



Fusarium Wilt (Panama Disease) of Banana

Fusarium wilt is a severe disease of banana plants caused by the fungus *Fusarium oxysporum* f.sp. *cubense* (*Foc*). This disease kills susceptible banana plants and there is no cure. Fusarium wilt is the preferred name for what was first called Panama disease because it became prominent in that Central American country early last century. The fungus infects banana plants through the roots and invades the plant's water conducting tissues. Once *Foc* is introduced into banana gardens, it remains in the soil making it impossible to grow susceptible bananas in the same location for up to several decades.

Foc is thought to have originated in Asia, then spread during the 20th century to become a major problem throughout most banana production regions of the world. An important exception is the South Pacific, where fusarium wilt is a new disease and not yet widespread.

Moderately damaging strains of *Foc* have established in some Pacific nations close to south east Asia and also recently in Tonga. This Pest Advisory Leaflet deals with these strains and also warns of a much more serious new strain in the region.

SYMPTOMS

As *Foc* disrupts the plant's water conducting vessels, leaves become yellow (progressing from older to younger leaves) and wilted (Figure 1). This is also a sign of drought stress that is reduced when water supply is good. Distinctive symptoms appear inside the pseudostem: brown, red or yellow lines are visible in vertical section which appear as rings in cross-section (Figure 2a and 2b). These are the infected water conducting vessels. Smaller brown streaks or flecks appear in the corm, at ground level (Figure 3). Later, all leaves turn yellow and die and internal rotting becomes extensive. Splits may also

appear in the pseudostem. Infected plants usually do not produce fruit.

THE FUNGUS

There is great strain variation in *Foc*. Several methods have been developed to separate them. Strains have most commonly been grouped by their ability to cause disease in different types of banana in the field. They have been described as "race" 1, 2, or 4. The race system has often caused confusion. It is actually more accurate to name strains using a method called Vegetative Compatibility Group (VCG), a laboratory technique that is based on reproductive compatibility of different strains of the fungus. Different strains are given a VCG number, and some clear relationships exist between VCG and ability to cause disease in different banana types. DNA analysis can provide finer differentiation between and within VCGs.

DISTRIBUTION IN THE PACIFIC REGION

Verified records

Following an early record of *Foc* in the Region over 30 years ago, a series of new findings in the 1990s is a matter of concern (Table 1, Fig. 4). The first confirmed record was of a "race" 1 strain (of unknown VCG) on three islands in the Northern Mariana Islands (NMI) in 1971. It was 25 years before the next confirmation of the fungus (VCG 0126) in PNG in 1996, recorded at two more locations by 1998. VCG 0126 has also been found in the Federated States of Micronesia (FSM) on Pohnpei and VCG 0123 is known on Yap, FSM. These strains infect certain dessert (AAA and AAB genotype) and cooking bananas (ABB genotype) in



Figure 1: Early effect of Fusarium wilt on banana leaves



Figure 2a & b: Mid to advanced symptoms in longitudinal and cross sections of pseudostems.

south east Asia and are considered to be “race” 1. In 2002, VCG 0128 was found in the Vava’u group in Tonga. VCG 0128 was found before infecting cooking bananas in north Queensland and Africa and is considered to be “race” 2.

Other reports

An unverified report exists from 1934, of *Fusarium cubense* causing a severe wilt of bananas in Fiji (Parham, 1935). The Ministry of Agriculture at that time responded by destroying a large plantation and there have been no further reports of any banana wilt diseases in Fiji.

‘*Fusarium oxysporum-musae*’ was isolated from bananas in Guam in the early 1980s (Russo *et al.*, 1985), but no information was provided about symptoms. Today, fusarium wilt symptoms are known to occur on the cultivar Manila in Guam, and efforts are being made at the University of Guam to confirm the identity of the fungus. Reports of fusarium wilt-like symptoms elsewhere in FSM also exist.

THREAT FROM OUTSIDE THE PACIFIC

The very serious strain VCG01213/16 otherwise known as “tropical” race 4 has recently devastated Indonesian and Malaysian Cavendish plantations and probably would attack many of the other bananas of importance in the Pacific. “Tropical” race 4 is a very serious quarantine threat to the Pacific as it is spreading in the western half of the island of New Guinea (in the Indonesian province of Papua previously called Irian Jaya). “Tropical” race 4 has been confirmed in three places in Papua, the nearest being the town of Merauke, which is less than 70 km from the PNG border. This strain is also now under quarantine containment in Australia’s Northern Territory.

In addition to its potential impact on banana production in the region, the spread of *Foc* into the island of New Guinea and elsewhere in the Pacific endangers valuable germplasm resources. The native bananas of the

island of New Guinea and diverse banana types that developed in other parts of the South Pacific are thought to have evolved in the absence of *Foc*, and are likely not to be resistant.

SPREAD AND QUARANTINE

Spread occurs mostly in banana planting material (suckers or rhizome pieces). Infected suckers often appear symptomless when the water conducting vessels contain the fungus spores (microconidia).

The best way to combat this disease is to prevent its introduction. Movement of banana planting material out of infected regions or islands should be completely prohibited.

WHAT TO DO IF YOU SUSPECT THE DISEASE IS PRESENT

Suspect banana plants showing leaf yellowing, especially if the plant has not yet fruited, are cut down and examined for internal symptoms of the disease. To confirm new infections, samples must be collected and sent under strict

Table 1. Verified *Fusarium oxysporum f.sp. cubense* records in SPC member countries

Date	Location ^a	Cultivar (genome)	VCG ^b	“Race”	Citation
1971	Rota, Tinian, Saipan, NMI	Manila (AAB)	NA	1	Trujilo (1971)
1996	Bewani, SP, PNG	Unknown (ABB)	0126	1	Shivas <i>et al.</i> (1996)
1998	Vanimo, SP, PNG	Unknown (ABB)	0126	1	Davis <i>et al.</i> (2000)
1998	Kiunga, WP, PNG	Unknown (ABB)	0126	1	Davis <i>et al.</i> (2000)
1999	Yap, FSM	Tanyabech / Manila (AAB)	0123	1	Smith <i>et al.</i> (2002)
1999	Pohnpei, FSM	Manila (AAB)	0126	1	Smith (unpublished) ^c
2002	Vava’u, Tonga	Pata / Bluggoe (ABB)	0128	2	Davis <i>et al.</i> (in press) ^e

^a FSM: Federated States of Micronesia, NMI: Northern Mariana Islands, PNG: Papua New Guinea, SP: Sandaun Province, WP: Western Province.

^bVegetative Compatibility Group (VCG) as determined by VCG analysis or DNA fingerprint analysis.

^cAnalyses conducted by Linda Smith, Department of Primary Industries, Queensland, Australia, records not previously published elsewhere.



Figure 3: Small brown streaks or flecks found in the corm at ground level

quarantine containment to a specialist laboratory for identification. Contact SPC-Plant Protection Service for details.

POSSIBLE ACTIONS TO TAKE IN THE EVENT OF NEW OUTBREAKS

If isolated new outbreaks occur, containment may be possible by immediately destroying infected bananas and following this with a programme of very strictly enforced hygiene to prevent movement of spores off the

contaminated site. The area must be fenced off and no soil must be removed and all implements (such as knives used to cut plants, spades used in infested soil) and footwear that enters the site must be decontaminated before leaving. The best chemical to use for this is farmcleanse, an agricultural detergent-degreaser with anti-fungal properties made by Castrol. Banana roots from neighbouring clumps must be prevented from growing into the diseased site either by destroying these clumps or providing a physical barrier to root penetration around the site. Beyond this, there are many uncertainties about the best course of action to deal with fusarium wilt outbreaks. Some recent findings from Australia are outlined below:-

- when only 1-3 plants are infected, kill and chop up the diseased plants and stew all the material in water at a temperature of at least 70 deg C for 30 minutes.

- if only non-hosts of the fungus are allowed to grow on the infected site for many years, the fungus may eventually die out. Foc can survive in soil by infecting roots of certain weeds, including one grass species (*Chloris inflata*).

It is believed that populations of *Foc* would not increase in soil if only resistant banana cultivars are grown and

this may be an option to deal with strain: other than “tropical” race 4.

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