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Teak Diseases Assessment in Plantation Sites of West Bago Yoma Region, Myanmar

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Teak Diseases Assessment in Plantation Sites of West Bago Yoma Region, Myanmar

Abstract

Disease survey was carried out in teak plantations of Pyay and Thayarwaddy Districts in West Bago Yoma Region, Myanmar in order to investigate diseases of teak and identify the causal organisms during August-November 2022. Different disease symptoms (foliage, stem and root) were observed. Foliage diseases were more prevalent than stem and root diseases. Foliage diseases showed leaf spot, rust, leaf blight and powdery mildew symptoms. Five pathogens namely *Cercospora tectonae*, *Olivea tectonae*, *Rhizoctonia bataticola*, *Curvularia* spp. and *Erysiphe tectonae* were identified from infected leaves. Disease severity index of leaf spot and leaf blight reached medium disease severity index range (1.1-2) in teak plantations of Thayarwaddy and Gyobingauk Townships. More rust and powdery mildew infection were observed in young plantations (2 - 17 years old) than old plantations (18 - 44 years old). The highest disease severity index of rust 0.57 was found in teak plantations of Minhla Township. Powdery mildew infection was highest in 2 – 7 years old teak plantations. Die back and mistletoe incidence were high in old plantations (18 - 44 years old).

Key Words: Bago Yoma, disease symptoms, disease severity index, teak

ပဲခူးရိုးမ (အနောက်) ဒေသအတွင်း တည်ထောင်ထားရှိသော ကျွန်းစိုက်ခင်းတွင် ကျရောက်သည့် ကျွန်းရောဂါများအား လေ့လာအကဲဖြတ်ခြင်း

စာတမ်းအကျဉ်း

ပဲခူးတိုင်းဒေသကြီး ပြည်ခရိုင်နှင့် သာယာဝတီခရိုင်အတွင်း တည်ထောင်ထားရှိသည့် ကျွန်းစိုက်ခင်းများတွင် ကျရောက်တတ်သော ရောဂါများနှင့် ရောဂါဖြစ်စေသည့် သက်ရှိများအား ရှာဖွေဖော်ထုတ်ရန်အတွက် ရောဂါကျရောက်မှု စာရင်းကောက်ယူခြင်းကို ၂၀၂၂ ခုနှစ် ဩဂုတ်လမှ နိုဝင်ဘာလအထိ ဆောင်ရွက်ခဲ့ပါသည်။ အရွက်၊ ပင်စည်နှင့် အမြစ်တို့တွင် ကျရောက်သော ရောဂါလက္ခဏာများပေါ် မူတည်၍ ရောဂါစာရင်း ကောက်ယူခြင်းကို ပြုလုပ်ခဲ့ပါသည်။ ပင်စည်နှင့် အမြစ်တွင် ကျရောက်သော ရောဂါ လက္ခဏာများထက် အရွက် ရောဂါလက္ခဏာများသည် တွေ့ရှိရမှုအများဆုံး ဖြစ်ပါသည်။ ကျွန်းပင်များတွင် ရွက်ပြောက် လက္ခဏာ၊ သံချေးလက္ခဏာ၊ ရွက်ခြောက်လက္ခဏာနှင့် ဖားဥမှိုလက္ခဏာ စသည့် အရွက် လက္ခဏာများ တွေ့ရှိခဲ့ရပါသည်။ အရွက်ရောဂါလက္ခဏာပြ ကျွန်းရွက်မှ ရောဂါဖြစ်စေသည့် သက်ရှိများ ဖြစ်သော *Cercospora tectonae*၊ *Olivea tectonae*၊ *Rhizoctonia bataticola* ၊ *Curvularia* spp. *နှင့် Erysiphe tectonae* တို့ကို မွေးမြူရရှိခဲ့ပါသည်။ သာယာဝတီနှင့် ကြို့ပင်ကောက်မြို့နယ်များရှိ ကျွန်းစိုက်ခင်းများတွင် ကျရောက်နေသည့် ရွက်ပြောက် ရောဂါနှင့် ရွက်ခြောက်ရောဂါ၏ ရောဂါပြင်းထန်မှု ညွှန်းကိန်းသည် အလယ်အလတ်အဆင့် (၁.၁ – ၂) သို့ ရောက်ရှိလျက် ရှိပါသည်။ (၂)နှစ်မှ (၁၇) နှစ် သက်တမ်းရှိ ကျွန်းစိုက်ခင်းများသည် (၁၈) နှစ်မှ (၄၄) နှစ်သက်တမ်းရှိ ကျွန်းစိုက်ခင်းများထက် သံချေးရောဂါနှင့် ဖားဥမှို ရောဂါကျရောက်မှု ပိုမိုမြင့်မားနေသည်ကို တွေ့ရှိရပါသည်။ ကျွန်းစိုက်ခင်းများထဲတွင် သံချေး ရောဂါ၏ အမြင့်ဆုံး ရောဂါပြင်းထန်မှုညွှန်းကိန်း (၀.၅၇) ကို မင်းလှမြို့နယ်၌ တွေ့ရှိရပါသည်။ ဖားဥမှိုရောဂါကျရောက်မှုသည် သက်တမ်း (၂) နှစ်မှ (၇)နှစ်ရှိ ကျွန်းစိုက်ခင်းများတွင် အများဆုံးဖြစ်နေသည်ကို တွေ့ရှိရပါသည်။ *Mistletoe* ကပ်ပါးပင်နှင့် ကိုင်းခြောက်ရောဂါ ကျရောက်မှုသည် (၁၈) နှစ်မှ *(၄၄)* နှစ် သက်တမ်းရှိ ကျွန်းစိုက်ခင်းများတွင် ပိုမိုမြင့်မားနေသည်ကို လေ့လာတွေ့ရှိရပါသည်။

