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The discovery, identification and management of banana fusarium wilt outbreaks in the northern territory of Australia

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Summary

Fusarium wilt was found in the Darwin area of the Northern Territory of Australia (NT) on 19 June 1997. Two further detection were made on 7 October 1998 and 25 May 1999. The *Fusarium* from all three outbreaks was identified as tropical race 4, VCG 01213/16. These were the first detection of tropical race 4 from Australia. In the first and third outbreaks in 1997 and 1999, respectively, the infection on the farms was already extensive. The second outbreak involved three ratoon plants only. This second outbreak was successfully contained because of early reporting and swift implementation of quarantine procedures.

Keywords: Fusarium wilt, banana.

Introduction

The Northern Territory (NT) of Australia has a small but developing banana industry, based mainly on the Cavendish cultivars, Williams Hybrid and Grande Naine. For the period January-December 1998, a total of 4 633.02 tonnes was marketed, of which 3 009.57 tonnes was marketed interstate; the total estimated value for the crop being $7 118 600. The Northern Territory is in the northern central part of Australia. Bananas are grown in the 'Top End' of the NT, which is the area of the NT from the coast, inland to about 300 km. The Top End is described climatically as semi-arid tropics with distinct monsoon wet season and dry season. Most of the commercial planting is within 100 km of the NT's capital Darwin.

Bananas have been grown on a small scale in the NT since the last century. The first commercial plantation was at the town of Adelaide River, approximately 100 km south of Darwin in the 1960s. The first Middle Point Farm was established in 1977, followed by one at Tortilla Flats near the town of Adelaide River, another plantation at Middle Point, one at Berry Springs, then two at Lambells Lagoon. There are also several smaller plantations in the Darwin area. There are two medium size commercial plantations which have existed off and on in Arnhem Land, at Yirrkala (Gove) and Galiwinku (Elcho Island).

Because of the NT banana industry's relative freedom from serious diseases, legislation was enacted in 1991 to restrict entry of planting material into the

NT to tissue cultures on agar enclosed within containers. This legislation was designed to prevent the introduction of bunchy top disease (virus), fusarium wilt (Panama disease) and CMV (cucumber mosaic virus) in to the NT. Because it was assumed that the NT was free of these two serious diseases, there was no restriction of planting material or any measures to prevent soil contamination between farms in the NT. Since 1997 when fusarium wilt was first found in the NT, restrictions have been placed on the movement of banana planting material and any soil off properties infected with fusarium wilt.

Background

Fusarium wilt (Panama disease) was not known from the Northern Territory of Australia (NT) prior to June 1997. It was first detected on 19 June 1997 (Moore 1998). Two further detection were made on 7 October 1998 and 25 May 1999. The localities of the three outbreaks are shown in Figure 1. The *Fusarium* (FOC) from all three outbreaks was identified as tropical race 4 (TR4), VCG 01213/16 by Dr Natalie Moore and Dr Suzy Bentley, Brisbane, Queensland, Australia. This was the first detection of TR4 from Australia. Prior to this, TR4 was known only from Indonesia and peninsular Malaysia.

