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Diseases and Insect Pests Problems in Nurseries Stage on Some Forest Tree Species of Myanmar Reforestations and Rehabilitation Programmee (MRRP)

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Abstract

This study was carried out to assess some diseases and insect pests nurseries problems; incidence and severity of diseases and insect pests in four nurseries under the Myanmar Reforestation and Rehabilitation Programme (MRRP). In this study, three kinds of fungal diseases; seedling blight, teak leaf rust and pine needle blight were found and also three kinds of insect pests: sap sucking, leaf defoliator and shoot borer were collected respectively in seedling *Tectona grandis* L.f., *Pinus kesiya* Royal ex Gordon, *Xylia xylocarpa* Taub., *Hopea odorata* Roxb. , *Bruguiera hainesii* C.G.Rogers, *Xylocarpus moluccensis* (Lam.) M.Roem. and *Avicennia officinalis* L.. In laboratory examinations, an obligate parasite *Olivea tectonae* and five facultative parasites *Rhizoctonia solani*, *Fusarium solani*, *Aspergillus* sp., *Colletotrichum* sp., and *Mycosphaerella* sp. were identified. The insect pest species, *Calliteara* sp., *Cenopic* sp., *Hyblaea puera*, *Hypsipyla robusta* and unidentified species (Thripidae) were recorded. According to the results, teak leaf rust, teak blight, pine needle blight and sap sucking insects were high percentage of incidence and severity rate. It can be concluded that the diseases mortality rate were higher than the insect pests except the sap sucking insects. This result showed that nurseries are less resistance than plantations and can spread disease more quickly and increase losses of seedling in the event of fungal infestations. Therefore, nurseries should be more cared according to the nurseries management procedures. This results to be provide the nurseries management information to the MRRP Project as well as other forest nurseries.

Key words: Disease, Facultative parasite, Incidence, Insect pest, Obligate parasite, Severity

မြန်မာနိုင်ငံ သစ်တောများပြန်လည်တည်ထောင်ရေးစီမံကိန်း ပျိုးဥယျာဉ်များရှိ အချို့သစ်မျိုးစိတ်များ၌ ကျရောက်တတ်သော ရောဂါပိုးမွှားများအားလေ့လာခြင်း

ဝါဝါလင်း၊ သုတေသနလက်ထောက်–၂
ရဲထက်နိုင်၊ သုတေသနလက်ထောက်–၂
ခင်မာမြင့်၊ လက်ထောက်သုတေသနအရာရှိ

စာတမ်းအကျဉ်း

မြန်မာနိုင်ငံ သစ်တောများပြန်လည်ထူထောင်ရေးစီမံကိန်း ပျိုးဥယျာဉ်များရှိ အချို့သော သစ်မျိုးစိတ်မတူသည့် ပျိုးပင်များ၌ ကျရောက်သောရောဂါပိုးမွှားများအား စာရင်းကောက်ယူခြင်း၊ ကျရောက်မှုရာခိုင်နှုန်းနှင့် ကျရောက်မှုပြင်းအားတို့အား သုတေသနပြုလေ့လာရန် ဤသုတေသနအား ဆောင်ရွက်ခဲ့ပါသည်။ လေ့လာမှု၌ ပျိုးပင်မျိုးစိတ်မတူညီသည့် ကျွန်း၊ ပျဉ်းကတိုး၊ ထင်းရှူး၊ သက်ိန်း၊ သမဲကြီး၊ မြိုင်ကြီး၊ နှင့် ကျန် မျိုးစိတ် ၇ မျိုးမှ seedling blight, pine needle blight နှင့် teak leaf rust မှိုရောဂါ ၃ မျိုးနှင့် အင်းဆက်ဖျက်ပိုးများအနေဖြင့် leaf defoliator, sap sucking insect နှင့် shoot borer ကျရောက်မှုများအား လေ့လာတွေ့ရှိခဲ့ပါသည်။ ဓါတ်ခွဲစမ်းသပ်မှု အဖြေများအရ *Olivea tectonae*, *Rhizotonia solani*, *Fusarium solani*, *Aspergillus* sp., *Colletotrichum* sp. နှင့် *Mycosphaerella* sp. မှိုရောဂါပိုးအသီးသီးတို့အား စမ်းသပ်တွေ့ရှိခဲ့ပါ သည်။ အင်းဆက်ဖျက်ပိုးများမှာ *Calliteara* sp., *Cenopic* sp., *Hyblaea puera*, *Hypsipyla robusta* နှင့် unidentified species မျိုးရင်း (Thripidae) တို့ဖြစ်ပါသည်။ ကျရောက်မှုအပြင်းထန် ဆုံးအနေဖြင့် pine needle blight, teak leaf rust, teak seedling blight မှိုရောဂါများနှင့် ပျဉ်းကတိုးပျိုးပင်၌ ကျရောက်သည့် sap sucking insect တို့မှာ အပြင်း ထန်ဆုံး ဖြစ်ပါသည်။ ဤ တွေ့ရှိချက်များအရ ပျိုးဥယျာဉ်များ၌ မှိုရောဂါကျရောက်မှု ရာခိုင်နှုန်းနှင့် ကျရောက်မှု ပြင်းအား တို့မှာ အင်းဆက်ဖျက်ပိုးများ ကျရောက်မှု ရာခိုင်နှုန်း ထက်ပိုများသဖြင့် ပျိုးပင်ပျက်စီး ဆုံးရှုံးမှု သက်သာနိုင်စေရန်အတွက် ပျိုးဥယျာဉ် စောင့်ရှောက်မှု နည်းလမ်းများဖြင့် သေချာစွာ ပြုစု စောင့်ရှောက်သင့်သည်။ ဤသုတေသနရလဒ်များသည် မြန်မာနိုင်ငံ သစ်တောများ ပြန်လည် တည်ထောင်ရေးစီမံကိန်း (MRRP) အတွင်း ပျိုးဥယျာဉ် များနှင့်

