bacteria block the water conducting tissues of the plant, resulting in severe wilting, crop loss and eventually death of the entire plant mat. Whole plantations are commonly affected, causing complete loss of the crop. The bacterium survives well on infected plant material and moves easily in soil water, making this pest very difficult to manage.

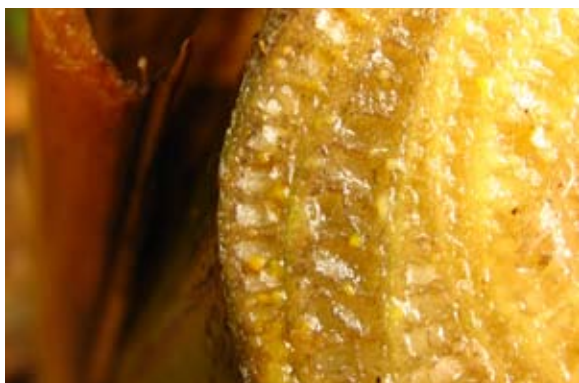
What do the symptoms look like?

Symptoms include general wilting of the plant prior to flowering, fruit rotting and premature ripening and eventual death of the entire plant.



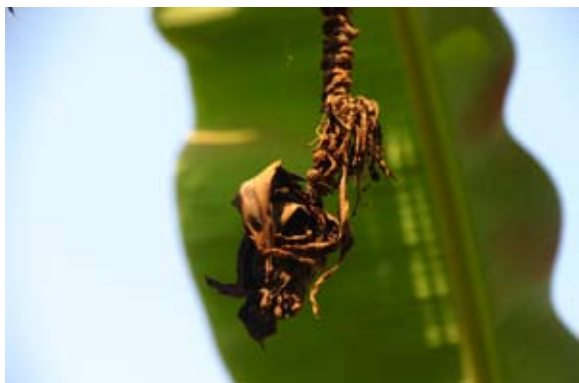
Anthony Young

Banana plant exhibiting yellowing and collapse of leaves typical of banana *Xanthomonas* wilt



Anthony Young

Oozing pseudostem and uneven ripening



Anthony Young

Desiccated flower of a banana plant affected by *Xanthomonas* wilt



Anthony Young

Internal discoloration and dry rot of fruit

What can it be confused with?

Banana *Xanthomonas* wilt symptoms are similar to those of other bacterial wilts (blood disease, Moko and bugtok) and Panama disease.

What should I look for?

- Infected stems produce a thick yellow ooze 5–15 minutes after being cut.
- Pockets of cream-yellow coloured bacterial ooze within leaf bases of the stem.
- Yellow and brown streaking in vascular tissues, especially the stem.
- Wilting of bracts, followed by shrivelling and rotting of the male buds.
- Flower stalks turning yellow-brown.

How is it spread?

Infection occurs either through the inflorescence or from soil-borne bacteria moving up through the lower plant parts. Bacteria only survive in the soil on infected plant parts, but these can survive in the soil for over 6 months.

Short and long distance transmission of the pest mainly occurs via contaminated tools and insects, though other organisms such as birds, rats, bats, and livestock can also spread the pest.

Where is it now?

The pest has been recorded in Burundi, Democratic Republic of Congo, Ethiopia, Kenya, Rwanda, Tanzania and Uganda.

How can I protect my farm from banana *Xanthomonas* wilt?

Check your farm frequently for the presence of new pests and unusual symptoms. Make sure you are familiar with common banana pests, so you can tell if you see something different.

Bacterial oozing from any banana plant or heliconias should be reported immediately.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

EXOTIC PLANT PEST HOTLINE
1800 084 881

Panama disease

What is Panama disease?

Panama disease (also known as fusarium wilt) is caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *cubense*.

There are four races of the fungus:

- Race 1 infects Lady Finger, Sugar and Ducasse, but not Cavendish
- Race 2 generally infects cooking bananas like Bluggoe and Blue Java
- Race 3 infects only *Heliconia* species and not bananas
- Race 4 infects most varieties including Cavendish. There are two important strains of this race:
 - Subtropical Race 4 usually produces symptoms in Cavendish after a period of cold stress
 - Tropical Race 4 is a serious threat to the Australian Cavendish banana industry

Panama disease is considered to be the most destructive disease of banana in modern times. Subtropical race 4 has been under quarantine control in south east Queensland, northern New South Wales and Western Australia for some time. Tropical race 4, which has rapidly spread throughout South East Asia, has been detected in the Darwin area, and is currently under strict quarantine control. Both strains represent a significant risk to the North Queensland production area, but Tropical race 4 is particularly devastating.

What does it look like?

The first external symptom of Panama is the irregular yellowing of the margins of older leaves, which later turn brown and dry out. These leaves eventually collapse along the leaf stalk or at the junction of the stalk and stem, resulting in a skirt of dead leaves forming around the lower part of the plant. Heart leaves may remain unusually upright giving the plant a spiky appearance. Following this, plants can take on a generally wilted appearance. The stem may split, which is often followed by death of the parent stem, but suckers do not necessarily die.

Internal symptoms of Panama include discolouration of the inner tissue in the corm and pseudostem. The easiest way to observe these symptoms is to cut through the pseudostem near ground level. The discolouration is usually seen as reddish-brown or black lines running up and down the pseudostem, or rings running around the cross section of tissue.

Affected plants rarely produce marketable bunches.



Jeff Daniells

Internal browning of stems and corms is the key diagnostic symptom of Panama disease



Jeff Daniells

Initial external symptoms of Panama disease include yellowing leaf margins on older leaves

What could it be confused with?

In the early stages Panama disease can be mistaken for nutritional problems or water stress.

Panama disease can also be confused with endemic bacterial wilts and exotic bacterial diseases such as Moko or blood disease. However, neither of these diseases currently occur in Australia.