Teak Diseases Assessment in Plantation Sites of West Bago Yoma Region, Myanmar

1. Introduction

Teak (*Tectona grandis* L.f.), tropical deciduous forest tree, inhabits naturally in Myanmar, India, Thailand and Laos. Teak is one of the most expensive timbers in tropical countries (Kaosa-ard, 1989) and it is a source of premium hardwoods for diverse applications (eg, furniture, construction, panel work, railway carriages (Keogh, 2009). The reputation of teak timber is due to its matchless combination of qualities: termite, fungus and weather resistance, strength, attractiveness, workability and seasoning capacity without splitting, cracking, warping or materially altering shapes (Hoe, 1969). Teak constitutes about 75% of the world's high quality tropical hardwood plantations. Teak is mostly used species for forest plantation establishments in Myanmar. Teak plantation area from 1981-1982 to 2018 was 395,492 ha covering 43.55 % of total plantation area of different species (FD 2020). In Myanmar, teak mainly occurs in dry and moist deciduous forests growing together with other deciduous trees species such as Legumes, *Lagerstroemia* species, *Terminalia* species and bamboo (Thein et al., 2007). Robertson (2002) reported that teak is susceptible to various kinds of pests and diseases. Different genera of various fungal groups are associated with cultivated plants and forestry species, such as teak (Nagadesi and Arya, 2014). In Myanmar, teak plantations often suffer severe damage from insect and disease attack and outbreak of infestation have been occasionally reported. The occurrence of teak rust has recorded by Common wealth Mycoligical Institute (CMI) (Mulder and Gibson, 1973). Teak rust incidence was also observed in nursery and plantations of Mandalay, Mawlamyine, Yezin, Yangon and Pathein (Than, 2000). Teak seedling blight caused by *Phytophthora* spp. occurred in East Bago Yoma teak nurseries (Saw , 1983). Teak mistletoe infection in Moeswe teak plantation was recorded by Win and Than, 2015. Investigation of reliable control measures against teak diseases is important. Therefore, Asian Forest Cooperation Organization (AFoCO) collaborated with Forest Department (FD) is implementing Integrated Pest and Disease Management (IPDM) Project in Teak Plantation in West Bago Region, Myanmar with the objectives to contribute to maintaining healthy forests and the vitality of the West Bago Yoma Region through exploring pest and disease lists, their possible control and prevention measures, and enhancing capacity building programs for all stakeholders.

2. Objectives

The present investigation was undertaken to assess different teak disease problems on plantations in West Bago Yoma Region.

3. Materials and Methods

3.1 Study Sites and Sampling

The project site was West Bago Yoma Region which covers two main Districts; Tharyarwaddy and Pyay. Pyay District is located in Bago Region of West Bago Yoma (between the latitude 18° 20' to 19° 22' N and longitude 95° 06' to 97° 66' E), Myanmar. Tharyarwaddy District is also located in Bago Region of West Bago Yoma (between the latitude 17° 28' to 18° 48' N and longitude 95° 09' to 96° 05' E), Myanmar. The research was conducted in Paukkhaung, Padaung Townships of Pyay District and Thayarwaddy, Minhla and Gyobingauk Townships of Thayarwaddy District. The main criteria for selecting different plantation areas based on the age of plantations and spatial distribution. Five teak plantations from each township were selected for disease survey (Table 1). Each sample plot area was 20 acres and the coverage of sample plot area was equivalent to 100 acres of teak

plantation. There were five sub-plots in each sample plot. In each sub-plot, eight trees were randomly selected for monthly disease survey (Figure 1).

Table 1. List of representative teak plantations area for disease survey

No.	Plantation No.	Year of Establishment	Location
1	2/1979	1979	Nawin (S) Reserve, Paukkhaung Township
2	2/1998	1998	Nawin (S) Reserve, Paukkhaung Township
3	2/2007	2007	Nawin (M) Reserve, Paukkhaung Township
4	3/2013	2013	Nawin (S) Reserve, Paukkhaung Township
5	2/2021	2021	Nawin (M) Reserve, Paukkhaung Township
6	1/2008	2008	Thayetan Reserve, Padaung Township
7	2/2010	2010	Thayetan Reserve, Padaung Township
8	2/2012	2012	Thanlaegyi Reserve, Padaung Township
9	1/2020	2020	Thani Reserve, Padaung Township
10	1/2021	2021	Thayetan Reserve, Padaung Township
11	1/2008	2008	Thonese Reserve, Thayarwaddy Township
12	1/2011	2011	Thonese Reserve, Thayarwaddy Township
13	1/2016	2016	Kanni Reserve, Thayarwaddy Township
14	1/2019	2019	Thonese Reserve, Thayarwaddy Township
15	1/2021	2021	Thonese Reserve, Thayarwaddy Township
16	1/2004	2004	Minhla Reserve, Minhla Township
17	2/2009	2009	Minhla Reserve, Minhla Township
18	1/2016	2016	Mokkha Reserve, Minhla Township
19	1/2017	2017	Mokkha Reserve, Minhla Township
20	1/2019	2019	Mokkha Reserve, Minhla Township
21	1/2008	2008	Bawbin Reserve, Gyobingauk Township
22	4/2010	2010	Bawbin Reserve, Gyobingauk Township
23	5/2010	2010	Bawbin Reserve, Gyobingauk Township
24	2/2011	2011	Bawbin Reserve, Gyobingauk Township
25	1/2021	2021	Bawbin Reserve, Gyobingauk Township

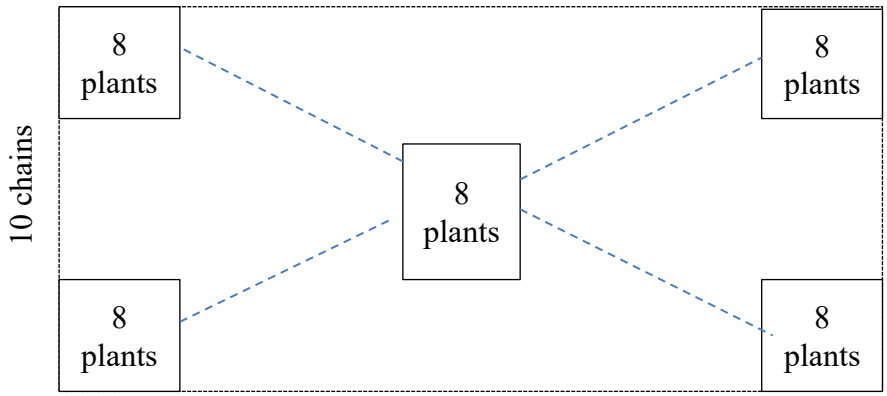


Figure 1. Layout design of sample plot

3.2 Study Period

Disease surveys were conducted during August-November 2022 and observation recorded on disease (Plate 1).

Plate 1. Teak disease survey during August-November 2022

3.3 Assessment of Disease Incidence and Disease Severity

Assessment of disease was designed to be able to conduct in different seasons (summer, monsoon and winter). Diseases were classified based on the symptoms of tree parts (foliage, stem and root). Disease severity assessment was rated on numerical scale (0-3) of disease severity index by using Sharma et al., (1985) (Table 2). The rating system of teak mistletoe infection was calculated by Win and Than, 2015.