အခြားသောသစ်တောပျိုးဥယျာဉ် များအတွက် အထောက်အကူပြု ပံ့ပိုးပေးနိုင်လိမ့်မည် ဟု မျှော်လင့်ပါသည်။

Diseases and Insect Pests Problems in Nurseries Stage on Some Forest Tree Species of Myanmar Reforestations and Rehabilitation Programmee (MRRP)

1. Introduction

According to the Forest Resource Assessment, Myanmar has a forest cover of 58.66% of the country's area in 1990 and a forest cover of 42.92% in 2015 (FRA 2015). It is the third most deforested country in the world in terms of area of annual deforestation (2017-2027, MRRP). Therefore, to prevent deforestation and forest degradation; To restore the country's forest cover and reduce climate change the Forest Department is accelerating the implementation of the Myanmar Reforestation and Rehabilitation Programmee (MRRP) as a 10-years plan from 2017 to 2027 to grow locally adapted trees throughout Myanmar (2017-2027, MRRP). However, the diseases and insect pests are invading forests plantations and nurseries in a variety of ways (Mead, 2001). Some micro-organisms are very virulent and can attack and invade healthy plants and some diseases spread and develop quickly within a plant (Cynthia, 2006). Abiotic casual organisms can cause a large number of rapidly growing seedlings to fungal attack and young seedlings are an important first step in establishing a plantation (Landis 1984, 1989). Therefore, need to assess the diseases and insect pests infestations in nurseries. If preventive measures are not taken in nursery, unforeseen losses can occur. This study is the first step to list the spread of diseases and insect pests for these purposes and to record incidence and severity of diseases and insect pests in each nurseries within six zones in MRRP Project. The MRRP zones in the Regions and States are shown in (Table 1).

Table 1. Regions and States of Nurseries in each MRRP Project Zones

SI. No	Zone	Regions and States
1.	Zone- 1	Kayin, Mon and Tanintharyi
2.	Zone- 2	Ayawaddy and Rakhine
3.	Zone- 3	Pague, Yangon and Naypyitaw
4.	Zone- 4	Sagine, Kachin and Chin
5.	Zone- 5	Mandalay and Magway
6.	Zone- 6	Shan and Kayar

Source: Natural Forest and Plantation Division, Forest Department

1.1 Literature Review

Family Thripidae (sap sucking insect) is the majority pest thrips from this family. Some species of thrips create curls, rolls or folds, or causing to leaf blades and reduce the photosynthesis (Bailey, 1940).

Larvae of *Calliteara cerigoides* (Lepidoptera, Lymantridae) were found to be important defoliators of *Hopea odorata* (Dipterocarpaceae) in nurseries and plantations (Messer et al. 1992). Attacks by defoliators have frequently been noticed in plantations

towards the close of the rains and continue until the end of the hot weather when new and healthy leaves appear (Orwa et al., 2009).

Caterpillar *Hyblaea puera* Cramer is a well-known pest causing significant losses on tree growth in teak plantations during their seasonal outbreaks. Apart from Teak, it also attacks an alternative host plant, *Avicennia marina*, a prominent mangrove tree species abundant along the west coast of India, causing severe and extensive defoliation (Arun and Mahajan, 2012). Mass defoliation of the mangrove tree *Avicennia germinans* (L.) Stearn has been observed in larvae *Hyblaea puera* (Cramer) (Lepidopetra: Hyblaeidae) (Bouchon et al. 1991, Mehlig & Menezes, 2005). *Hyblaea puera* larvae feed exclusively on *A. germinans* in the mangroves and the larvae may play an important role in the regulation of the leaf dynamics of *A. germinans* in the mangrove.

Bruguiera hainesii is a hybrid between *Bruguiera cylindrica* as the maternal parent and *Bruguiera gymnorhiza* as the paternal one (Junya Ono, et al, 2016). No serious diseases or insect pests are known for *B. gymnorhiza*. Seedlings. Sometimes plantations may suffer from caterpillars (Mainga, et al, 2005). There is a low level of attack by *Capua* sp. and the *Odites* spp. (Browne, 1961). The larvae (Tortricidae) roll the leaves as their retreats and damage them by feeding, resulting in reduction the leaf. Leaf quality is also reduced because the rolled leaves contain feces and silk (Nakai et al., 2017).

Floyd, 1996 described that one of the long-standing pest problems in forestry in India is that of the mahogany shoot borer, *Hypsipyla robusta* (Lepidoptera: Pyralidae) and it is a serious pest of the *Xylocarpus moluccensis*.

Andriani Rafael, 2013 described that Brown Leaf Spot disease (BRS), Black Leaf Spot disease (BLS) and White Leaf Spot disease (WLS). BRS was found in *Sonneratia alba* and *Avicennia marina* in natural forests and reforestation sites in all areas.

