INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 13, No. 6, p. 146-151, 2018
http://www.innspub.net

RESEARCH PAPER | OPEN ACCESS

# Incidence of heart rot in a university owned plantation forest: Implication on forest management

**Mark Jun A. Rojo*, Joseph C. Paquit***

*Faculty, Forest Biological Department, College of Forestry and Environmental Science, Central Mindanao University, Musuan, Maramag, Bukidnon, Philippines*

Article published December 15, 2018

**Key words:** Heart rot, wood decay, Plantation forest, Tropical plantation, Tree disease.

**Abstract**

Occurrence of heart rots in logs reduces the yield. Thus, assessment of heart rot occurrence is necessary to provide information necessary for proper forest management intervention to reduce the severity of heart rot and thereby increase total yield. In this study, a survey on the occurrence of heart rot in logs harvested from a university owned plantation forest was conducted to assess its severity. The implication of heart rot occurrence on forest management was also determined. All *Acacia mangium* Willd. and *Gmelina arborea* Roxb. logs present at the sawmill were inspected. The gross and cull volume were computed and the severity of heart rot were classified according to the percentage of heart rot volume to the gross volume of the logs. A total of 40 logs were assessed for heart rot intensity, 21 of which were *G. arborea* and the remaining were *A. mangium*. A 100 percent occurrence of heart rot were observed in alllogs but generally the severity was low. However, in some *A. mangium* logs, moderate and high level of heart rot intensity were observed in which a cull volume of 20% and 38% were recorded. There is a positive correlation between age and occurrence of heart rot. The plantation forest in this study were already over mature hence, the plantation manager is advised to reconsider their practice and follow the prescribed harvesting method for plantation forest.

***Corresponding Author:** Mark Jun A. Rojo ✉ mackyrojo@gmail.com

## Introduction

Central Mindanao University is one of the best performing state universities in the Philippines. The university has a total area of 3,080 has and 575.16 has of which is devoted to industrial tree plantation forest. Industrial tree species purposely grown in the area are Yemane *(Gmelina arborea)* Mangium and Mahogany. The university also has its own mini sawmill which aside from catering the needs of the university for lumber it provides venues for BS in forestry students for field practicum.

These industrial tree species are mostly exotic (Harrison *et al.*, 2005) one of the reasons for its dominance in the Philippines is its fast growth and high yield (Tolentino, 2008). In 2016, the total log production of the country for planted species was 780,243 $m^3$ mostly from falcata, mangium, yemane and mahogany (PFS 2003). However information on log quality is not available. It has been observed that some industrial tree species are prone to heart rot especially Gmelina (Wingfield and Robinson, 2004).

Heart rot is an asymptomatic infection of heartwood which reduces the quality of wood but not killing the tree (Mohammed *et al.*, 2006). Many fungal species, mainly basidiomycetes, are capable of causing considerable amount of stem decay in forest trees (Arhipova, 2012). In the tropics, the incidence of heart rot is very high ranging from 50% to 98% of trees being affected however the volume of affected wood per log can be quite small (Old *et al.*, 2000). In North America, Gilbertson and Ryvarden (1986) argued that virtually every important timber species is invaded by one or more heart rot causing fungi. The negative impact of heart rot economically is undeniable but ecologically, Hennon (1995) considered heart rot fungi as important disturbance agents by initiating and sustaining canopy gaps.

Forest management may influence the occurrence of heart rot in industrial tree plantations. The proportion and size of the heart rot column increased with tree age (Arhipova 2012).

In addition, Heart rot frequency is directly related to tree diameter with a sharp increase in stems > 50cm DBH (Heineman *et al.,* 2015).

The Forest Resources Enterprise Office (FREO) of Central Mindanao University (CMU) does not follow a recommended clear cutting harvesting method for plantation forest because the log requirement is dependent on the lumber demand for university use. Hence, much of the trees are beyond the rotation age. Thus, this study is conducted to assess the severity of heart rot in logs harvested from the university managed plantation forest.

## Materials and methods

*Study site*

Assessment of heart rots in logs were conducted at CMU-FREO sawmill, Musuan, Maramag, Bukidnon. Logs processed in the said sawmill were all harvested from a plantation forest also owned and managed by the same university. All logs in the log deck were inspected and extent of heart rot damaged were assessed.

*Assessment*

All logs in the log deck of CMU FREO sawmill were inspected for presence of heart rot. The percent cull (heartrot) was computed using the following formula (Eusebio 1998). The length of heart rot was determined by inserting a calibrated stick into the rotten portion of the heartwood.

The intensity of heart rot as shown in Table 1 was classified according to the percent cull per logs adopted from Lacandula *et al.* (2017) and Lakomy and Iwariczuk(2010) and the severity index was computed based on the formula by Eusebio (1998) and Singh (1978):

Gross volume (GV)

$$GV = .7854\ x\ Ave.diameter\ inside\ bark^2\ x\ lenght$$

Cull volume for (CV) for heart rot

$$CV = .7854\ x\ (average\ diameter)^2\ x\ lenght$$

$$Percent\ cull = \frac{CV}{GV} x\ 100$$

**Results and discussion**

*Heart rot assessment*

A total of 40 logs were assessed for heart rot intensity, 21 of which were *G. arborea* and the remaining were *A. mangium*. On the average, *G. arborea* logs measured 3.350m and .193m length and diameter, respectively while *A. mangium* measured 3.773m length and .277m diameter (Table 2).

Incidence of heart rot were observed in all logs (Table 2). However, mostly at low level of intensity (Table 3). As observed in some *A. mangium* logs moderate and high level of intensity were observed in which 20% and 38% of the gross volume were rotten (cull).

These values area bit higher of what is observed by Mahmud *et al.* (1993) in which the volume of wood affected by heart rot ranged between 0.03 and 18.0%.However, the prevalence of heart rothave lessen the popularity of *A. mangium* in forest plantation in Malaysia (Lee, 2005). Further, the result also agrees with the findings of Zakarira *et al.,* (1994) in which an incidence of heart rot reaches 98%.

**Table 1.** Classification of heart rot intensity adopted from lacandula *et al.*, (2017) &Lakomy and Iwariczuk (2010).

| Rating | Remarks | Qualitative rating |
|---|---|---|
| 0 | no rot | Sound log |
| 1 | ≤ 15% rotten | Low |
| 2 | 16-30% rotten | Moderate |
| 3 | 31-50% | High |
| 4 | ≥ 50% | Severe |

The severity of heart rot in *G. arborea*in this study was generally low however, it occurred in all sampled logs. Although heart rot has been described in *G.arborea,* there has been no work done regarding this category of disease (Wingfield & Robinson, 2004). However occurrence of butt rot in *G. arbore* was also observed by Umana *et al.,* (2015).

**Table 2.** Log measurements and Percent heartrot occurrence.

| | Total no. of logs | Mean Length (m) | Mean Diameter (m) | % heartrotoccurence |
|---|---|---|---|---|
| *A. mangium* | 19 | 3.733 | .277 | 100 |
| *G. arborea* | 21 | 3.350 | .193 | 100 |

Butt rot is believed to be early stage of heart rot disease. According to Kumar (2013) the fungus causing heart accumulated in the butt region of host tree and slowly grows and invading only the tree's central column of heartwood. Wood decays occur in heartwood not because decay fungi prefer heartwood but because infection in sapwoods is compartmentalized by active processes (Shortle *et al.,* 2012). There are only few, probably not over several hundred species of fungi that can cause heartrots in trees*viz*., *Polyporusdryophilus* and *Fomesrobustus* in broad-leaved species (Wagner & