Diseases and potential threats to *Acacia mangium* plantations in Malaysia

S.S. Lee

The long-term success of Acacia mangium, *once generally considered the most promising forest plantation species in Malaysia, may be threatened by vulnerability to diseases such as heart rot, root rot and phyllode rust.*

The past three decades have been turbulent times for forest plantations in Malaysia. In the 1970s exotic pines (*Pinus* spp.) were favoured as plantation species with the objective of pulp and paper production. Later, in the continued absence of local pulp and paper mills, there was an intention to use *Pinus* spp. for poles and timber, but this did not come about because planting material was difficult to obtain in Malaysia. Plantations of a number of other exotic species such as *Acacia mangium*, *Araucaria* spp., *Eucalyptus* spp., *Gmelina arborea*, *Maesopsis eminii* and *Falcataria moluccana* (=*Paraserianthes falcataria*) were established in the 1980s with the aim of producing general utility timber. Similarly, Sabah Softwoods was established in Sabah in 1974 to plant *Pinus caribaea* for the pulp industry, but slow growth and seed supply problems led to replacement of the pines with *A. mangium*, *F. moluccana*, *G. arborea* and *Eucalyptus deglupta*. The Sabah Forestry Development Authority (SAFODA) was established in 1976 for the rehabilitation of degraded areas and planted mainly *A. mangium*. The Sabah Forest Industries (SFI) integrated pulp and paper mill began commercial production in 1988 and mainly relied on hardwood timber from the natural forest for its raw materials, but SFI also planted *A. mangium* and *Eucalyptus* spp.

Of the species planted, nitrogen-fixing *A. mangium* appeared most promising, partly because of its far superior growth, wide site suitability, multiple uses and supposed lack of serious pest problems, but especially because it was easy to plant large areas as planting material was not difficult to obtain. *A. mangium*, planted on a 15-year rotation for production of general-utility timber, came to constitute the largest area of forest plantations in the country. While these *A. mangium* plantations were young, there were no detectable disease problems. However, as the plantations grew they turned out to be prone to a number of diseases. The most publicized of these is heart rot; yet two other diseases, root rot and phyllode rust, have turned out to be far more threatening.

Partly as a result of the heart rot problem, *A. mangium* is no longer a popular forest plantation species in Peninsular Malaysia, although it is still planted for pulp and paper production in the eastern Malaysian states of Sabah and Sarawak.

Phyllode rust of* Acacia mangium *– note the deformation of the phyllodes and stem

S.S. LEE

Su See Lee is Senior Research Officer at the Forest Research Institute Malaysia (FRIM), Kepong, Kuala Lumpur, Malaysia.

DISEASES AFFECTING *ACACIA MANGIUM* PLANTATIONS IN MALAYSIA

Heart rot

It has been recognized since the 1980s that *A. mangium* is prone to heart rot, a stem defect which is closely associated with fungal infection of branch stubs, wounds from pruning and singling (pruning of multiple stems to leave a single leader shoot) and forking injuries (Ivory, 1988; Lee *et al.*, 1988). The most common type of heart rot found in *A. mangium* is a white fibrous rot which may occur as small pockets or throughout the length of the heartwood. The rot is only evident when the tree is felled. In Peninsular Malaysia and Indonesia the disease appears to be associated with several basidiomycete fungi (Lee and Noraini Sikin, 1999; N. Bougher, personal communication).