Sharma,1985 mentioned that *Tectona grandis* leaf rust is one of the important leaf diseases, was widespread in nurseries as well as in plantations, especially in dry areas and though the rust occurred almost round the year, it was most prevalent during August to January/February. In nurseries, severe rust infection, causes extensive necrosis and premature defoliation, definitely will have detrimental effect on the growth of seedling. And then the severity of rust disease is favoured by hot and dry conditions (Wai Wai Than, 2000).

Mycosphaerella. Gibsonii causes a serious needle blight of both exotic and native pines, particularly at the later nursery stage, and has become a major obstacle to production of pine seedlings in Japan and Taiwan. The disease causes severe defoliation of susceptible seedlings (Ivory, 1972; Gibsom, 1979), slow growth of seedlings, a high cull rate, and in some cases mortality up to 85% (Ivory, 1987). Ito (1972) also reported that, *M. Gibsonii* infected up to 100% of seedlings.

2. Objectives

The aim of this study was to provide baseline information that could be used to develop and disseminate management for diseases and insect pests in nurseries of MRRP Project. The specific objectives were to:

(i) Identify diseases and insect pests of tree species in nurseries of MRRP Project.

(ii) Determine the current status on incidence, severity and distribution of diseases and insect pests problems in tree nurseries.

(iii) Provide recommendations to the MRRP Project on possible management for observed diseases and insect pests problems and how such information could be disseminated to tree growers.

3. Materials and Methods

3.1 Study Sites and Study Periods

The experiment was carried out in the four nurseries within the six zones under the ten-year Master plan of Myanmar Reforestation and Rehabilitation Programmee (MRRP). The survey was conducted intensively, the number of diseases and insect pests were recorded within two years from 2018 to 2020. According to the information of the Natural Forest and Plantation Division, there are several nurseries in each of the six project zones. Therefore, the study areas were selected with criteria depend on maximum yield and hectare of plantations at different locations (Table 2).

Table 2. Inspect of Tree Species from Four Nurseries of Selected Regions and States

SI. No.	Zone	Region & State/ Nurseries	Tree Species	Total No. of Seedlings	Hect are	GPS Locations
1.	Zone- 1	Mon State, Thahtone Township, Da Nu Reserve Forest, Compartment (10,12,13,14,15), Warbar MRRP nursery	1. *Xylia xylocarpa* 2. *Hopea odorata*	87,120 203,280	80.9	N16°54'42 E097°23'47
2.	Zone- 2	Bokalay Township, Byome Mwae Kyune, Kadone kani Reserve Forest, Compartment (55) MRRP nursery	1. *Avicennia officinalis* 2. *Bruguiera hainesii* 3. *Xylocarpus moluccensis*	179,385 896 234,645	303.5	N15°58'31.0" E095°15'33.5"
3.	Zone- 3	Hmawbi Township, Oakkan Reserve Forest, Compartment (63) MRRP nursery	1. *Tectona grandis*	242,200	80.9	N17.626617 E095.993775
4.	Zone- 6	Taunggyi Township, Taung Lay Lone, Reserve Forest, Compartment (17) MRRP nursery	1. *Pinus kesiya*	70,000	50.6	N2047°56'386" E097°21'413"

3.2 Photography

To study the symptoms of the diseases and insect pests, photographs were taken as far as possible of fresh diseased specimens.

3.3 Specimens Collection

Diseases and insect pests specimens were collected in the field using paper bags and plastic bottles for laboratory diagnoses.

3.4 Sterilization of Lab Apparatus and Media

Potato, Dextrose Agar (PDA) boiled for the nutrient media about 15 minutes. PDA media and lab instruments were sterilized in the autoclave Pressure 120 lb, for 20 minutes. Then all of cleaning Petri dishes were sterilized in the oven temperature 60 C ˚ for 4 hours.

3.5 Isolation and Identification

To avoid any saprophytic growth on the specimens, isolations were made within one week after the collection. Only under unavoidable situations the specimens were stored in a refrigerator. Using the Koch's Postulate, the infected parts of seedlings were washed under the tap water, again sterilized by mercuric chloride ($HgC1_2$) (1.1) g for 1 minute and then washed by double distilled water (DDW) for 1 minute. Then those were isolated on the media at the laminar flow chamber.

Isolated Petri dishes were first examined under a dissecting microscope. To study the detailed structure of fructifications of various pathogenic fungi (conidia, conidiophore, pycnidia, perithecia, rust sori, etc.) were slide preparation stained with Lactophenol Cotton Blue and also the covered glass was sealed with colorless nail polish. Photomicrographs of fungal species were taken using a Nikon Cool Pix B700 digital camera. Fungi were identified to genus level according to various mycological references; the book of H.L.Barnett. Ph.D., Illustrated Genera of Imperfect Fungi, Second and Third Edition and George B. Cummins, Illustrated Genera of Rust Fungi. After then approved by the Plant Protection Division (PPD), Yangon for specific identification or confirmation. The identified cultures were stored in a refrigerator at 25±20°C.

3.6 Insect Pests Identification

Rearing the insect pests larvae was done under the laboratory conditions (room temperature about 25 ± 1º C and R.H. (65 ± 5 %) at the Entomology Section of FRI. Collected insect larvae were individually placed in separate glass bottle with specific leaves as food. Fresh leaves were provided every day until the pupa and adults. The adult emerged within fifteen days and then identification were carried out.

3.7 Survey Design and Data Formulation

Five nursery plots were selected in each nurseries using the Systematic Sampling Method, 100 sample seedlings were collected from each five selected nursery plots using the Random Sampling Method, to calculate the percentage incidence (PI) of diseases and insect pests. Moreover, 25 sample seedlings were collected again from each of 100 seedling using the Random Sampling Method, to calculate the severity index (SI). Used of the formulas are as follow:

- PI = Nd x 100 /N, where Nd for number of affected and N the total number of trees,

- SI = n L x 1 + n M x 2 +n S x 3 / N, where nL, nM, nS represent total number of plants with Low1-25%, Medium 26-50%and Severe 51–75 or > 25% seedlings dead; 1, 2, 3 severity index (SI) for Low, Medium and Severe and N the total number of trees (Sharma et al. 1985).

4. Results

4.1 Recorded Diseases and Insect Pests of Individual Tree Species

In this experiment, three kinds of fungal disease symptoms and three kinds of insect pest symptoms were observed from seven kinds of tree species (Table-3**)**.

Table 3. Recorded Tree Species, Diseases/Insect Pests and their Nature of Damage

Sl. No.	**Tree species/ Common Name**	**Disease Symptom**	**Insect Pest Damage Symptom**	**Nature of Damage**
1.	*Xylia xylocarpa* (Pyinkado)	-	Sap Sucking Insect	Leaf
2.	*Hopea odorata* (Thingan)	-	Leaf Defoliator	Leaf
3.	*Avicennia officinalis* (Thamegyi)	Seedling Blight	Leaf Defoliator	Leaf /Stem
4.	*Bruguiera hainesii* (Myinggyi)	-	Leaf Defoliator	Leaf
5.	*Xylocarpus moluccensis* (Kyana)	-	Shoot Borer	Shoot
6.	*Tectona grandis* (Teak)	1. Teak Blight 2. Teak Leaf Rust	-	1. Leaf/Stem 2. Leaf
7.	*Pinus kesiya* (Pine)	Pine Needle Blight		Needle

4.2 Descriptions of Disease, Insect Pests and their Incidence and Severity Rate

4.2.1 Sap Sucking Insect of *Xylia xylocarpa* Taub.

Symptoms: This insect pest causes the leaves to deform, curls, folds (Fig.1a). It was most commonly found on the shoots of seedlings. The insect together with white mealy bugs were observed along with white sap between the twisted leaves.

Occurrence: In this study, sap sucking insect was found in 3 months old seedlings of *Xylia xylocarpa* in January.

Incidence and Severity: This pest was serious, the incidence and severity were 75% and 31%.

Pest: Unidentified species (Hemiptera, Thripidae) (Fig.1b).

Figure 1. (a) Symptom of leaves deformation; (b) Unidentified species

4.2.2 Leaf Defoliator of *Hopea odorata* Roxb.

Symptoms: The larva destroyed all leaves of entire seedlings of *Hopea odorata*. (Fig.2a).
Occurrence: The leaf feeding insect was found on seedlings of *Hopea odorata* in January. The larva of the leaf defoliator was found on 3-month-old seedlings (Fig.2b). The adult emerged within fourteen days (Fig.2c).
Incidence and Severity: The incidence was 4.8% and severity was 10.13%.
Insect Pest: *Calliteara* sp. (Lepidoptera, Lymantridae)

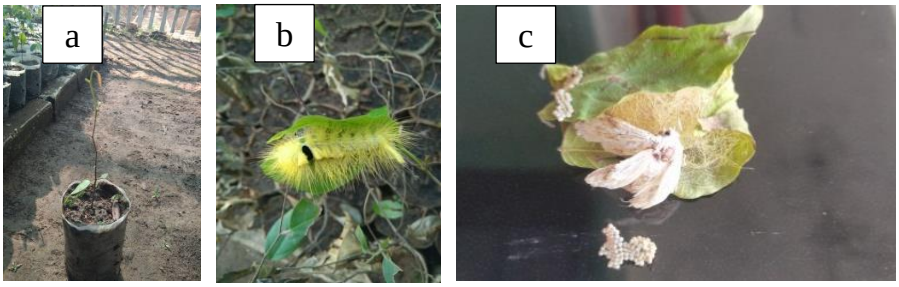

Figure 2. (a) *Calliteara* sp. attacked seedling; (b) Larva; (c) Moth

4.2.3 Leaf Defoliator of *Avicennia officinalisn* L.

Symptoms: Larvae of *Hyplaea puera* feed on the leaf of *Avicennia officinalisn* (Fig.3a).
Occurrence: The leaf defoliated insect was found on seedlings of *A. officinalisn* in January. The caterpillar of the leaf defoliator was found on 3-month-old seedlings (Fig.3b).
Incidence and Severity: The incidence was 10.5% and severity was 16.2% within survey period.
Insect Pest: *Hyplaea puera* (Lepidoptera, Hyblaeidae)

Figure 3. (a) Larva (b) Pupa stage of *Hyplaea puera* (Lepidoptera, Hyblaeidae)

