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WILT DISEASE OF ANGSANA (*PTEROCARPUS INDICUS*) IN PENINSULAR MALAYSIA AND ITS POSSIBLE CONTROL

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PHILIP, E. 1999. Wilt disease of angsana (*Pterocarpus indicus*) in Peninsular Malaysia and its possible control. The study was conducted to investigate the cause of death of angsana trees in and around Kuantan, which is located in the east coast of Peninsular Malaysia. Four sites were monitored for a period of 15 months to understand the epidemiology of the disease. Typical symptoms of the disease are yellowing of leaves in the early stages and appearance of bare branches and infestation by pin hole borers at later stages and eventually tree death. *Fusarium oxysporium* and *F. solani* were isolated from infected trees but results obtained from the pathogenicity test indicated that *F. oxysporium* caused death of the trees. Preliminary fungicidal screening was also conducted and initial results suggested that Thiabendazole was effective against this disease.

Key words: Wilt disease - *Fusarium oxysporium* - *Pterocarpus indicus* - symptoms - Thiabendazole

PHILIP, E. 1999. Penyakit layu angsana (*Pterocarpus indicus*) di Semenanjung Malaysia dan kawalannya. Kajian ini dijalankan untuk menentukan punca kematian pokok-pokok angsana di sekitar bandar Kuantan yang terletak di pantai timur Semenanjung Malaysia. Empat kawasan dikaji selama 15 bulan untuk memahami epidemiologi penyakit ini. Simptom ketara yang diperhatikan ialah kekuningan daun di peringkat awal dan batang tanpa daun dan serangan serangga ulat pengorek batang dan kematian di peringkat akhir. Kedua-dua *Fusarium oxysporium* dan *F. solani* telah didapati daripada pokok berpenyakit tetapi keputusan daripada ujian kepatogenan menunjukkan *F. oxysporium* yang menyebabkan kematian pokok-pokok ini. Kajian peringkat awal cara kawalan menggunakan racun kimia mencadangkan bahawa Tiabendazola dapat merencat penyakit ini.

Introduction

Angsana, *Pterocarpus indicus*, is native to Malaysia (Burkill 1935). It is highly valued for its aesthetics, grows fast and is relatively free from pests and diseases (Wong 1982). Owing to the beauty of its spreading crown and ease in propagation, angsana became a popular tree for urban planting in most towns in the country in the early 1980s.

The advent of this decade saw angsana facing problems. In areas like Kuala Lumpur, Penang and many other towns, leaf miners were found to cause defoliation. On the other hand, in Kuantan (in the state of Pahang), angsana trees were dying rapidly due to a fungal disease. The latter caused alarm because of the large population of planted angsana and the possibility of the decimation of this species in urban areas.

With the exception of a report by Furtado (1935) early in this century, no records of any fatal disease on angsana have been noted. Furtado (1935) reported that angsana trees in Malacca, Penang and Singapore were dying due to an unknown disease. As the disease was spreading very rapidly, infected trees were removed immediately in order to contain the disease. Although attempts were made to identify the causal agents, no concrete conclusion could be made. There were no further records of the disease until an epidemic occurred in Singapore in 1985 (Y. K. Fong, personal communication), necessitating the removal of about 800 trees from the roadsides due to a wilt disease (Sanderson 1992). In Malaysia, a similar disease was observed on angsana in Kuantan in 1992 and a year later in Johore Baru, Kemaman and Chuping. The extensive planting of these trees, especially in Kuantan, probably aided the rapid spread of the disease.

As angsana is extensively planted in most towns, a study was formulated to determine the epidemiology of the disease and possible control measures. Trees along roadsides in Kuantan were observed, examined and samples taken to determine the causal agent.

Materials and methods

Four different widely scattered sites in Kuantan, viz. Tanah Puteh Sports Field, Jalan Indera Mahkota, Jalan Teluk Cempedak and Taman Gelora, were chosen. A total of 50 trees at each site were monitored from September 1992 to December 1993 on a monthly basis. Scores (0 - no symptom; 1 - early stages of infection, less than 30% of the trees infected; 2- advanced stages of infection with more than 30% of the trees infected; and 3 - advanced stages of infection with more than 50% of the trees infected and with standing dead trees) were given based on the number of trees infected at each site. The roots of wilting trees were cut into convenient lengths of approximate 30 cm, while plugs of 2.5 × 2.5 × 1 cm dimensions were taken from the stems with a chisel. These samples were brought to the laboratory for isolation and determination of the pathogen. Numerous isolations were attempted from the roots and stems of wilted trees.

Small slivers (approximately 2 × 3 × 4 mm) of wood were cut from the sapwood of both roots and plugs, surface sterilised in 3% Chlorox (sodium hypochlorite) and transferred onto Petri dishes with 2% potato dextrose agar (PDA). Attempts were also made to isolate fungi from the bark. Sub-culturing was done to obtain pure cultures. The cultures were maintained at 25 ± 2 °C. Pure cultures were incubated for five days in the dark prior to identification of isolated fungi using a transmition light microscope.