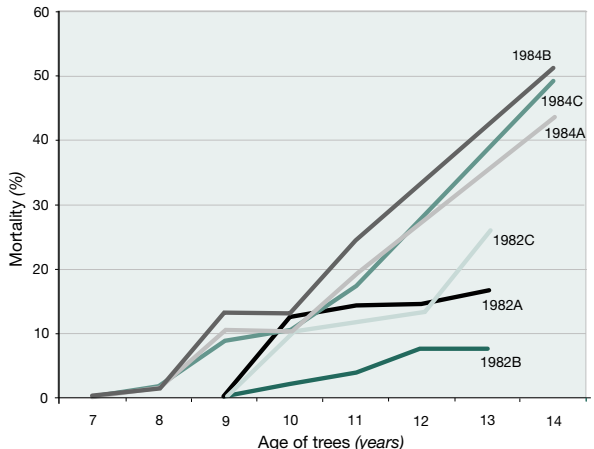
Heart rot incidence can be very high, ranging from about 50 to 98 percent (Ivory, 1988; Mahmud, Lee and Ahmad, 1993; Zakaria *et al.*, 1994). However, the volume of wood affected is usually rather small; mean volume loss is only about 1 percent of merchantable volume.

Unsound knots and wane (defective edges or corners on a plank of wood) are prevalent in sawn timber from *A. mangium* affected by heart rot, which reduces yield, especially of small logs (Ho and Sim, 1994). Timber with heart rot is not suitable for general purposes such as construction because of loss of structural strength and poor recovery of high-value products during processing.

An *A. auriculiformis* x *A. mangium* hybrid is reputed to be less susceptible to heart rot than *A. mangium*, but there are few data to support that theory.

Because of the observed impact of heart rot on timber quality, the Ministry of Primary Industries of Malaysia imposed a temporary moratorium on further planting of *A. mangium* in 1992. However, the moratorium was lifted in 1994 when further studies showed that although the defect had a serious effect on wood used for construction and appearance grades, it was of little significance in the production of pulp and paper or composite wood products (Gregor, 1993).

Heart rot can be controlled through proper pruning operations carried out according to schedule and through tree improvement aimed at producing single-stemmed trees with small-diameter branches which effectively self-prune (see Old *et al.*, 2000).



Source: Lee, 2000.

Increasing mortality rates with age of* Acacia mangium *trees affected by root rot in six plots (identified by year established), Kemasul, Pahang, Peninsular Malaysia

Root rot – a serious disease of *A. mangium*

Although the initial panic was a reaction to heart rot, *A. mangium* is susceptible to other more serious diseases which impair growth or cause tree mortality.

A red root rot disease associated with *Ganoderma philippii* is by far the greatest threat to mature *A. mangium* plantations. This disease is very serious in parts of neighbouring Indonesia, where mortality is high (about 20 percent) (I. Ragil, unpublished data). Mortality is increasing in much younger second- and third-rotation plantations, where trees as young as six months old are being killed by the disease (Old *et al.*, 2000).

Large numbers of trees have been killed in ten-year-old plantations in Peninsular Malaysia (Ito, 1999; Lee, 2000). Tree mortality generally increases with time in areas where the disease is already present (see Figure). Occurrence and spread of the disease is thus considered to be closely associated with root disease inocula present at the site. In a long-term root disease survey in *A. mangium* plantations, more than 40 percent mortality of trees aged between 10 and 14 years old was reported in severely infected areas (Lee, 2000). No figures are available as to how production is affected as large-scale assessment of the impact of the disease has not been carried out.

Leaves of affected trees turn pale green and are much reduced in size and number. Crown condition declines and growth rate is poor. Young shoots may wilt and trees in advanced states of root rot are very prone to wind throw. Root rot centres in plantations may be recognized by the appearance of slowly enlarging patches of dead and dying trees (see Old *et al.*, 2000).

Control of root rot diseases is difficult as the pathogens survive on woody material in the soil. Where mortality resulting from root rot is high, planting of resistant

Acacia cultivars or alternative species may have to be considered.

Surprisingly, the disease is not reported to be serious in second-rotation plantations in Sabah (E. Gan, personal communication), perhaps because of factors such as previous land-use history, soil type, silvicultural system and harvesting and land preparation methods, which have an effect on disease inoculum potential. The relationship between occurrence of root rot and soils is at present unclear and warrants further study.

