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COMMON FOREST TREE DISEASES IN THAILAND

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บทคัดย่อ

การวิจัยด้านโรคไม้ป่าในประเทศไทย ได้ริเริ่มดำเนินการเป็นครั้งแรกภายใต้ความรับผิดชอบของฝ่ายปราบศัตรูพืชป่าไม้ กองบำรุง กรมป่าไม้ เมื่อปี พ.ศ. ๒๕๒๐ ตั้งแต่นั้นมาจนถึงปัจจุบัน ได้มีนักวิจัยเฉพาะด้านนี้น้อยมาก วัตถุประสงค์หลักในการศึกษาวิจัยด้านโรควิทยาป่าไม้ก็เพื่อ ทำงานวิจัยเพื่อแก้ไขปัญหาด้านโรคพืชป่าไม้และด้านจุลชีววิทยาป่าไม้ซึ่งมีผลกระทบต่อระบบนิเวศวิทยาของป่าชนิดต่าง ๆ ในประเทศไทย เอกสารวิจัยนี้ได้มุ่งเน้นและสรุปผลงานการวิจัยซึ่งได้พิสูจน์แล้วว่าโรคที่ตรวจพบนี้เป็นศัตรูร้ายแรงทางป่าไม้ที่พบบ่อยในประเทศไทย มาตรการที่ใช้ในการป้องกันและกำจัดโรคชนิดที่สำคัญได้แนะนำไว้ในรายงานนี้ด้วย สรุปข้อเสนอแนะการศึกษาวิจัยในอนาคต ควรมุ่งเน้นการวิจัยด้านชีววิทยาวงจรชีวิตและด้านนิเวศวิทยาของโรคชนิดที่สำคัญ ซึ่งเป็นศัตรูร้ายแรงทางป่าไม้ เพื่อใช้เป็นข้อมูลพื้นฐานสำหรับนำไปประยุกต์ใช้ในการจัดการโรคพืชป่าไม้ในสภาพจริงได้อย่างมีประสิทธิภาพ

ABSTRACT

Forest Pathology research in Thailand was initiated by the Forest Pest Control Branch, Division of Silviculture, Royal Forest Department, Bangkok, Thailand in 1977. At present, very few researchers are working in this specialized field. Their objectives are to carry out research in Forest Pathology and Microbiology in different forest ecosystems of Thailand. This paper summarizes current potentially dangerous forest tree diseases identified and reported in Thailand. Some control measures are also recommended on the basis of laboratory and field practices. Future research should focus on the biology and ecology of serious diseases to provide data for control management in the field.

INTRODUCTION

Forest plantation in Thailand was initiated with Teak (*Tectona grandis* Linn.f.) by Taungya system (agroforestry) at Phrae Province, Northern Thailand, in 1906 but larger-scale plantation only started in 1941 (Kuerkool and Sangpoo, 1986). At present, plantation programs dealing with fuelwood and charcoal, village woodlots (agroforestry), soil and water-shed rehabilitation, and industrial plantations are being established in extensively denuded areas. The major species used are *Tectona grandis* Linn.f., *Pinus kesiya* Royle ex Gordon, *P. caribaea* More.var. *hondurensis*, *Eucalyptus camaldulensis* Dehn., *Casuarina*

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Junghuhiana Miq., *Leucaena leucocephala* de Wit., *Acacia auriculaeformis* Cunn., *A. mangium* Willd., *Swietenia macrophylla* King., *Pterocarpus macrocarpus* Kurz., *Melia azedarach* Linn., *Dipterocarpus alatus* Roxb., *Hopea odorata* Roxb., *Afzelia xylocarpa* Craib, *Paulownia tomentosa* (Thunb.) Steud., *Croton sublyratus* Kurz., *Dalbergia cochinchinensis* Pierre, *Gmelina arborea* Roxb., *Xylia xylocarpa* Taub. var *kerrii* Nielsen, *Rhizophora apiculata* Bl., *R. mucronata* Poir., and many species of bamboos.