Pathogenicity test

Isolated fungi were tested for their pathogenicity on angsana seedlings according to Koch's postulate. Seedlings used were propagated from cuttings and had been raised for approximately a year in the nursery and later preconditioned

for a month in the greenhouse for the purpose of this experiment. Inoculum of the fungus was prepared by mixing a young culture (7 days old) of the fungus grown at 25 ± 2 °C on PDA. These seedlings were dipped into spore suspensions (5×10^6 cm^{-3}) of the isolated fungi, *Fusarium oxysporum* and *F. solani*, singly and in combination and planted in sterilised soil in polybags (30 × 45 cm). Distilled water was used as control. Twenty seedlings were used for each treatment. Inoculated plants were then placed in the greenhouse with 20% shade, watered regularly and monitored for symptoms development. Plants were considered diseased when they showed symptoms of wilting. Root samples of the dying seedlings were taken and isolation procedures were done to determine the fungi.

Preliminary chemical control

At Taman Gelora and Tanah Puteh, chemical treatments were evaluated for control of the disease. Two systemic fungicides, Benomyl and Thiabendazole, previously known to be effective against *Fusarium* in laboratory test (Philip 1994) were applied to the soil and sprayed on the bark of test trees. The treatments used were Benomyl (50 WP) at 5.0 g l^{-1}, Thiabendazole (60 WP) at 2.8 g l^{-1} and water as control. The amount of fungicide applied was based on the tree size. At each site, a total of 40 trees were tested. These trees were different from those chosen for monitoring of disease development. Fungicidal trials at Taman Gelora were preventative treatments to ascertain whether healthy trees would be protected from the disease. In contrast, at Tanah Puteh, treatments were conducted to test if the infected trees would recover from the disease. Trees with initial symptoms of infection were chosen for treatment.

Results and discussion

Distribution of disease

The disease was observed to occur in pockets, with a few trees showing symptoms in a particular locality. It was observed that three or four trees in a group would be infected while the rest of the trees beyond the group showed no symptoms of infection. In the initial stages of the study, trees along Jalan Indera Mahkota and Taman Gelora did not show any disease symptoms, while less than 30% of the trees along Jalan Teluk Cempedak and Tanah Putih were infected. The spread of the disease was rapid; by March 1993, all four sites had symptoms of infection. In September 1993, more than 50% of the tress were infected at all sites except Taman Gelora (Table 1).

Table 1. Distribution and development of wilt disease of angsana caused by *F. oxysporum* at four sites. Number of trees monitored at each site was 50.

Site	Score		
	Sept 92	March 93	Sept 93
Tanah Puteh	1	3	3
Indera Mahkota	0	2	3
Jalan Teluk Cempedak	1	3	3
Taman Gelora	0	1	2

Score: 0 = healthy trees with no infection
1 = early stages of infection, less than 30% of trees infected
2 = advanced stages of infection with more than 30% of the trees infected
3 = advanced stages of infection with more than 50% of the trees infected and with standing dead trees

Symptoms of wilt

Wilt was observed in trees from the ages of three to ten years after planting at the four sites. The entire tree showed symptoms of infection. In the early stages of infection, diseased trees are characterised by drooping of leaves and branches due to loss of turgor. The leaves turn yellow, dry up and eventually drop off thus exposing the bare branches (Figure 1). Single branches may in some cases show this effect but usually several dead branches appear simultaneously just as had been observed by Furtado (1935). Death of the affected trees is rapid and occurs within four to five weeks after the trees first show symptoms of being affected. Early in the century, death of the infected trees occurred about 2 - 3 months after the onset of the disease (Furtado 1935).

Figure 1. Standing dead trees

A closer look at the roots of the diseased trees revealed that they had become soft, macerated and dark in colour (Figure 2). It was also observed that the infected roots and the dead branches were on the same side of the tree in the early stages of infection. Infection appeared to spread from the finer lateral roots to larger ones and finally to the stem. In severe cases of wilting, a visible stain in the wood was evident. These extended up to the stem to approximately 3 m above ground level.

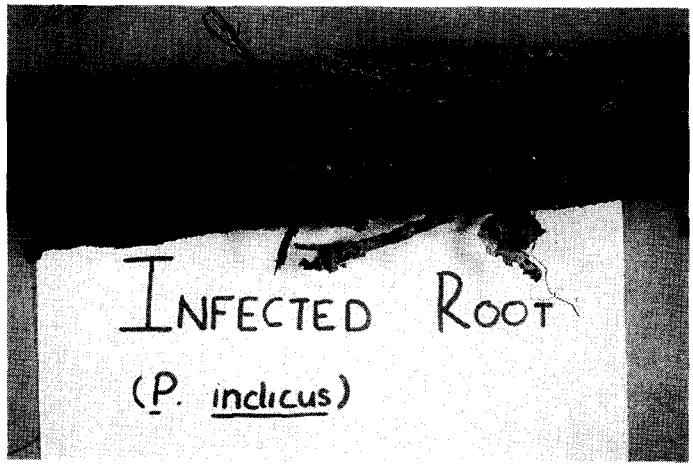

Figure 2. Infected root

When the infected stems or roots were cut they did not produce the characteristic red exudate that is common in normal healthy tissues. Scraping off the bark revealed clear zone lines between healthy and infected areas (Figure 3).