Phyllode rust – a potential threat

Another disease with potentially devastating effects is a phyllode rust associated with the fungus *Atelocauda digitata*. This disease has been present for some time in its native habitat in Australia and in *Acacia* plantations in Java, Sumatra and Kalimantan in Indonesia (Hadi and Nuhamara, 1997); however, until recently it was thought to be absent from Malaysia. It was recently observed on young *A. mangium* plants in Sabah. Spores of the fungus are wind dispersed and it would appear that the disease is spreading to Malaysia from neighbouring Kalimantan. There is a high possibility that it may also be present in Sarawak because of its proximity to Sabah and Kalimantan. It may be just a matter of time before it spreads to the existing disease-free *A. mangium* plantations in Peninsular Malaysia and other neighbouring countries in Southeast Asia.

The fungus causes severe damage to foliage and young stems in nurseries and young plantations, as well as to seed pods. Heavy infestation results in deformation of the foliage, defoliation, stunted form and reduced growth. The overall impact of the disease has yet to be assessed and at present there is no specific method of control apart from

Acacia mangium *seed pods deformed by the rust* Atelocauda digitata

C.Y. WONG

Is *Acacia mangium* an invasive species?

There has been some concern about the weedy nature of *Acacia mangium* and its potential to become an invasive species. Its ability to rapidly colonize roadsides, abandoned, degraded or open areas and marginal lands is well known, and like its close relative *Acacia auriculiformis*, *A. mangium* is now a common feature of the landscape in Malaysia and many other Southeast Asian countries. As a result, some sources have described *A. mangium* as an alien weed and invasive species, believing that it will diminish the rejuvenation potential of the original biota and invade highland secondary forests and rain forests (Certified Source Timber Programme, 2004). However, to date there are no data to support these predictions.

Alien and native species have been known to coexist in harmony without any deleterious effects on sites or the capacity to deliver services to society, and in some cases such new forests can reverse site degradation processes (Lugo and Brandeis, 2003). In Malaysia, the Forestry Department of Peninsular Malaysia and private forest plantation companies consider *A. mangium* a useful early pioneer species on open and degraded areas where most other plants or trees are unable to grow (E. Gan, Sabah Forest Industries, personal communication; B. Chan, Sarawak Timber Association, personal communication). *A. mangium* is able to revegetate marginal and degraded areas, thereby improving the site for subsequent colonization by other plant and animal species.

Furthermore, *A. mangium* plantations have been located in natural forests in Malaysia, yet there have been no incidences where the species has been found to invade undisturbed sites.

Disease threatens exotic plantation species in Sabah, Malaysia

Falcataria moluccana **(Leguminosae: Mimosoideae) (syn.** ***Paraserianthes falcataria*****), also called albizia, is a fast-growing native of the Moluccas, Papua New Guinea and the Solomon Islands. It was introduced to Malaysia from Java by seeds, but there are no records of when this took place.** ***F. moluccana*** **plantations in Malaysia are largely confined to the state of Sabah, where they cover an estimated 12 000 ha (Jabatan Perhutanan Sabah, 2004). The trees are grown on a rotation of about seven years for the production of chips and pulp.**

In late 1992, an epidemic outbreak of gall rust was reported from ***F. moluccana*** **plantations in Sipitang on the west coast of Sabah. Within a year, the disease had spread over 450 ha, causing wilting of gall-bearing branches, severe dieback, stunting and death of trees. Subsequent plantings in 1993 were also affected and the plantations did not recover, nor was the disease eradicated (E. Gan, personal communication). In 1999, this disease was reported to be widespread in a large, previously gall rust free** ***F. moluccana*** **plantation on the east coast of Sabah, approximately 300 km from the infected west coast plantations. The disease appears to be spreading in this plantation, affecting both seedlings in the nursery and mature trees in the field. Infected seedlings become stunted and die after several months while infected trees in the field have sparse crowns and produce fewer flowers and pods. However, no figures are available on the impact of the disease in the plantations. The disease is controlled in the nursery with fungicidal sprays, but no control measures are currently applied in the field. Studies are under way to find disease-tolerant or disease-resistant trees for a breeding programme.**

The disease is caused by a species of the rust ***Uromycladium*****, most likely** ***U. tepperianum*****. The origin of the disease in the** ***F. moluccana*** **plantations in Sabah is not known. This disease was reported from Mindanao, the Philippines in 1988 and 1989, where it caused very severe damage and economic losses (Eusebio, Sinohin and Dayan, 1990). It is not inconceivable that the infection of the Sabah plantations in 1992 had its origin in the Philippines, given the proximity of Sabah to Mindanao, the dispersal of the spores by wind and the high volume of traffic between the two regions. Between 1999 and 2002 this disease was found throughout all the coffee-growing districts of East Timor, where** ***F. moluccana*** **is planted as a shade tree for coffee plants. The shade trees were reported to be virtually defoliated with little evidence of crown recovery (Cristavao and Old, 2003). Gall rust of** ***F. moluccana*** **is definitely a very serious and devastating disease that requires urgent attention.**

S.S. LEE

Gall rust infection has caused discoloration, swelling and deformation of this **Falcataria moluccana** ***shoot from a mature tree in a plantation***

destroying infected plants. Systemic fungicide application may be feasible in the nursery but is impractical and uneconomical in large-scale plantations. Inclusion of resistant strains in *Acacia* improvement programmes would appear to be the most feasible approach to combating this disease in the long term.

EFFECTS ON PLANTING

Prior to the moratorium on *A. mangium* planting imposed because of heart rot in 1992, all *A. mangium* plantations in Peninsular Malaysia were developed by the federal government. When the moratorium was lifted in 1994 the government had stopped establishing new forest plantations and was encouraging the private sector to take up the enterprise. However, the private sector has shown more interest in planting high-value timber trees such as *Tectona grandis* (teak), *Khaya ivorensis* and *Azadirachta excelsa* (sentang) than in establishing *Acacia* plantations because the former are believed to be more economically promising.

On the peninsula no new significant *Acacia* plantations have been established apart from those previously planted by government projects. Indeed, existing *A. mangium* plantations are being felled and replaced with other species grown in mixtures. Current *A. mangium* areas on the peninsula stand at about 64 000 ha (D.B. Krishnapillay, personal communication).

However, *A. mangium* continues to be planted in Sabah and Sarawak for planned pulp and paper production, which is not influenced significantly by heart rot. In 2000, Sabah had approximately 75 000 ha of *A. mangium* plantations (Jabatan Perhutanan Sabah, 2004) and Sarawak about 4 000 ha (Sarawak Forest Department, 2004).

CONCLUSION

Of the less than 250 000 ha currently under forest plantations in Malaysia (not counting some 1.5 million hectares planted to rubber, *Hevea* spp.), approximately 60 percent has been planted with the fast-growing exotic *A. mangium*. Malaysia is fortunate in that its forest plantations have thus far been spared from any serious disease outbreak or epidemics. However, *A. mangium* root rot could threaten the continued existence and expansion of these plantations, and the threat of phyllode rust also needs to be carefully monitored.

In addition, other as yet unknown diseases could appear as areas under forest plantations expand and other tree species are planted. Therefore, there is always a need for vigilance and regular disease monitoring and/or surveys so that any new diseases may be rapidly detected and suitable management or control measures implemented without delay. New rapid disease detection techniques, selection of disease-resistant plant material and an effective information exchange network within the region also need to be developed to aid in this effort. ◆

Bibliography

Certified Source Timber Programme. 2004. *Promoting plantation grown timber*. Internet document: www.certified source timber.co.uk/examples.htm

Cristavao, C.S. & Old, K.M. 2003. A rust epidemic of the coffee shade tree (*Paraserianthes falcataria*) in East Timor. Poster presented at the International Congress of Plant Pathology (ICPP) 2003, Christchurch, New Zealand, 2-7 February.