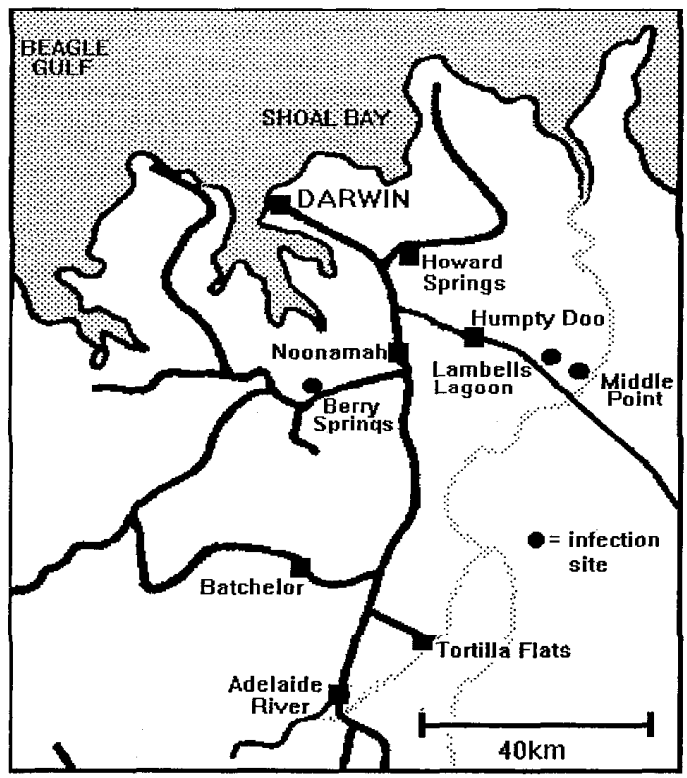

Figure 1. Map showing the locations of Berry Springs, Lambells Lagoon and Middle Point, the sites of the three fusarium wilt outbreaks in 1997, 1998 and 1999, respectively, in relation to Northern Territory's capital Darwin.

First detection: The first outbreak detected on 19 June 1997 was at Berry Springs, southwest of Darwin. The *Fusarium* fungus was isolated from symptomatic tissue onto PDA in Darwin, and a subculture sent to QDPI (Queensland Department of Primary Industries). A culture was forwarded from QDPI to CRCTPP (Cooperative Research Centre for Tropical Plant Protection) for DNA fingerprinting. CRCTPP compared the isolate from Berry Springs NT with DNA fingerprints from cultures from Australia and overseas held in the QDPI culture collection, and found the NT isolate to be identical to the banana fusarium wilt from Indonesia and Malaysia, called tropical race 4 (Anon. 1997). QDPI later confirmed the NT isolate as the tropical race 4 VCG (vegetative compatibility group) 01213/16. This was the first time that this VCG had been detected from Australia. A detailed survey indicated that the infection had spread through a substantial area of the farm and it is likely that it had been present for several years prior to its detection. Since there was no hope of isolating the infection to an area of the farm, and to protect the banana industry in the NT and elsewhere in Australia, the property was quarantined and all banana plants were destroyed by injection with glyphosate. An animal proof fence with locked gate and concrete wash down area for vehicles was constructed. Six-monthly surveys of all commercial banana farms were commenced soon after to confirm that the remaining farms were free of the disease.

Second detection: The second detection was made on 7 October 1998 when the owners of a commercial plantation in the Lambells Lagoon area, about 60 km southeast of Darwin, reported symptoms suggestive of fusarium wilt in three plants in one block of their plantation. This consisted of three plants only, one ratoon sucker in each of three nearby mats (stools) in 'H7' block of a farm at Lambells Lagoon, southeast of Darwin. These plants showed early symptoms of leaf yellowing, and typical internal symptoms. Samples from these plants were forwarded to QDPI where *Fusarium* was isolated. Cultures of the isolate were forwarded to CRCTPP where DNA analysis showed them to correspond with isolates from the Berry Springs infection and with reference isolates of tropical race 4 from Southeast Asia. VCG analysis at QDPI also showed these isolates to be identical to those from the first infection. Because only three nearby mats were affected, it was decided to attempt to contain the infection by killing these infected plants and a 12-metre surrounding buffer area of healthy plants. This quarantine area was fenced to separate it from the remainder of the farm. For ease of farm operation, the eastern end of H7 block of approximately 1/3 ha. was quarantined. This meant that the buffer area was somewhat more than the 12 metres required. A bund was constructed to contain the heavy monsoon rains falling on the area to prevent it from contaminating the remainder of the plantation. The owners of the affected plantation have been conscious of hygiene since the establishment of the plantation, and of banana fusarium wilt since the first detection at Berry Springs in 1997. Planting material has been sourced only as tissue culture from an accredited laboratory. No outside soil or machinery has been brought in. The mechanism by which this latest infection reached the property is not known.

Hygiene measures were put in place; including footbaths and sterilization of implements and washdown of any vehicles leaving the area. The affected property and an adjoining property, which had been supplied with planting material, were placed under quarantine with appropriate signage. Vehicle control was put in place to confine outside vehicles to a bituminised area in the vicinity of the packing shed. Regular intensive inspections of the remaining plants in adjacent blocks were started, initially at weekly intervals, later extended to monthly intervals. These have not detected any new infections on the farm in over 12 months.

Early detection and early implementation of the quarantine procedures appears to have contained the outbreak in a very small area of the farm. The farm is still producing. The early detection is due to good education of owners, managers and all staff as to symptoms of fusarium wilt, and the vigilance of staff at all levels in reporting plants with suspicious symptoms eventually to Plant Pathology staff for confirmation.