4.2.4 Leaf Defoliator of *Bruguiera hairesii* C.G. Rogers

Symptoms: *Cenopic* sp. rolled leaves and bud with feces and silk (Fig.4a, b).
Occurrence: The defoliation of leaf feeding insect was found in seedlings of *Bruguiera hairesii* in January. The larvae were collected on the five months age of seedlings. Within 20 days, the adult emerged from the larva stage under the laboratory condition (Fig.4c).
Incidence and Severity: The incidence was 14.6% and severity was 27.2% within survey period.
Insect Pest: *Cenopic* sp. (Lepidoptera, Tortricidae)

Figure 4. (a) Symptom of rolling leaves with their feces and silk; (b) Larva (c) Adult

4.2.5 Shoot Borer of *Xylocarpus moluccensis* (Lam)

Symptoms: In the field, showed sign the dried and broken shoot of the seedling (Fig.5).
Occurrence: The symptom of shoot borer was found in *Xylocarpus moluccensis* on the five months age of seedlings in January.
Incidence and Severity: The incidence and severity were 5% and 12.10%.
Insect Pest: *Hypsipyla robusta* (Pyralidae)

Figure 5. Symptom of Shoot borer attacked seedling *Xylocarpus moluccensis*

4.2.6 Seedling Blight of *Avicennia officinalis* L.

Symptoms: Seedling blight infection was found on the stem near the soil level, just above the root collar region and leaf margins. The sign of leaf margins area became yellowish to brown color and spot path on the leaves (Fig.6a).
Occurrence: Seedling blight was observed in 3 months old seedlings of *Avicennia officinalis* in January. In the laboratory experiment, the pathogens of *Collectrichum* sp. and *Rhizoctonia*

i. *Colletotrichum* sp. colony on PDA fast-growing, greyish white, setae present, conidia produced in acervuli, straight, cylindrical with rounded end.
ii. *Rhizoctonia solani* colony on PDA fast growing, white, initially hyaline turns pale yellowish brown, highly branched, septate, branches arising, produced singly or in groups, irregular in shape.

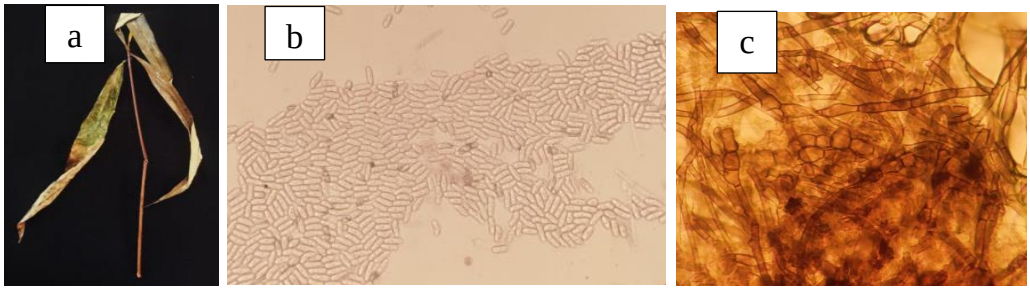

Figure 6. (a) Affected area became yellowish and brown in color and spot path. (b) *Colletotrichum* sp., (c) *Rhizoctonia solani*,

4.2.7 Seedling Blight of *Tectona grandis* L.f.

Symptoms: The sign of the disease was white of mycelium at the base of stem, spreading up to the leaves. The seedlings blight spread by the development of dead cell patches on the leaves and stem, finally infected seedlings turned brown and died (Fig.7a).
Occurrence: The seedling blight was recorded in 45 days old seedlings of *Tectona grandis* in January. The affected plants showed symptoms of blight which initially became the lower foliage and dried up. The blight proceeded upward eventually killing the growing shoot. It was an annual disease that has resulted in the loss of many seedlings. In lab experimentation, *Fusarium solani* and *Aspergillus* sp. were recorded from the isolation (Fig.7b, c).
Incidence and Severity of Disease: The incidence of seedling blight was 61% of the entire nursery and the disease severity was 33%.

Etiology:

i. *Fusarium solani*, fast growing cottony colony on PDA with carmine red pigmentation; conidia heterogenous, cylindrical, straight or slightly curved, 3-4 septate and singly or chains were observed.
ii. *Aspergillus* sp. filamentous fungi, hyphae, smooth and colorless conidiophores, globosely and dark brown spores from their conidial heads were observed under the microscope.

Figure 7. (a) Teak seedling blight affected of *Fusarium solani* and *Aspergillus* sp. (b) *Fusarium solani*; (c) *Aspergillus* sp.

4.2.8 Teak Leaf Rust of *Tectona grandis* L.f.

Symptoms: Masses of yellowish orange powder on the underside of the leaves were found. There were gray and black flecks appearance on the upper surface of infected leaves and masses of yellowish orange uredinia were abundant on the underside, in corresponding position (Fig.8a, b). The spores became visible only on the leaves did not appear other portions of seedling (petioles and stems). The color of urediniospores changed from yellowish to brownish color within a week. The rusty orange powder can be easily visible.
Occurrence: This infection was found affecting young seedling 3 months old seedling of *T. grandis* and this disease was recorded in January. The pathogen *Olivea tectonae* was showing with spines under the microscope (Fig.8c).
Incidence and Severity of Disease: The disease incidence was 64% and severity was 23%.