With the development of large-scale plantations in term of monoculture, the danger of losses due to pests and diseases has become apparent and increased. This paper briefly discussed the current state of knowledge with regard to diseases found in nurseries, plantations, natural forests, logged - over areas, newly-felled timbes, urban trees, and forest products.

MATERIALS AND METHODS

Forest pathology research started at the Royal Forest Department of Thailand in 1977 with appointment of one forest pathologist and] with appointment of one forest pathologist and the provision of limited equipment. Japanese aid since 1981 has provided a well-equiped laboratory in which forest pathology research has also expanded. The current research activities are as follows:-

1. To survey diseases in different forest ecosystems.

2. To study diseases of flowers, fruits and seeds.

3. To study nursery, plantation and natural forest diseases.

4. To study soil microbiology and soil-borne diseases.

5. To study mycorrhizae and N-fixing microorganisms of forest trees.

6. To study the taxonomy of forest fungi in Thailand.

7. To collect specimens and cultures of important forest tree diseases and microorganisms and establish on forest pathology museum.

8. To study edible, poisonous and medicinal mushrooms.

9. To study entomogenous fungi.

10. To study urban-tree diseases.

11. To study wood-decay fungi in newly-felled timbers and forest products.

12. To study forest fire-insect-disease relationships.

13. To study litter decomposition and nutrient recycling in various forest ecosystems.

14. To study the biology and ecology of current dangerous forest tree diseases.

15. To study control techniques related to chemical, biological, silvicultural, selection of resistant variety, and integrated control methods.

RESULTS AND DISCUSSION

Seed-borne Diseases

A wide variety of seed-borne microorganisms are capable of destroying seeds during storage, after sowing and before germination. They generally colonize seed nutrient reserves before they are fully mobilized and then destroy the seed embryo. Various factors can enhance these losses, including damage to the seed coat and declining viability and germinability of the seeds (Gibson, 1975 and Neergaard, 1977).

Seed-borne organisms commonly cause damping off, blight, wilt, anthracnose, leaf spot, canker and mosaic diseases.

Chalermpongse *et al.* (1984) reported seed-borne fungi of 21 general associated with seeds of 30 broad-leaved and coniferous trees in Thailand. It was evident that seeds of most forest trees indigenous to Thailand carry a wide range of fungi and bacteria.

Pongpanich and Chalermpongse (1985) also studied seed-borne fungi affecting common bamboo species grown in Thailand, namely : *Dendrocalamus strictus* Neer, *Bambusa natans* Wall., *Gigantochloa hasskarliana* (Kurz.) Back ex K. Heyne and *Thyrsostachys siamensis* Gamble. The authors reported that 48 species of fungi were identified.

It was noticeable that fungi colonized bamboo seeds more than seeds of general forest trees. However, The germinability of bamboo seeds was also notably high (80-90%) if stored not more than one year.

The best contral for seed-borne disease is to collect healthy seed and store it under optimum conditions until required.

Deterioration of the seeds is generally governed by the moisture content of the seeds and by storage conditions, mainly humidity and temperature. The only effective method of preventing damage due to storage fungi is by storing seeds in dry conditions and at a low temperature (5° C) which limit fungus growth on the seeds. Chemical seed dressings, such as Benlate, Daconil, Saprol, Thiram and Captan are commonly used in Thailand.

Nursery Diseases

About 50 forest nurseries have been established in Thailand which produce more than 30 millions of seedlings per annum. Forest tree species are often attacked by serious diseases during the rainy season. The following nursery diseases are very common in Thailand:

1. Damping off

Damping off is an important diseases of seedlings of *Eucalyptus spp.*, *Gmelina arborea*, *Melia azedarach*, *Tetrameles nudiflora*,

Dasbuxsa grandiflora, Cassia bakeriana, C. fistula, Afzelia xylocarpa, Ochroma lagopus, Pinus kesiya and Intsia palembanica in nurseries throughout Thailand (Chalermpongse, 1977), especially in the rainy season (May to September). Losses of young seedlings estimated from 10-100% in some nurseries. The disease may destroy the entire nursery stock in one rainy season but may not be important in other years. The use of chemicals and the use of high quality seeds are recommended. Seed protection by fungicides is sometimes effective, but results are often also inconsistent. Increasing the rate and uniformity of seed germination generally reduces losses. However, fungicides may sometimes reduce the amount and speed of germination if temperatures are high. Applying inorganic acids to reduce soil pH to about 5.5-6.5, drenching soils with systemic fungicides, treating soil prior to sowing with methyl bromide, chloropicrin or vorlex may give good disease control. Control of the density of seedlings, restriction of watering and modification of the nursery environment making it unfavorable for disease infection, are the best means of controlling damping off (Peterson and Smith, 1975).

2. Foliage Diseases

Powdery mildew (*Oidium* sp.) is the most serious disease of *Acacia mangium* seedling up to 90-100%. Infection has been recorded with mortality of about 75%. Careful observations revealed that seedling of *Acacia auriculaeformis* and *Peltophorum dasyrachis* nearby were also hosts of this powdery mildew. The disease can be controlled by spraying chemicals such as Benlate.

Sooty mould (*Meliola* sp.) is reported to attack leaves of *Acacia auriculaeformis* and many species of introduced *Acacia* from Australia planted in Prachuab Kirikarn and Ratchaburi province, south-western Thailand. Infection is rather heavy on leaves, but after rains, infection rate seems to be reduced. No control has been studied yet.

Needle casts of *Pinus merkusii* and *P. caribaea* have been recorded at Boa Kaew nursery, Hod, Chiangmai associated with the fungi *Lophodermium indianum, L. kumaunicum, L. australe, Melodermа sharmarum* and *Glomerella cingulata*. The diseases cause infection from 90-100% of seedling lots but mortality is about 20-30%. Control can be achieved in nursery beds by repeated application of Maneb with systemic fungicides such as Benlate, Fundazol or Daconil. Normally 4-6 application at 1-2 week interval will give adequate control.

Black tar spots (*Phyllachora pterocarpi*) on leaves of *Pterocarpus macrocapus* are prevalent in forest nurseries throughout the

country causing severe defoliation of one year seedlings. Seedlings of *Dalbergia cochinchinensis* are also infected. Less frequently *P. macrocarpus* seedlings are affected by the leaf spot (*Cercospora* sp.).

Leaf blight (*Colletotrichum gloeosporioides*) on *Hopea ferrea* seedlings in Sakaerat Project nursery has caused more than 70-80% mortality. Systemic fungicides seem to control this disease effectively.

Maravalia pterocarpi was first recorded as leaf rust of *Dalbergia cochinchinensis* seedlings at Sakaerat Project, Nakorn Ratchasima and ASEAN-CANADA seed Center. Seedlings of 4-8 months are very susceptible during the season of the year. Control can be achieved by spraying with sulphur dust, Benlate, Fundazol or Daconil.

Leaf rust of Teak (*Tectona grandis*) occurs throughout its range of distribution. The disease, caused by *Olivea tectonae*, is a microcyclic rust, attacking only Teak leaves. The damage is severe on young seedlings and plantations. The Teak rust can be controlled by application of systemic fungicides in nurseries but in plantation, it may be controlled by opening the canopy.

A powdery mildew, *Uncinula tectonae*, is commonly widespread in Teak nurseries, plantations and natural forests. However, it does not appear to be serious as the infected leaves are shed along with healthy leaves during normal leaf-fall.

Needle rust, *Coleosporium tussilaginis*, was found on *Pinus kesiya* seedlings of 8-12 months at Boa Luang nursery, Chiangmai in 1985. Very low infection rate was recorded at about 1-2% in nursery.

Ravenelia sp., leaf rust of *Albizia odoratissima* seedlings was recorded in the nursery center of the Sakaerat Project, N.E. Thailand. About 50% infection was detected. Systemic fungicides can control this rust. Another important foliage disease is *Phaeseptoria eucalypti*, leaf spot of *Eucalyptus camaldulensis*. This is a new record in Thailand and the host is a new one for the pathogen (Tanaka and Chalermpongse, 1985).

3. Root rots

Helicobasidium compactum causes root rot of teak (*Tectona grandis*) in nurseries particularly on sites with poor drainage. The affected seedlings should be removed and destroyed while the seedbeds should be sprayed with systemic fungicides.

A severe collar rot of *Melia azedarach* seedlings was found at nursery, Sakaerat Project in January, 1985 after a period of heavy rain. Infection occurred directly on the base of the main stem causing rapid wilt of foliage and subsequent death of infected

seedlings. Surviving seedlings produced new sprouts below the dead region. Mortality was not so high but infection rate was 80-90%. *Phytophthora* sp., *Leptostroma* sp. and *Periconia* sp. were detected on affected parts.

Planting stumps of teak (*Tectona grandis*) stored under ground are often destroyed by *Botryodiplodia theobromae* (15-90%). However, surviving stored stumps outplant much better than freshly-lifted stumps (Kaosa-ard, 1980). Control can be achieved by dipping stumps in 10,000-20,000 ppm Benlate, Dacoal, Fundazol, Vitavax or Saprol for 10-30 min. before storage.

Plantation Diseases

1. Nutrient deficiency

Eucalyptus camaldulensis, an introduced species from Australia, is widely raised for many purposes in Thailand. Mineral deficiencies are probably the most serious problems of *E. camaldulensis*. The best known disorder is boron-deficiency, but lack of N, P, K and other major and minor elements are also observed. The symptoms of nutrient deficiency may be confused with disease caused by biotic agencies. Symptoms usually appear during the dry season (hot season) and disappear on the onset of the rains. At first the leaves turn yellow, then reddish-purple and then they are cast away. Bark necrosis may occur, leading to death of part or all of the tree. The progress of these diseases may be halted by spraying or fertilizing with the deficient nutrients.

2. Root rots

Root rots in teak plantations caused by *Helicobasidium compactum*, *Fusarium solani* and *F. oxysporum* have been recorded in wet and water-logged areas. The fungi generally spread from infected roots killing trees in groups. Chlorosis and leaf cast precede the death of the trees, which may fall over where rooting is shallow. Control can be achieved by the removal of infected stumps. Avoidance of sites favouring the diseases is also recommended.

Root rots caused by *Fusarium oxysporum* and *F. solani* are frequently found in *Gmelina arborea* plantations. The same procedure used to control root rot of teak can be applied for these diseases.

Wilt and dieback of *Pinus kesiya* and *Pinus oocarpa* are probably the most serious problems at plantation age about 12-14 years. Mortality ranges up to 80-90%. Plantation history indicated that 2 continuous years of drought gave rise to the condition in Chanta-buri province, and at the Mae Sariam Pine Improvement Center, Chiangmai. At the same time 12 years old *Acacia auriculaeformis* at a dry site in Ratchaburi province also died out completely.

Root colar rot of *Croton sublyratus* caused by *Fusarium solani* occurs in Prachuab Kirikarn Province, South Thailand. The pathogen attacks root and colar regions of 2-3 year old trees resulting in wilting and death. *C. sublyratus* has been established in plantation of more than 7,000 rai by Thai Zankyo Co. for the purpose of producing medicinal products (Ogiso *et al*, 1981). Control is achieved by improved drainage in affected planting areas and the removal of infected plants.

3. Stem and branch diseases

A canker disease, *Nectria haematococca* (Imperfect stage: *Fusarium solani*) caused 25-30% mortality in 12-16 years old teak in Mae-Kah Seed Orchards, Phayao province, north Thailand. Control was achieved by scraping out lesions and painting with Santa SM fungicidal paste. After 1-2 years, new callus covers the canker wounds.

Infection of *Botryodiplodia theobromae* on stems and branches of *Casuarina junghuhniana* plantation at age 4-5 years causes wilting and dieback of shoots in Nakorn Prachom and Suphan Buri provinces (10-15% and 30-40% respectively). Control is very difficult, but removing infected trees as soon as possible and-up rooting stumps are effective in minimizing the incidence of the disease.

Gummosis of 4-year-old *Eucalyptus camaldulensis* is common at dry sites associated with splitting and swelling of the bark.

4. Heart rot

Heart rot of 12 to 14-year-old *Melia azedarach* plantations associated with a *Phellinus* sp. has been observed in 80-90% of trees at Thai Plywood Company in Chachoengsao province. The degraded logs can only be used for hardboard chips instead of plywood veneer. Dieback caused by *Graphium* sp. also occurs. Avoidance of wet sites for planting and selection of resistant varieties are recommended.

5. Mistletoes

Dendrophithoe pentandra is common on *Tectona grandis*. Severe damage was observed in Khao Bin Teak Plantation, Ratchaburi province where 80-90% of trees adjacent to villege and rice fields were damaged. Control can only be integrated with pruning and thinning operation as chemical control is too expensive and damaging to the surrounding environment.

6. Foliage disease

Most common foliage diseases in plantations are caused by members of imperfect fungi, Ascomycotina and Basidiomycotina. These diseases affect photosynthesis and thus reduce growth. *Olivea tectonae*, a leaf rust, and *Uncinula tectonae*, a powdery mildew

are commonly found in teak plantations but not in serious proportions. *Pestalotiopsis* sp. is known to cause leaf spots on *Rhizophora apiculata* and *R. mucronata*.

Natural Forest and Logged-over Area Diseases

1. Heart rots

Heart rots account for the most important loss in natural forest timber production and logged-over forests. Infection occurs through broken branches, stems, cracks, insects and animal wounds, knots and fire scars.

Ganoderma applanatum, *G. australe* and *G. lucidum* commonly cause butt and heart rots in a wide range of forest tree species in Thailand especially on *Dipterocarpus alatus* and other species of Dipterocarpaceae in which 50-60% of logs may be affected. These fungi can also cause butt and heart rots of *Casuarina* spp. through wounds and fire scars.

Other decay fungi are typically associated with rots of particular tree species:-

Phellinus rimosus on *Shorea obtusa* and *S. siamensis*

Phellinus badius and *Daedalea andamani* on *Xylia xylocarpa* var. *kerrii*

Fluviporus robaflavus on living and dead of *Tectona grandis*

Polyporus bicolor on *Terminalia corticosa*

Phellinus fastuosus on *Hopea odorata* and *H. ferrea*.

Phellinus melanoporus and *P. demidoffii* also cause butt and heart rot on *H. ferrea*.

Pseudophaeolus baudonii on *Acacia catechu*

Phellinus senex on *Toona ciliata*

Elfvingia mastopora on *Schoutenia hypoleuca*

Heterobasidion insulare on fresh stumps of *Pinus kesiya*.

Fomitopsis pinicola and *F. pini* cause butt and heart rots on *Pinus merkusii*, *P. caribaea* and *P. kesiya* in pine forests.

Phellinus pachyphloeus on *Rhizophora apiculata*

Phellinus rimosus on old growth *Xylocarpus granatum*

Phellinus lamaensis on *Dipterocarpus tuberculatus*.

Control of butt and heart rots in natural forest and logged-over areas can be accomplished by silvicultural and management practices. Selection cum improvement felling and salvage cutting should be implemented during harvesting periods.

2. Witches' broom

Natural *Pinus kesiya* and *P. merkusii* are known to be susceptible to witches' broom disease.

3. Stem galls

Stem gall may be caused by insects, fungi, bacteria, viruses or mycoplasmas. *Afzelia xylocarpa, Tectona grandis, Melia azedarach, Shorea obtusa, S. siamensis, Pinus kesiya, P. merkusii,* are susceptible to attack by stem galls but so far the details have also not yet been studied.

4. Mistletoes

Many mistletoes have been found in natural forests in Thailand. Some have been identified but many have not yet been studied. *Dendrophtoe pentandra* and *D. falcata* seem to have a wide host range. *Scurrula ferruginea* is known to infect branches and stems of *Shorea obtusa* and *Pterocarpus macrocarpus* but *Viscum liquidambaricum* is known to occur only on *S. obtusa* in dry-deciduous dipterocarp forests.

Major and Minor Forest Products

1. Blue Stains and Mould

Mould develops superficially on wood and may be easily brushed or planed off. Blue stains, which penetrate deep into the wood, are caused by fungi which belong to Ascomycotina and Fungi Imperfecti. Infected wood, especially newly-felled timbers may show different shades of blue, black, yellow or brown colors. Blue stain is more common on softwoods than on hardwoods. Stain in wood may also be caused by decay fungi.

Botryodiplodia theobromae is the most common and important blue stain fungus affecting woods of *Pinus kesiya, P. caribaea, P. merkusii, P. oocarpa, Casuarina junghuhniana* and *Hevea brasiliensis.*

2. Wood-decaying fungi

Wood decay can be divided into white rot, brown rot, soft rot and bacterial rot. In white rot both lignin and cellulose are attacked. In brown rot, only cellulose and hemicellulose are attacked while lignin remains unaffected. In soft rot, cellulose is removed but the mechanism of action on cell walls is different. Bacterial rot degrades wood by a slow process which is different to that caused by fungi.

Phanichapol (1968) reported 67 fungi belonging to 11 families on decaying wood in Thailand. Hjortstam and Ryvarden (1982) also published the Aphyllophorales from northern Thailand on which there are 145 species of decay fungi belonging to Corticiaceae and Polyporaceae. About 116 of which are recorded as new to Thailand.

Wood-decaying fungi can be controlled by using water-borne and oil-borne preservative treatments applied by pressure and none-pressure processes.

Diseases of Urban Trees

In cities soil aeration, water-logging and water supply become critical because of

numerous buildings, pavement and soil compaction. Leaf litter fall is removed instead of allowing it to decompose and recycle nutrient into or around the rhizosphere of trees.

In heavily industrilized areas, damage to trees occurs from various air pollutants resulting in disturbance to their physiology. Mechanical damage to trees occurs during construction works, movement of vehicles or deliberate wounding by man. All these lead to infection by pathogens causing death of branches, leaves, shoots or the whole tree.

Around Phramane Ground, the oldest and most famous recreation area in the heart of Bangkok, old *Tamarindus indica* trees are affected by butt and heart rots caused by *Ganoderma applanatum* and stem cankers.

Old *Swietenia mahogani* trees planted in the campus of National Bank of Thailand in Bangkok are also infected by butt and heart rot caused by *Phellinus fastuosus*.

These are a few examples of diseases affecting urban trees in Thailand.

Remedial measure to tackle affected *T. indica* is done by artificial pruning, surgery and wound protection techniques. Information about decoration, art works, civil engineering and protection techniques of urban trees is detailed by Peace (1962).

CONCLUSIONS AND RECOMMENDATION

Increase of net wood production comes not only from stimulating tree growth but also from reduction of losses. The damaging agencies of our forest resources are both non-biotic and biotic.

Disease problems of forest trees in Thailand have become increasingly more significant in recent years with the impact on native stands at record level. Forest diseases markedly reduce forest productivity and increase the risks of long-term forest investments. Research and development to provide effective, environmentally safe fungicides for suppressing forest diseases are urgently needed. The encouragement of cooperative efforts and exchange of data among the various countries is also a high priority.

Microbial aspects of decomposition and nutrient cycling in various forest ecosystems, research on tropical mycorrhizae, N-fixing microorganisms (*Rhizobium, Bradyrhizobium, Azotobacter, Frankia*, etc.), insect pathology, forest fire-insect-disease relationships, and other beneficial microorganisms like edible, poisonous and medicinal mushrooms and geomicrobiology are the main gaps awaiting research in Thailand.

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