Third detection: Following reports of suspicious symptoms in bananas at a plantation at Middle Point, southeast of Darwin, a survey was done on 25 May 1999. This Middle Point plantation is 75 km by road from Darwin and about 5 km in a direct line from the banana growing areas at Lambells Lagoon. The survey revealed external and internal symptoms typical of fusarium wilt. *Fusarium* was consistently isolated from discolored vascular strands and samples were also sent to QDPI for VCG analysis while DNA analysis was conducted at the CRCTPP. Results of the DNA analysis were received on 11 June and results of the VCG analysis were received on 30 June. Both confirmed the isolates as VCG 01213/16, tropical race 4 of *Fusarium oxysporum* f. sp. *cubense* (FOC), identical to those from the two earlier infections.

A detailed plant by plant survey of the plantation to determine the extent and distribution of the infection was done on 31 May and 1 June. Infected plants were recorded on a plan of the plantation. It was estimated that more than 25% of the 16 ha plantation was infected with two areas of severe infection. Intensive surveys of two nearby plantations revealed no signs of infection. The extent and severity of infection indicates that the infection was present in the farm for several years. Strict quarantine has been placed on this farm. As in the Berry Springs case, an animal proof fence with locked gate and concrete wash down area for vehicles was constructed. There is a prohibition on the removal of banana material except for detached bunches. All banana plants were destroyed by glyphosate injection in December 1997 to prevent spread of infection into nearby banana farms.

It is worthwhile noting that the rainfall for the last three seasons was very heavy. The prolonged high water table possibly stressed infected bananas at the first and third outbreaks causing severe symptoms. Also, the heavy rains may have led to a faster rate of spread of the disease inoculum and the infection.

Discussion

Cavendish varieties were grown commercially in communities in the Top End for over 20 years before fusarium wilt (FOC, TR4) was detected for the first time in the Top End from a farm at Berry Springs in 1997. The disease may have been there 2-4 years before it was detected. This shows that fusarium wilt is a fairly recent introduction and was not endemic. There have been only three outbreaks in 1997, 1998 and 1999, all of which were TR4, VCG 01213/16 only. The 1998 outbreak consisted of three nearby ratoon plants only with no further infections over 12 months. Therefore, fusarium wilt is still not considered to be endemic in the Top End banana growing areas. This is in contrast with the situation of TR4 in Malaysia and Indonesia and sub-tropical race 4 in south Queensland, Australia where these diseases are considered to be endemic. Eradication from the soil is not possible because the resistant chlamydospores survive for over 20 years. In the Top End we do not manage fusarium wilt as if it were an endemic disease to the area, but rather, our strategy is called 'permanent containment' of known infestation outbreaks.

Our procedure for extensive surveys of banana plantations for the fusarium wilt every six months has not proven to be effective in the management of the disease problems in the NT. Limited surveys have their place in monitoring the progress of the disease on an infested property or in possibly confirming that a block adjoining an infected block remains healthy. The NT industry needs to be informed regarding fusarium wilt management.

We need to educate banana farmers, their managers and their key staff about the seriousness of the fusarium wilt, the importance of vigilance in early symptom detection and reporting any suspicious plants to Plant Pathology, and in knowing the symptoms of fusarium wilt. Education could be achieved by holding seminar-workshops at each farm. The farmers, managers and key staff are the most important people in detecting early outbreaks in the farms. This was proven by the well-trained staff at the Lambells Lagoon farm in detecting up the second outbreak early; this outbreak was confirmed by Plant Pathology.

If further extensive outbreaks occur, then, we can conclude that fusarium wilt (TR4) is widespread in the Top End or at least the Darwin banana growing areas, and is endemic. Then, containment can no longer be relied on to manage the disease in the industry. At this point, it will be necessary to find banana cultivars with resistance or tolerance to fusarium wilt race 4 in the tropics.

The NT government is considering taking over a block of land infected with fusarium wilt (TR4), to be set aside and developed into a trial site for testing banana cultivars and lines with possible resistance to the disease. This will be operated in co-operation with Dr Natalie Moore and Mr Ken Pegg, Queensland DPI. The Cavendish banana group may have to be replaced by other resistant cultivar(s), just as the industry's previously standard Gros

Michel banana had to be replaced by the Cavendish bananas to enable it survive fusarium wilt race 1. Secondarily, the trial site could also be used to test soil suppression techniques and chemical additives, which might be useful in managing the fusarium wilt disease.

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