What distinguishes Panama from nutritional problems, water stress, Moko or blood disease?

Nutritional problems and water stress do not normally cause internal discolouration of vascular tissues.

Panama disease can be differentiated from Moko in that Panama does not discolour fruit.

Panama disease does not cause the production of bacterial (blood-like) ooze from cut stems.

How is it spread?

The disease is most commonly introduced in infected planting material. Panama disease can also spread over short distances via root to root contact, and through soil. Spread from an infected parent plant into the suckers can also occur. It can also spread with soil and water movement or on contaminated pruning tools. Once established, the fungus persists in the soil for many years.



As the disease progresses, older leaves die and form a skirt around the lower part of the plant

Jeff Daniels



Splitting of the pseudostem associated with Panama disease infection

Jeff Daniels



Where is it now?

Race 1 – under quarantine control in banana production areas of Queensland, New South Wales and Western Australia.

Race 2 – under quarantine control in banana production areas of Queensland, and New South Wales.

Race 3 – Northern Territory.

Subtropical Race 4 – under quarantine control in banana production areas of south east Queensland, northern New South Wales and Western Australia.

Tropical Race 4 – under strict quarantine management in the Darwin area.

How is it controlled?

The most effective control measure for Panama disease is the exclusion of the pest and simple farm hygiene procedures.

Prompt detection is essential, and affected plants must be destroyed because the disease cannot be cured. Minimal site disturbance after the affected plants have been destroyed (e.g. by herbicide injection) is crucial to avoid further spread of the pest via movement of soil or plant material. There are strict quarantine regulations to prevent spread of infected material to clean areas through movement of soil, water or plant materials.



Aerial view of Panama affected banana plants

How do I protect my farm from Panama disease?

Prevention and farm hygiene

- Protect land currently free of the pest.
- Use clean planting material, such as tissue culture plants.
- Avoid sharing farm machinery and equipment with other growers. A common way of spreading Panama disease is in soil attached to equipment.
- Remove all plant material and soil from all machinery, equipment, vehicles and footwear upon entry to the farm.
- Erect signs at your front gate to notify visitors of your farm biosecurity requirements.
- Train your staff and family about your farm biosecurity requirements.

Early detection of outbreaks

- Regularly examine your crop for signs of Panama disease.
- Immediately report any suspect plants to the Exotic Plant Pest Hotline on 1800 084 881.

Containment of outbreaks

- If you suspect you have Panama disease, it is important that a specimen is taken by a trained person for diagnostic analysis. Please contact a plant health inspector in your state or call the Exotic Plant Pest Hotline on 1800 084 881 to arrange for a sample to be taken and for advice on pest management.
- Inject affected plants and adjacent healthy plants with glyphosate to kill the plants.
- Leave plants to die in place – no chopping!
- Fence infected areas to restrict movement of workers, machinery and equipment.
- Sow infected sites with a persistent ground cover to reduce movement of infected soil and drainage water.
- Do not replant with susceptible varieties.
- If Panama disease is confirmed, an inspector will issue an Inspector's Approval outlining strict hygiene measures that must be met to allow movement of anything that has been in contact with plant material or soil. These measures are necessary to help prevent the spread of Panama disease to unaffected areas.

Have you seen Panama disease symptoms?

Early detection and reporting of symptoms are the key elements in controlling the pest.

For more information about Panama disease contact Queensland Primary Industries and Fisheries on 13 25 23 or visit the website at www.dpi.qld.gov.au.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**

Bunchy top disease

What causes bunchy top?

Bunchy top is the most devastating viral disease of bananas world-wide. Caused by banana bunchy top virus (BBTV), this disease is characterised by the 'bunched' appearance of newly emerging leaves and dot-dash flecking of leaves and stem sheaths. Affected plants do not produce fruit, resulting in significant loss of production on commercial farms.

BBTV is a regulated banana pest under active quarantine control in Australia.

What does it look like?

- Dark green dot-dash flecks along veins of leaves, most visible on the underside at the base of the leaf adjacent to the midrib.
- Flecks in veins which can form characteristic 'hooks' into the midrib from the leaf blade (also seen on the petioles and in the leaf sheaths of stems).
- Reduced growth with emerging leaves becoming choked and 'bunched'.
- Affected leaves appearing more upright with pale yellow margins, often having wavy leaf margins.
- If infected at an early stage, plants become very stunted and rarely produce bunches.
- If infected at a later stage, distorted bunches may be produced.



Jeff Daniells

Affected leaves are more upright with pale yellow margins. Leaf margins may also be more wavy than normal



Jeff Daniells

Typical bunching of emerging leaves



John Thomas

Vein-flecking can be seen on the petioles and in the lamina of some leaves

How is it spread?

BBTV is spread in infected planting material, or by the banana aphid (*Pentalonia nigronervosa*). Aphids can retain the virus for several weeks and may cover large distances especially when blown by the wind. Plants can also be infected without showing symptoms.

Where is it now?

Bunchy top is currently present in the south east Queensland and northern New South Wales production areas. North Queensland, Western Australia and Northern Territory production areas remain free of the pest.

How is it controlled?

Control can only be achieved through the destruction of affected plants. Control depends on prompt detection and destruction of infected stools. There are strict quarantine restrictions to prevent movement of contaminated planting material. Control also depends on the use of planting material free of the virus and intensive eradication schemes.

Key strategies for bunchy top control are:

- Regular inspection of crops and prompt removal of plants with symptoms.
- Use of tissue-cultured, pest-free planting material.
- QBAN tissue culture plants are tested for BBTV to provide industry with a source of quality virus-free plants.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

**EXOTIC PLANT PEST HOTLINE
1800 084 881**



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