Table 2. Disease scoring scale to access the severity of foliage infection, stem canker and root disease in plantation

Disease Severity	Foliage Infection	Main Stem Canker	Branch Canker	Root Disease	Disease Severity Index (1-3)
Nil	Nil	Nil	Nil	Nil	0
Low (L)	Up to 25% of the foliage infected	1 canker, no apparent harm to tree	Up to 25% of the shoots of tree affected	Die back of branches(.25%) in the crown	1(0.1-1)
Medium (M)	> 25-50% of the foliage infected; >10% defoliated prematurely	1-2 cankers, epicormic shoots present	> 25-50% of the shoots of tree affected	Die back of branches(>50%), thinning of crown	2(1.1-2)
Severe (S)	50-70% or more foliage infected; >25 defoliated prematurely	1-2 or more cankers, epicormic shoots present, apical shoot dead due to girdling	> 50-70% of the trees affected	Foliage of pale yellow accompanied by premature defoliation, extensive die-back, death of tree	3(2.1-3)

Disease incidence percentage was calculated by using the formula.

$$\textbf{Percent Disease Incidence} = \frac{\textbf{nd}}{\textbf{N}} \times \textbf{100}$$

nd = total number of plants affected

N = total number of plants observed in all the plots (Karnataka, 2010)

Disease severity index (DSI) was calculated by using the formula.

$$\text{Disease Severity Index (DSI)} = \frac{nL \times 1 + nM \times 2 + nS \times 3}{N}$$

nL. = number of plant with low
nM = number of plant with medium
nS = number of plant with severe
N = total number of tree accessed in all observation plots (Sharma et al., 1985)

3.4 Collection, Isolation and Identification

Infected plant parts showing various symptoms were collected and kept into sterile polyethylene bags and plastic bottle (containing cotton and silica gel for moisture control purpose). Leaves showing same symptoms were collected together in the same polyethylene bag. Place of collection, locality, date of collections and weather conditions were noted. Rust and powdery mildew disease observations were recorded based on occurrence.

Isolation of collected samples was carried out at the Laboratory of Plant Pathology Research Section, Department of Agricultural Research (DAR). The infected plant parts were cut into small piece (3mm) and surface-sterilized in 70% sodium hypochloride solution (NaOCl) for 3 minutes and rinsed 3 times in sterile distilled water. The cut pieces were inoculated aseptically on potato dextrose agar (PDA) in sterile Petri dishes. The plates were incubated at room temperature for the growth of associated organisms. Slides were prepared and observations were made by using compound microscope. Observed growths were sub-cultured several times to obtain pure cultures. Pathogens were identified based on disease symptoms, colony morphology and spores identification by using standard literature (CMI, 1966).

3.5 Pathogenicity Test

In order to determine the related organisms isolated from the teak leaves, a pathogenicity test was carried out separately with each of the isolates. Artificial inoculation experiments were conducted using detached leaf method (Amadi, 2003). Healthy mature leaves were collected from the teak plantations in sterile polyethylene bags and used for artificial inoculation. Samples were surface-sterilized in 70 % ethanol for 3 minutes and rinsed 3 times in sterile distilled water. The leaves were injured at four points with sterile needle and then placed on layers of moist filter papers in sterile Petri dishes. Spore suspension was inoculated into each test leaf (Plate 2). Inoculated leaves were incubated at room temperature and observed frequently for symptom development. Re-isolations were carried out from inoculated leaves showing symptoms. Control plates were inoculated with sterile distilled water and incubated at room temperature.

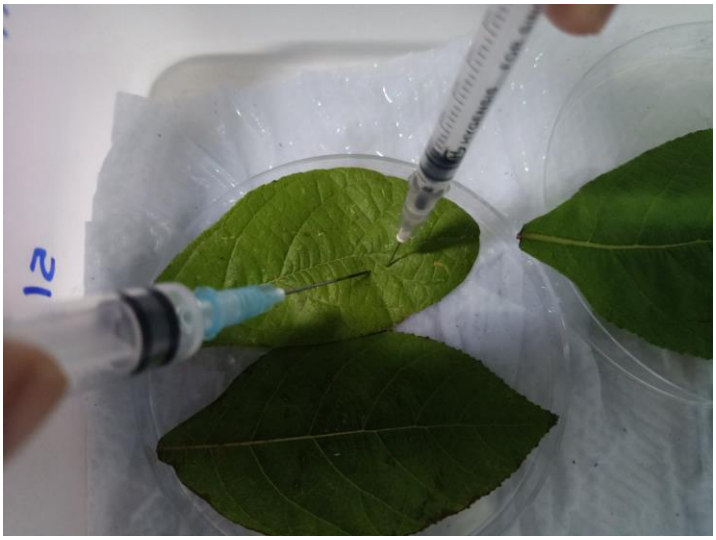


Plate 2. Pathogenicity test

4. Results and Discussion

4.1 Disease Incidence and Disease Severity Index

During disease survey, it was found that foliage diseases was more prevalent than stem and root diseases. Among foliage diseases, leaf spot, rust and leaf blight infection were found in all survey areas. Powdery mildew and stem disease infections were not detected in survey areas of Gyobingauk. Only stem disease symptom was observed particularly dieback in Padaung and canker in Minhla. Both dieback and canker disease symptoms were found in Paukkhaung and Thayarwaddy. Mistletoe infection was occurred only in Paukkhaung. The root disease symptoms were not detected in survey area (Table 3).

Table 3. Disease occurrence in surveyed teak plantations during August-November 2022

Tree Part	Name of disease	Township				
		Paukkhaung	Padaung	Thayarwaddy	Minhla	Gyobingauk
Foliage	Leaf Spot	√	√	√	√	√
	Rust	√	√	√	√	√
	Leaf Blight	√	√	√	√	√
	Powdery Mildew	√	√	√	√	-
Stem	Dieback	√	√	√	-	-
	Canker	√	-	√	√	-
	Mistletoe	√	-	-	-	-
Root	Wilt	-	-	-	-	-
	Root Rot	-	-	-	-	-
	Damping Off	-	-	-	-	-

√ = Detected, - = Not Detected

In 25 teak plantations, mean disease incidence and disease severity index of foliage diseases (except powdery mildew) was higher than those of stem diseases. Ashajyothi et al., (2021) similarly reported that among various diseases, foliage diseases mainly leaf rust, leaf spot and leaf blight are the most common diseases in many areas of India. The occurrence of leaf spot was maximum with a mean of 64.83 %, followed by leaf bight (58.10%) and least mean disease incidence was observed for canker (0.85%). Maximum disease severity index was recorded for leaf spot (0.76) and least severity index was recorded for canker (0.01) (Table 4). Soni and Nag, (2021) revealed that the major tree disease in *Tectona grandis* was leaf spot that compared with leaf blight, leaf gull and stem canker.