Etiology: *Olivea tectonae,* Orange-yellow uredinia covered with a peridium; peridium ruptures due to the pressure exerted by the urediniospores; urediniospores light orange yellow in color, globose to oval; paraphyses abundant, mostly marginal, light yellow, straight to slightly curved with swollen distal ends.

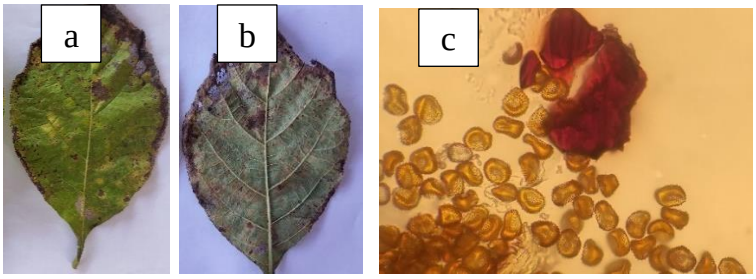

Figure 8. (a) Upper surface of infected leaves, (b) Underside of the leaves, (c) Uredinia with Urediniospores of *Olivea tectonae* showing spines

4.2.9 Pine Needle Blight of *Pinus kesiya* Royal ex Gordon

Symptoms: The infected seedlings showed prominent spots and discoloration near the tip (Fig.9a) which gradually extended and also spread, turn brown color and girdle the needles. The infection of stem and leaves resulted in blighting of shoots.
Occurrence: Needle blight was recorded in seedling of *Pinus kesiya*. The disease was noticed in 6 months old seedlings in June 2019. The pathogen *Mycosphaerella* sp. and conidia were observed in lab experiment (Fig.9b, c). The disease caused widespread and heavy mortality in pine seedlings.
Incidence and Severity of Disease: The disease incidence was 65% and severity was 61%.
Etiology:

- *Mycosphaerella* sp. stromata are dark-brown, tuberculated, conidiophore dark-brown, straight, slightly curved, rarely septate and not branched. Conidia straight or slightly curved, 3-5 septate with a truncate or rounded unthicken base, bluntly rounded apex, rarely saccate, obliquely biseriate were observed under the microscope.

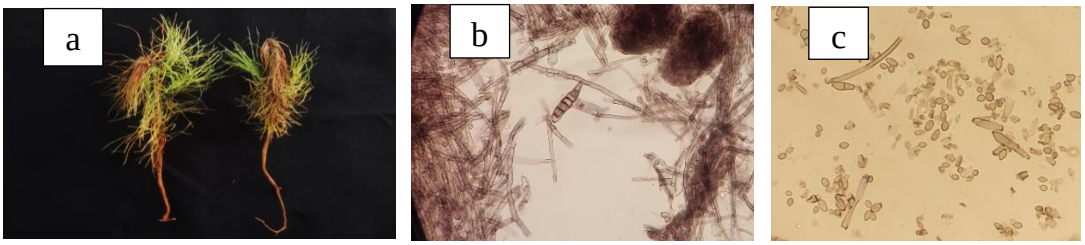

Figure 9. (a) Affected seedlings showed prominent dark brown discoloration at the tip of seedlings, (b) Conidia of *Mycosphaerella* sp., (c) Conidiophores emerging through stomata

Table 4. Recorded Fungal Pathogens, Insect Pests, their Incidence, Severity and Status

Sl. No.	Tree Species and Disease & Insect Pest Name	Fungal Pathogens (Species)	Insect Pests (Species & Family)	PI %	SI %	Disease & Insect Pest (Status)
1.	*Xylia xylocarpa* (Sap Sucking Insect)	-	Unidentified Species (Thripidae)	75	31	Serious
2.	*Hopea odorata* (Leaf Defoliator)	-	*Calliteara* sp. (Lymantridae)	4.8	10.13	Potential Serious
3.	*Avicennia officinalis* (Leaf Defoliator)	-	*Hyplaea puera* (Hyblaeidae)	10.5	16.2	Potential Serious
4.	*Bruguiera hainesii* (Leaf Defoliator)	-	*Cenopic* sp. (Tortricidae)	14.6	27.2	Potential Serious
5.	*Xylocarpus moluccensis* (Shoot Borer)	-	*Hypsipyla robusta* (Pyralidae)	5	12.10	Potential Serious
6.	*Avicennia officinalis* (Seedling Blight)	*Collectrichum* sp. *Rhizoctonia solani*	-	4	8.15	Potential Serious
7.	*Tectona grandis* (Teak Blight)	*Fusarium solani* *Aspergillus* sp.	-	61	33	Serious
8.	*Tectona grandis* (Teak Leaf Rust)	*Olivea tectonae*	-	64	23	Serious
9.	*Pinus kesiya* (Pine Needle Blight)	*Mycosphaerella* sp.	-	65	61	Serious

In this experiment, in insect identification, unidentified species (Thripidae), *Calliteara* sp. (Lymantridae), *Hyplaea puera* (Hyblaeidae), *Cenopic* sp. (Tortricidae) and *Hypsipyla robusta* (Pyralidae) were observed. In fungal diseases, *Collectrichum* sp., *Rhizoctonia solani*, *Fusarium* solani, Aspergillus sp., *Olivea tectonae*, and *Mycosphaerella* sp. were identified respectively. In this table show that the sap sucking insect, teak blight, teak leaf rust and pine needle blight were serious among all infestations. However, some other diseases and insect pests were potential serious in nursery. The percentage of incidence and severity rate of disease and insect pest infestations are showed as following graphs (Fig.10, 11).