Figure 3. Clear zone line between the healthy and infected areas

The symptoms observed were identical to those described by Furtado (1935), suggesting that diseased angsana reported early in the century may have also been infected by *F. oxysporum.* The current epidemic was not observed in locations where the disease was reported to occur between 1875 and 1912. Except for an isolated case in Kuala Lumpur, the disease was not found in the central and northern states of Peninsular Malaysia. Dying trees were eventually invaded by pin hole borers, *Platypus parallelus* (Figure 4).

Figure 4. Pin hole borers invading the dying tree

Causal agent

The pathogen isolated from the sapwood was identified as *Fusarium oxysporum* while *F. solani* was isolated from the bark (Nelson *et al.* 1983). The pathogenicity test indicated that only *F. oxysporum* caused mortality of angsana (Table 2). This suggests that *F. solani* was either a saprophyte or secondary pathogen. Once the disease symptoms appeared on the inoculated potted plants, *F. oxysporum* extensively colonised the whole root system. Species of *Fusarium* are common widely distributed soil-borne fungi. They produce chlamydospores that can persist in the soil until a suitable host is found (Beckman 1987).

Table 2. Effect of inoculation of angsana seedlings with *F. oxysporum* and *F. solani* after seven weeks

Treatment	Dead trees	Symptoms
F. oxysporum	20	Wilt, root rot, death
F. solani	0	Healthy
F. oxysporum + *F.solani*	20	Wilt, stunted, root rot , death
Control	0	Healthy

Twenty seedlings were used for each treatment.

Control

At Taman Gelora, application of Benomyl provided initial control of the disease. Symptoms of the disease were only noted six months after the experiment began. At untreated sites the disease was spreading rapidly. Both Benomyl treated and untreated trees showed symptoms of infection while those treated with Thiabendazole did not (Table 3). On the other hand, at Tanah Puteh, application of Benomyl did not succeed in suppressing the infection and angsana trees continued to die (Table 3, Figure 5). However, trees treated with Thiabendazole were able to recover (Table 3, Figure 6). New flushes of leaves were noticed after 5–8 weeks of fungicide application.

Table 3. Effect of Benomyl and Thiabendazole on wilt disease severity in field experiments two months after being treated

Treatment	Taman Gelora		Tanah Puteh	
	Initial	After treatment	Initial	After treatment
Thiabendazole	All healthy	All healthy	Early stages of infection	70 % recovered
Benomyl	All healthy	Early stages of infection	Early stages of infection	No recovery, standing dead
Control	All healthy	Advanced stages of infection	Early stages of infection	No recovery, standing dead

Figure 5. Standing dead trees despite being treated with Benomyl

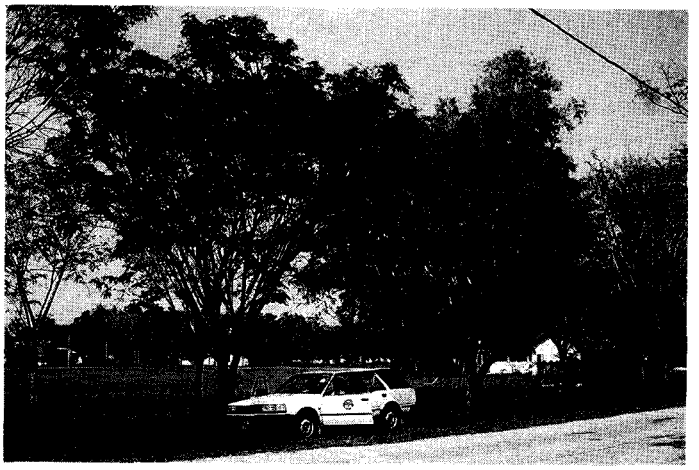

Figure 6. Recovered angsana trees treated with Thiabendazole

Fungicides could be used as a short term control measure but for long term control, the predisposing factors for this disease must be determined. Environmental factors like water stress, nutritional imbalances or adverse soil factors such as soil disturbance and high temperatures could be possible predisposing factors. Moreover, *Fusarium inoculum* remains viable for long periods in the soil as chlamydospores. Under optimum environmental conditions, i.e. temperature, moisture, nutrients and the presence of a suitable host, these spores will germinate and infect the roots (Woltz & Jones 1981). Cook (1981) has suggested that water stressed plants are more susceptible to infection and increased severity of the disease. The use of fertilisers, high in ammonia and nitrogen, and excessive use of phosphorus and magnesium are also known to favour development of disease (Beckman 1987).

Conclusion

The wilting symptom observed in Kuantan appears to be distinctive, often widespread and sudden, fitting the description of a vascular wilt disease (Dimond 1970). Although the mechanism of infection was not identified in this study, it was clear that infection caused a disruption in water supply from the roots to the branches resulting in wilt. Results obtained from the present study indicated that *Fusarium oxysporum* caused wilting and death of angsana trees in Kuantan. Preliminary fungicidal screening indicated that diseased angsana is able to recover when treated with Thiabendazole.

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