Table 4. Teak diseases incidence and disease severity index at survey area during August-November 2022

Sr. no.	Diseases	Mean Disease Incidence (%)	Mean Disease Severity Index
1	Leaf Spot	64.83	0.76
2	Rust	26.13	0.36
3	Leaf Blight	58.10	0.73
4	Powdery Mildew	2.93	0.03
5	Dieback	8.95	0.09
6	Canker	0.85	0.01
7	Mistletoe	1.03	0.02

In Paukkhaung teak plantations, the disease severity index was highest in leaf blight (0.52%) followed by leaf spot (0.43%), rust (0.05%) and least in powdery mildew (0.008%) (Figure 2). The disease severity index was found maximum in leaf blight, leaf spot, rust and powdery 0.66, 0.65, 0.14 and 0.003 respectively in Padaung teak plantations (Figure 3). Maximum disease severity index was recorded for leaf spot (1.01) and least severity index in powdery mildew disease (0.14) that found in Thayarwaddy teak plantations (Figure 4). In Minhla teak plantations, disease severity index of rust (0.57) was highest, followed by leaf spot (0.29), leaf blight (0.15) and powdery mildew (0.008) (Figure 5). Disease severity index of leaf spot and leaf blight in Gyobingauk teak plantations reached 1.41 and 1.56 respectively (Figure 6).

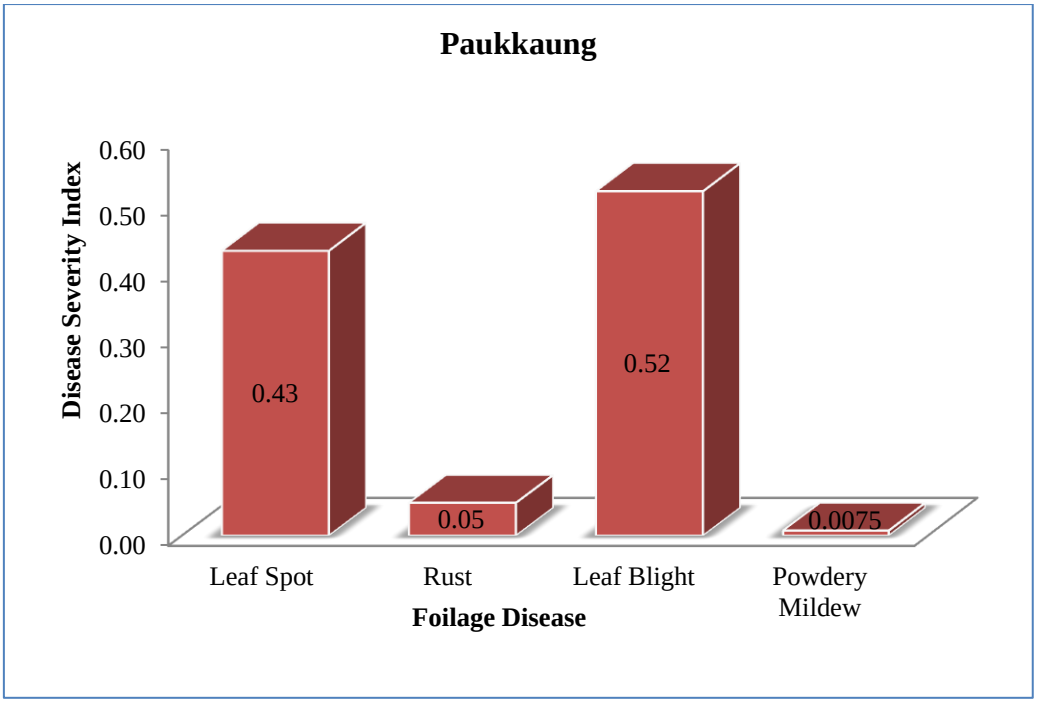


Figure 2. Disease severity index of foliage diseases in Paukkhaung Township during August-November 2022

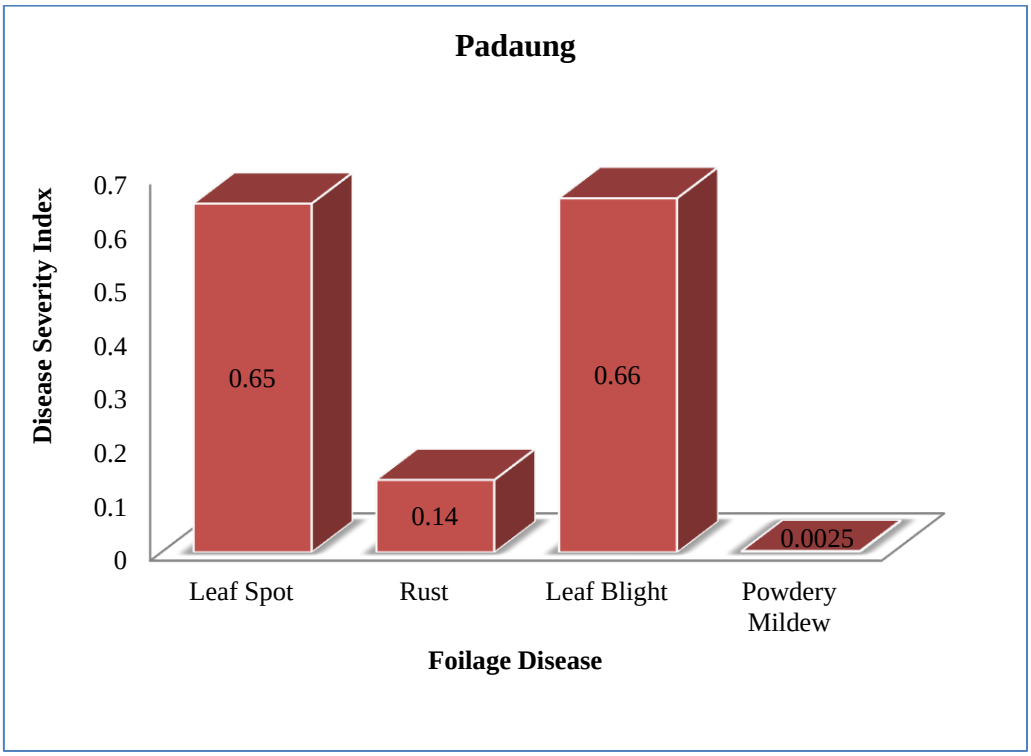


Figure 3. Disease severity index of foliage diseases in Padaung Township during August-November 2022