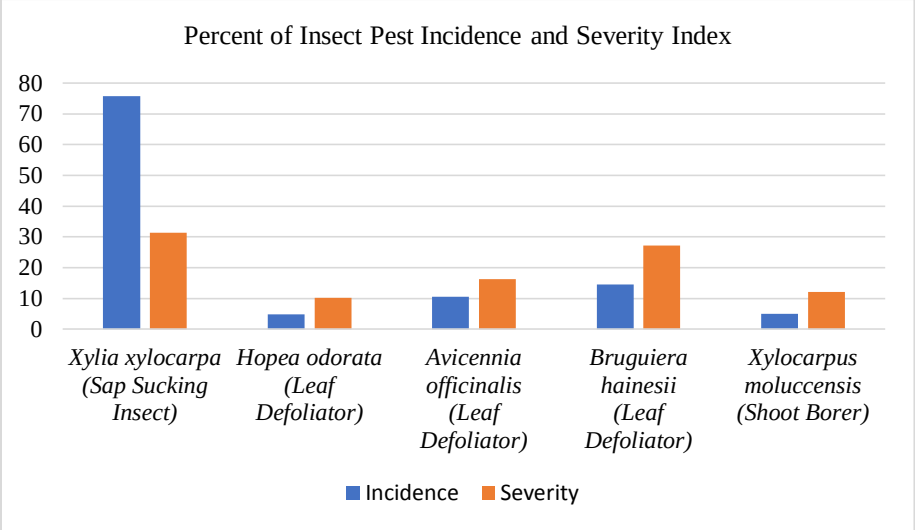

Figure 10. Incidence and Severity rate of Insect Pests in Different Species of Seedlings

This figure showed that the sap sucking insect pests on *Xylia xylocarpa* seedling were most serious among those insect infestations. The incidence and severity rate of this insect was (61%, 33%). Moreover, insect pest infestations were more observed than the diseases in mangrove species in this experiment.

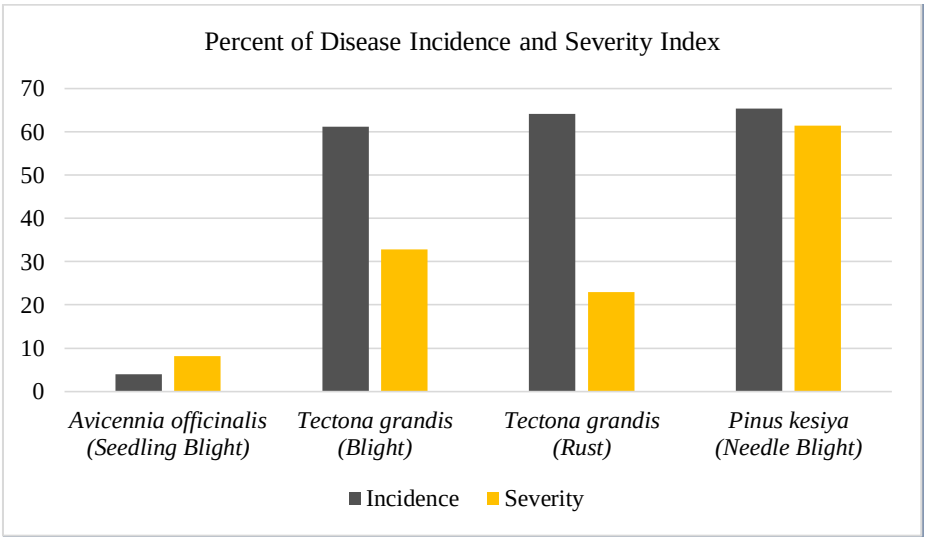

Figure 11. Incidence and Severity rate of Diseases in Different Species of Seedlings

This figure showed that teak blight, teak leaf rust and pine needle blight were serious diseases in nursery. Their incidence and severity rate were (61%, 33%), (64%, 25%) and (65%, 61%) respectively. The seedling blight of seedling *Avicennia officinalis* was potential serious in this experiment.

5. Discussion

The present survey, the incidence and severity of diseases and insect pests from the seedling of *Xylia xylocarpa*, *Hopea odorata*, *Bruguiera hainesii*, *Xylocarpus moluccensis*, *Avicennia officinalis*, *Tectona grandis* and *Pinus kesiya*, were conducted systematically. In this results 5 insect pest species were recorded on the seedling of *X. xylocarpa*, *H. odorata* and mangrove species *B. hainesii*, *X. moluccensis* and *A. officinalis* and also 6 fungal pathogens were observed from 3 kind of fungal diseases of seedling *A. officinalis*, *T. grandis* and *P. kesiya*.