Eusebio, M.A., Sinohin, V.O. & Dayan, M.P. 1990. Gall rust disease of *Albizia falcataria* (L.) Beck. *Research Information Series on Ecosystems*, Special Issue.

Gregor, E.W. 1993. Products and market potential for *Acacia* and other plantation species. In *Proceedings of the Seminar on the Potential of* Acacia *and Other Plantation Species*, p. 44-55. Kuala Lumpur, Malaysia, Malaysian Timber Industry Board and Asian Development Bank.

Hadi, S. & Nuhamara, S.T. 1997. Diseases of species and provenances of acacias in West and South Kalimantan, Indonesia. *In* K.M. Old, S.S. Lee & J.K. Sharma, eds. *Diseases of tropical acacias*, p. 23-46. CIFOR Special Publication. Jakarta, Indonesia, CIFOR.

Ho, K.S. & Sim, H.C. 1994. Sawn timber from *Acacia mangium* affected by heartrot. *FRIM Research Pamphlet*, 114: 16-21.

Ito, S. 1999. Annex 8: Incidence and severity of root disease at *Acacia mangium* plantations in the Multi-Storied Forest Management Project. In *Integrated report on the Multi-Storied Forest Management Project in Malaysia (1991-1999)*. Kuala Lumpur, Malaysia, Forestry Department Malaysia, Perak State Forestry Department and Japanese International Cooperation Agency.

Ivory, M.H. 1988. *Forest pathology consultancy final report*. Kuala Lumpur, Malaysia, Silviconsult Ltd/Compensatory Plantation Unit and Federal Forestry Department of Peninsular Malaysia.

Jabatan Perhutanan Sabah. 2004. *Perladangan hutan*. Internet document: www.sabah.gov.my/htan/new/Malay/sumber_hutan/b_history.htm

Lee, S.S. 2000. The current status of root diseases in *Acacia mangium* Willd. *In* J. Flood, P.D. Bridge & M. Holderness, eds. *Ganoderma diseases of perennial crops*, p. 71-79. Wallingford, UK, CABI Publishing.

Lee, S.S. & Noraini Sikin, Y. 1999. Fungi associated with heart rot of *Acacia mangium* trees in Peninsular Malaysia and East Kalimantan. *Journal of Tropical Forest Science*, 11: 240-254.

Lee, S.S., Teng, S.Y., Lim, M.T. & Razali, A.K. 1988. Discoloration and heart rot of *Acacia mangium* Willd. – some preliminary results. *Journal of Tropical Forest Science*, 1: 170-177.

Lugo, A.E. & Brandeis, T. 2003. Human-dominated tropical landscapes: a new mix of alien and native species coexist in harmony. Plenary lecture presented at Biotic Interactions in the Tropics: A Special Symposium of the British Ecological Society and The Annual Meeting of the Association for Tropical Biology and Conservation, Aberdeen, UK, 7-10 July.

Mahmud, S., Lee, S.S. & Ahmad, H.H. 1993. A survey of heart rot in some plantations of *Acacia mangium* Willd. in Sabah. *Journal of Tropical Forest Science*, 6: 37-47.

Old, K.M., Lee, S.S., Shama, J.K. & Yuan, Z.Q. 2000. *A manual of diseases of tropical acacias in Australia, South-East Asia and India*. Jakarta, Indonesia, CIFOR.

Sarawak Forest Department. 2004. *Forest plantations*. Internet document: www.forestry.sarawak.gov.my/forweb/sfm/fdw.fplntn.htm

Zakaria, I., Wan Razali, W.M., Hashim, M.N. & Lee, S.S. 1994. The incidence of heart rot in *Acacia mangium* plantations in Peninsular Malaysia. *FRIM Research Pamphlet*, 114: 1-15. ◆