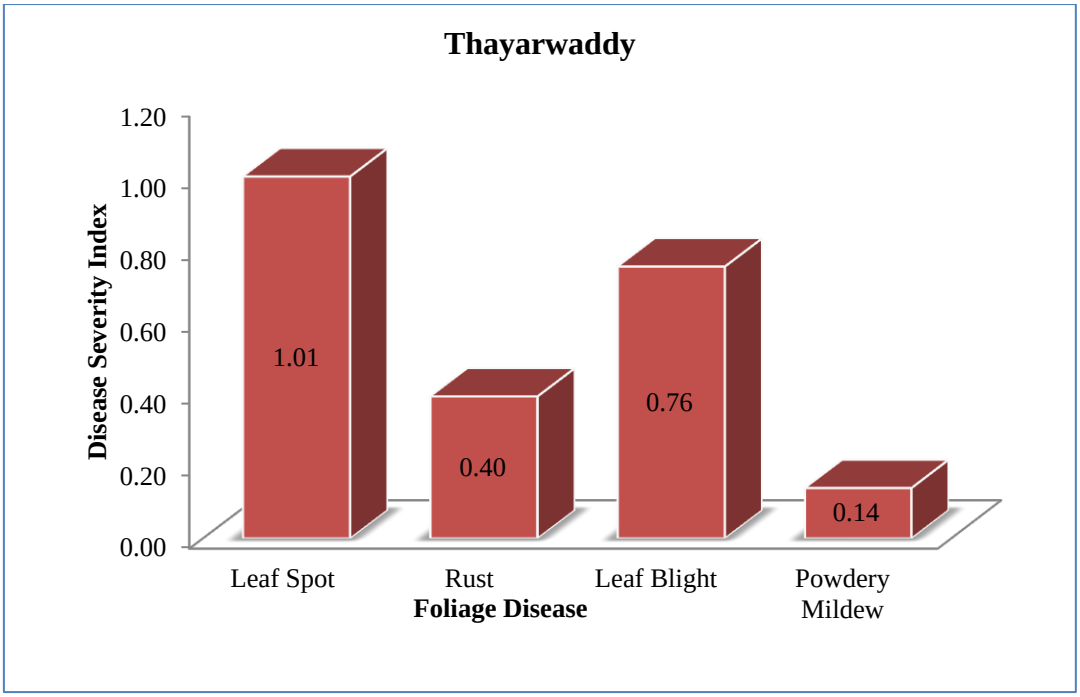


Figure 4. Disease severity index of foliage diseases in Thayarwaddy Township during August-November 2022

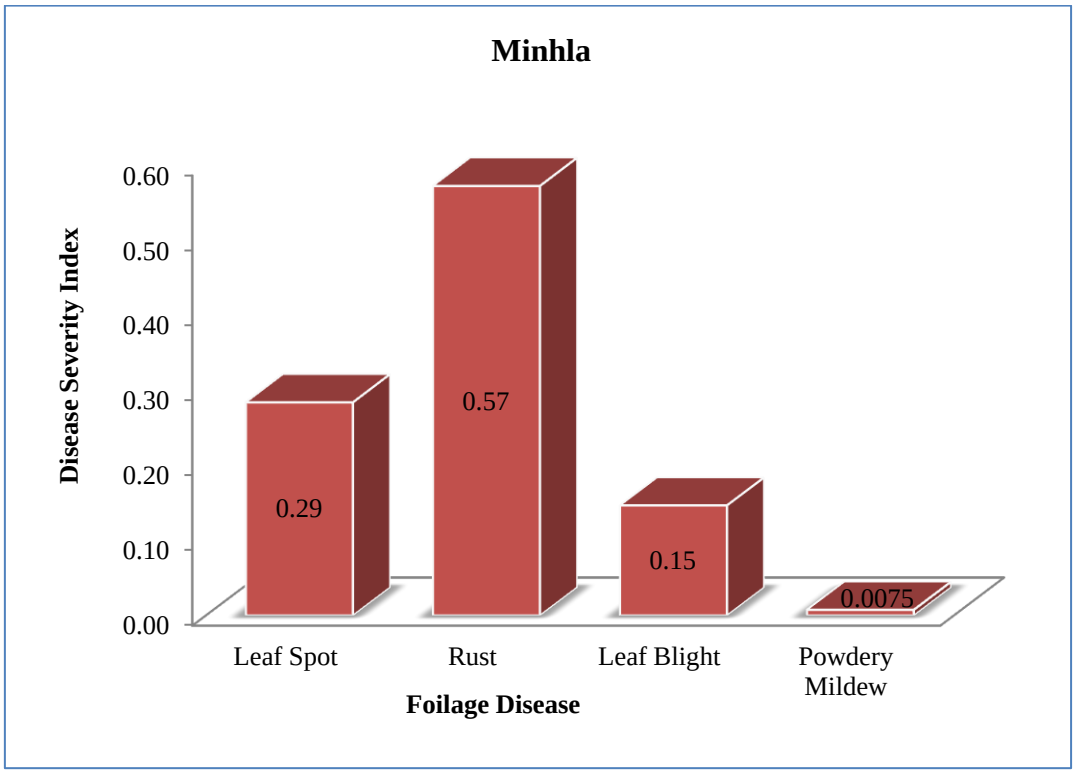


Figure 5. Disease severity index of foliage diseases in Minhla Township during August-November 2022