In insect pests, unidentified species (Hemiptera, Thripidae) attacked on leaves of *Xylia xylocarpa* and was the serious pest in nurseries according to result. The incidence and severity were 75%, 31%. Bailey, 1940 described that family Thripidae (sap sucking insect) is the majority pest thrips from this family. In finding result that the pest *Calliteara* sp. of *Hopea odorata* , the incidence and severity were 4.8% and 10.13% all of the entire nursery. However, Messer (1992) mentioned that the caterpillar *Calliteara cerigoides* is important defoliators of *H. odorata* in nurseries and plantations. However, the incidence and severity of leaf defoliator *Hyblaea puera* of *Avicennia officinalis* were low percentage in our finding. This caterpillar is a well-known pest causing significant losses on tree growth in *Tectona grandis*, *Avicennia marina*, and *A. germinans* plantations stands causing severe and extensive defoliation (Arun & Mahajan, 2012 and Mehlig & Menezes, 2005). Leaf Roller *Cenopic* sp. was potential serious pest of *Bruguiera hairesii*. Browne (1961) described that there is a low level of attack by this species in *Bruguiera gymnorhiza*. The incidence and severity of shoots borer in the seedling of *Xylocarpus moluccensis* were observed 5% and 12.10%. During the survey period, could not found any stage of pest. Only the symptom of insect attacked was observed in seedlings. However, according to the literatures that the shoot borer *Hypsipyla robusta* is the major pest of *X. moluccensis* (Floyd, 1996). Therefore, this shoot borer *H. robusta* may be confirmed the insect pest of *X. moluccensis.*

In fungal diseases; seedling blight and teak leaf rust diseases on teak seedlings and pine needle blight on pine seedling were the serious fungal diseases in this study. The incidence and severity in teak seedling blight were 61%, 33 % and in teak rust were 64%, 23% and in pine needle blight were 65% and 61% respectively. In laboratory experimentation, facultative parasites such as *Rhizoctonia solani*, and *Colletotrichum* sp. on the *Avicennia officinalis* and *Fusarium solani*, and *Aspergillus* sp. on the *Tectona grandis*, and *Mycosphaerella* sp. on the *Pinus kesiya* and also an obligate fungal parasite *Olivea tectonae* on the *T. grandis* were tested from each diseases under the microscope. However, in this result causal organism of the blight on teak seedling was observed *F. solani* and *Aspergillus* sp. but Saw C.Doo 1983 expressed that the causal organism of the blight on teak seedlings was identified to *Phytophthora* sp.. However, Browne (1968) described that *F. solani*, *Aspergillus* sp. and *Phytophthora* sp. fungal pathogens are common soil-borne pathogens and is known to parasitize seedlings of various tree species and attacks in their early stages of development. Therefore, the nurseries sanitation is very important to prevent the soil-borne pathogens. Sharma (1985) mentioned that teak leaf rust is one of the important leaf diseases, was widespread in nurseries as well as in plantations, especially in dry areas. Therefore, teak leaf rust should be noticed both nurseries and plantations. The incidence and severity of

Mycosphaerella sp. in pine needle blight were 65%, 61%. Therefore, it is a serious disease. Ivory, 1972; Gibsom, 1979 also mentioned that *Mycosphaerella. Gibsonii* causes a serious needle blight of pines in nursery stage. By analyzing the results, the nurseries should be more care to get the adequate shade when the dry season. In addition, as the disease spread rapidly and also some obligate fungal parasites hide in the underside of the leaf, fungicides may not be effective adequately, so immediately removal of diseased plants may be considered a suitable option to prevent further spread of the disease. This is because seedlings are less resistant than older plants.

In this study, teak seedling blight, teak leaf rust pine needle blight and sap sucking insect pest were serious in nurseries. Although, some other diseases and insect pests were potential serious but this survey could record the fungal pathogens and insect pests that may be infected in mangroves species and other species in nurseries. Some insect pests of tree species were found also in mangrove species. Moreover, insect pest infestations were more observed than the diseases in mangrove species in this experiment. Some insect pests infestations possibly that they are being recorded only now. This study will support as first of all information to different species in different regions of nurseries.

6. Conclusions

In this study, the incidence and severity rate of diseases were higher than the insect pests in nursery except the sap sucking insect pests. This result showed that nurseries are less resistances than plantations and can spread the disease more quickly and increase losses of seedling in the event of fungal infestations. Therefore, nursery in charges need to care the nurseries according to the nurseries management procedures.

This resulted finding out the percentage of incidence and severity of the diseases and insect pests and recorded of some nurseries diseases and insect pests infestations. Therefore, hope that this results to be provide the nurseries management information to the MRRP Project as well as other forest nurseries. In addition to this study, way to biological control methods instead of chemical controls and also other diseases and insect pests infestations in the nursery should be continue to study for the future research.

7. Recommendations

Most of the foresters are familiar to the nurseries management practices in the establishment of the nursery. However, necessary to guide the labor to follow the instructions of nursery. The nursery in charges should carefully follow the following nursery management procedures to minimize damage to the nursery –

- Select a suitable nursery site in a well-ventilated area.
- Should be well drained site.
- Use clean and good quality seeds.
- Good supply of suitable soil materials.
- Nursery shed should be removed as soon as monsoon break. But, need to obtain the shade in too young stage seedlings.

- Watering of seedlings should be adequate but not to the excess. Avoid; dirty water as it contains many plant diseases. Salty water is also not good.
- Infected diseases and insect pests should be removed as soon as possible to avoid spreading.
- In order to have an effective nursery management have to keep up-to date nursery records.
- Nursery in charges should be awareness that at least the disease and insect pest symptoms and signs.
- Good hygiene of the nursery site will lead to healthy and quality seedlings produced in the nursery.

The representatives of MRRP Zones should disseminate the information of diseases and insect pests infestation in nurseries and nurseries management practices to the tree growers.

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