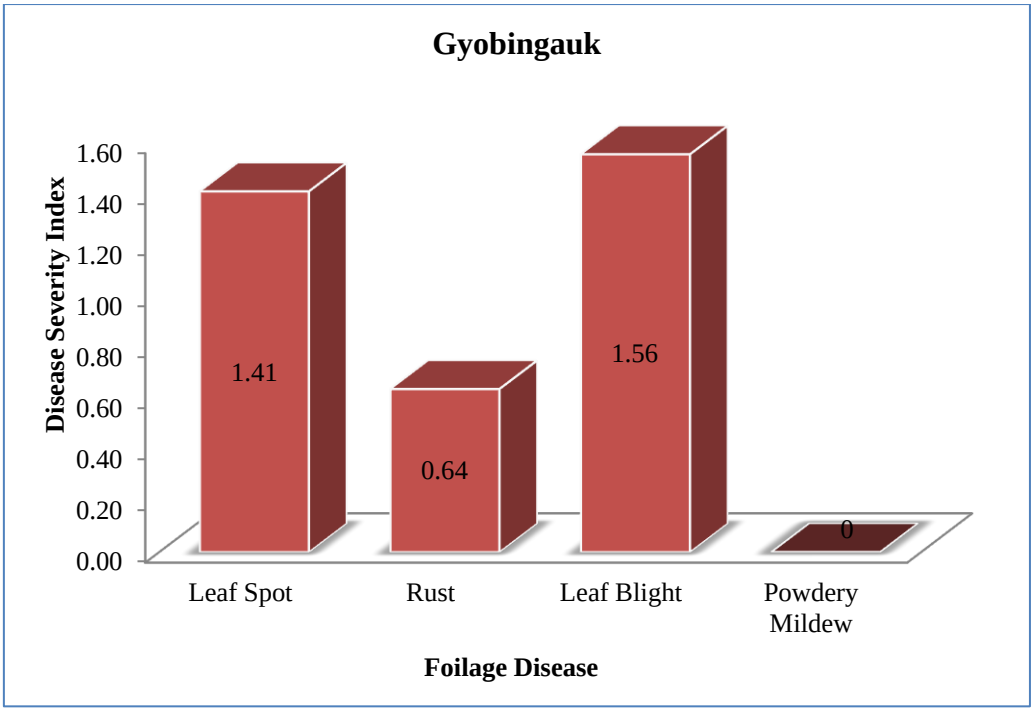


Figure 6. Disease severity index of foliage diseases in Gyobingauk Township during August-November 2022

Teak trees were categorized into four groups according to year of establishment. The teak trees with the year of establishment from 1979-2005 were categorized in Group 1, 2006-2010 in Group 2, 2011-2015 in Group 3 and 2016 – 2021 in Group 4. It was found that foliage disease incidence was higher in young plantations (Group 2, Group 3 and Group 4) than old plantations (Group 1). Rust and powdery mildew infection was highest in young plantations (Group 4) (Figure 7). Sharma et al., (1984) found that the severity of rust was relatively higher in nurseries and younger plantations (<10 years old) than in older ones. In this study, percent disease incidence of dieback was lowest in young plantations (Group 1) compared with old plantations (Group 1). Sharma et al., (1984) also found that dieback of teak in a 40 years old plantations and dieback were only infected in more than 10 years old plantations. Mistletoe infection was found in old plantations Group 1 (Figure 8).

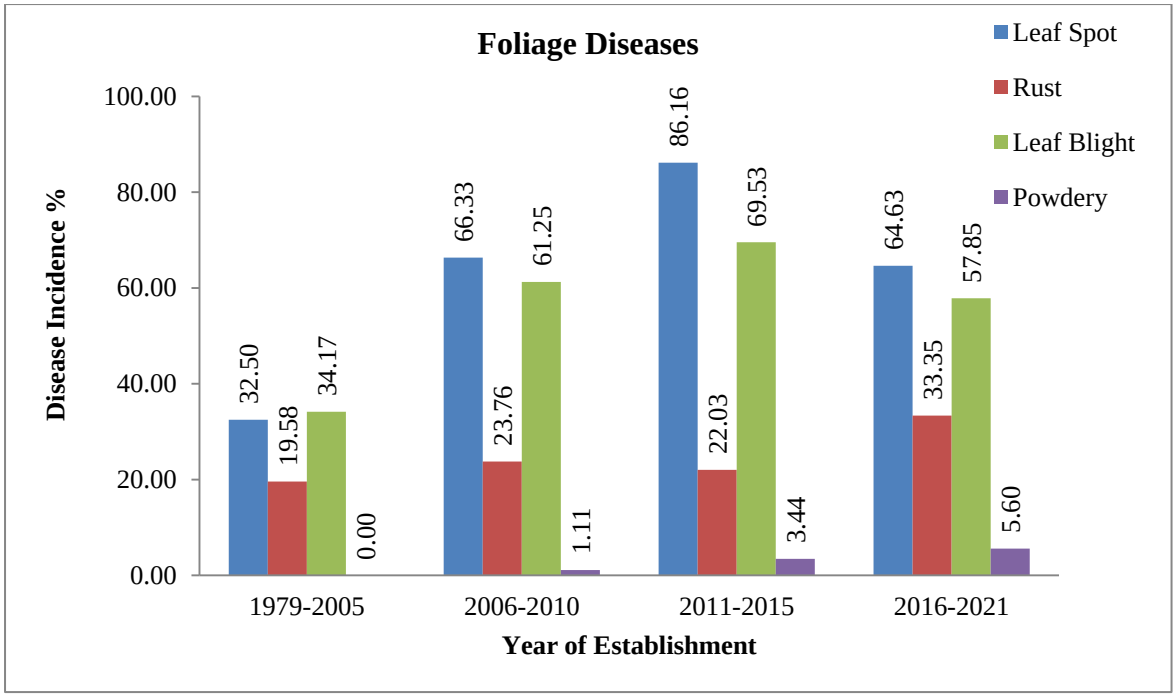


Figure 7. Percent disease incidence of foliage diseases based on year of establishment

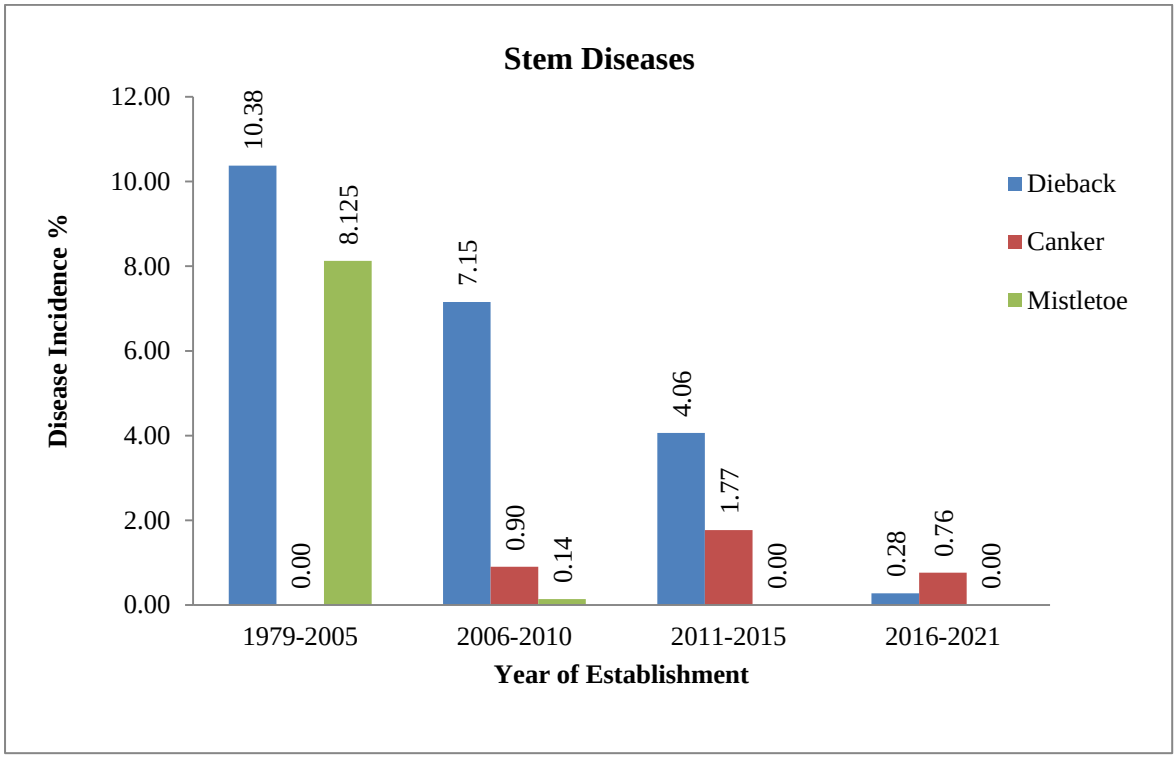


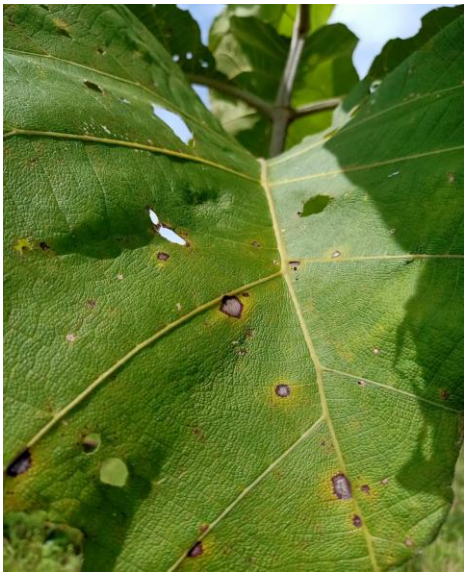
Figure 8. Percent disease incidence of stem diseases based on year of establishment

4.2 Identification of Pathogen

During disease survey from August-November 2022, the major teak disease was foliage disease. All important foliage diseases of teak plantations area of Paukkhaung, Padaung, Thayarwaddy, Minhla and Gyobingauk Townships were presented in Table 5. Five pathogens i.e *Cercospora tectonae*, *Olivea tectonae*, *Rhizoctonia bataticola*, *Curvularia* spp. and *Erysiphe tectonae* were identified.

Table 5. Foliage disease occurrence in survey teak plantation area

Sr.no.	Name of Disease	Name of Pathogen	Disease Symptom
1	Leaf Spot	*Cercospora tectonae*	The symptoms are angular or sub-orbicular leaf spots, brown to grayish brown at the center with a dark margin, which develop near the tip and along the margin of the leaves (Plate 3).
2	Rust	*Olivea tectonae*	Infected leaves showed angular brown to grey necrotic areas on the upper leaf surfaces due to the formation of flecks. As lesions coalesced, large necrotic areas were evident. The necrotic areas corresponded to numerous subepidermally erumpent orange yellow uredinia on the lower leaf surfaces (Plate 4).
3	Leaf Blight	*Rhizoctonia bataticola*	Infected leaves showed wedge shape lesions which develop near the tip and enlarge rapidly to the middle vein. These patches turn brown. Infected leaves dry up and are eventually shed (Plate 5).
4	Leaf Blight	*Curvularia* spp.	Irregular brown necrotic patches can be seen between the veins of leaves at close distance to each other; two or more patches may be fused into a larger size and the border between infected and healthy was reddish brown (Plate 6).
5	Powdery Mildew	*Erysiphe tectonae*	Irregular white patches appeared on the upper surface. As disease progressed, these patches coalesced and developed greyish-white powdery appearance (Plate 7).

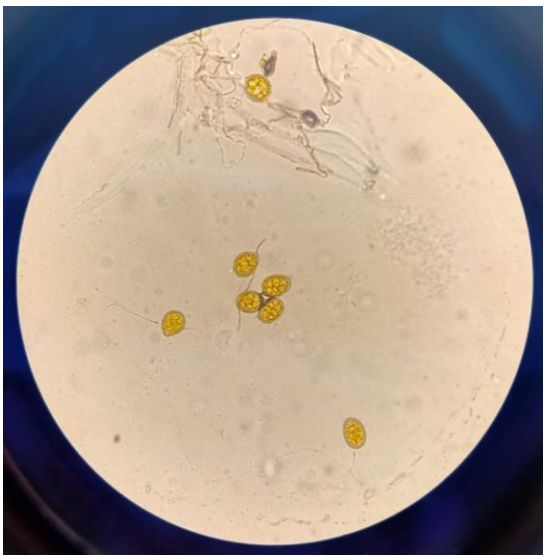


(a)

(b)

Plate 3. Leaf spot symptom (a) and its causal organism *Cercospora tectonae* 40x (b)

(a)



(b)

Plate 4. Teak Rust symptom (a) and its causal organism *Olivea tectonae* 40x (b)

(a)

(b)

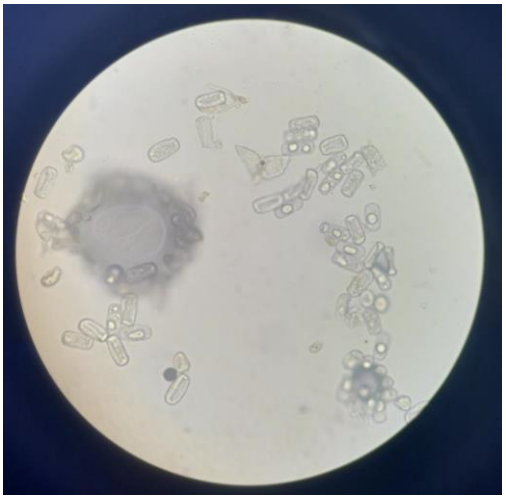
Plate 5. Leaf blight symptom (a) and its causal organism *Rhizoctonia bataticola* 40x (b)

(a)

(b)

Plate 6. Leaf blight symptom (a) and its causal organism *Curvularia* spp. 40x (b)

(a)

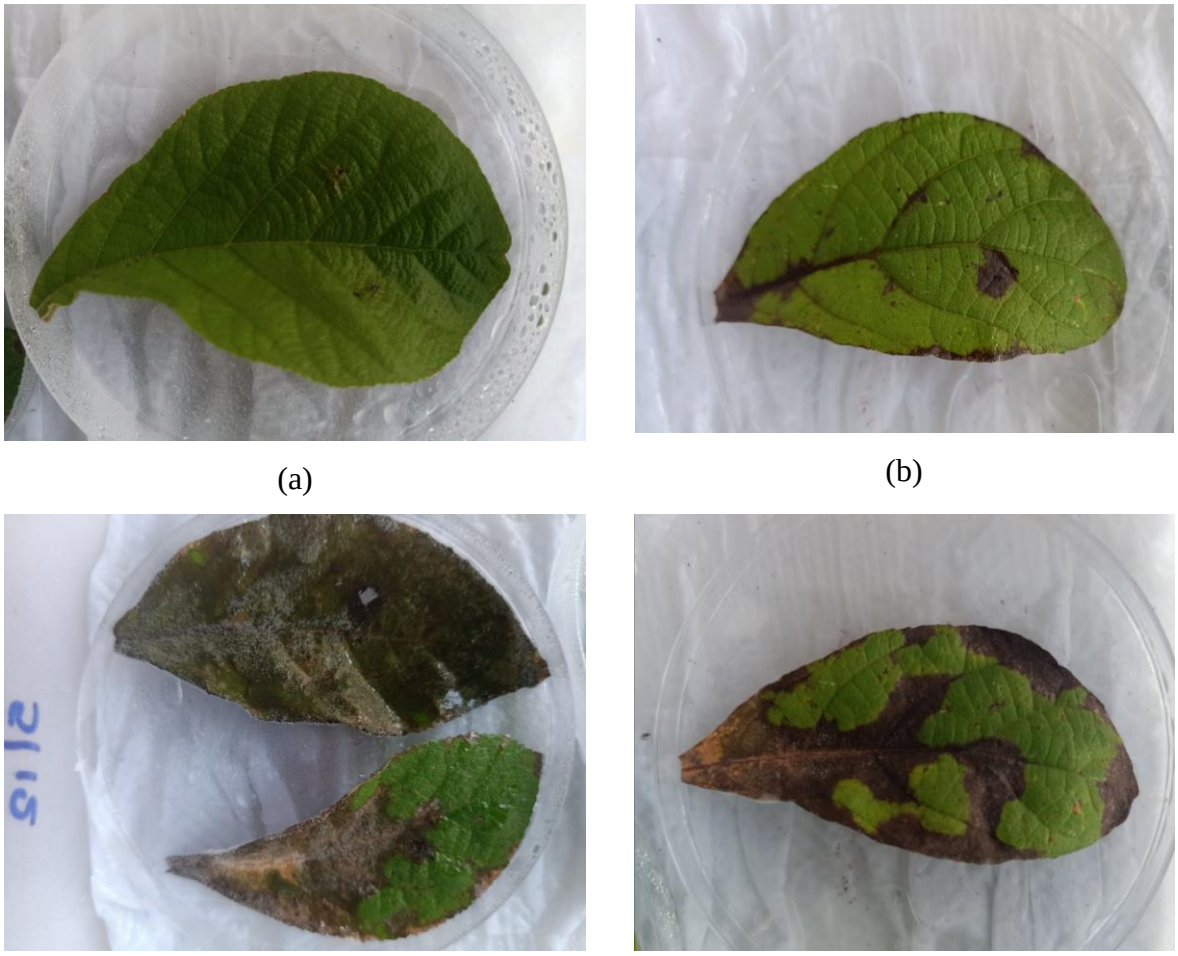


(b)

Plate 7. Powdery mildew symptom (a) and its causal organism *Erysiphe tectonae* 40x (b)

4.3 Pathogenicity Test

This study revealed that three isolates produced symptoms on artificially inoculated leaves under the conditions of this study. The three isolates are *Cercospora tectonae*, *Rhizoctonia bataticola* and *Curvularia* spp. Inoculated leaves showed soaked brown lesions (Plate 8). Symptoms started from the injured portions of leaves and spread throughout the leaf surface. The artificially inoculated organisms were re-isolated from the inoculated teak leaves.



(a) (b)

(c) (d)

Plate 8. Leaf inoculation of *Tectona grandis* with sterilized water (a), *Cercospora tectonae* (b), *Rhizoctonia bataticola* (c) and *Curvularia* spp. (d)

5. Conclusion

The study revealed that various types of disease present in survey teak plantation area of West Bago Yoma Region, Myanmar. Foliage disease was more prevalent than stem and root diseases. The causal organisms causing foliage diseases (leaf spot, rust, leaf blight and powdery mildew) were *Cercospora tectonae*, *Olivea tectonae*, *Rhizoctonia bataticola*, *Curvularia* spp. and *Erysiphe tectonae*. Among foliage diseases, leaf spot and leaf blight diseases commonly found in all survey area of teak plantations. Disease severity index of leaf spot and leaf blight reached medium disease score range (1.1-2) in teak plantations area of Thayarwaddy and Gyobingauk Townships. Young plantations had more rust and powdery mildew infection than old plantations. Disease severity index of rust 0.57 was highest in Minhla teak plantations area. Die back and mistletoe incidence were high in old plantations. This disease survey results can be useful in identification of disease symptom and causal

organism. The appropriate control measures can be developed, and then, it will be helpful for reducing the risk of teak diseases infection in West Bago Region.

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Authors' contributions

[1,3,4] Formulation of research design, regular survey, finalization of manuscript

[2] Formulation of research design, regular survey, conduct lab experiment, data entry and analysis, preparation of first draft manuscript, finalization of manuscript

[5] Formulation of research design, supervision in lab experiment, finalization of manuscript

[6,7] Formulation and approval of research design, regular survey, finalization of manuscript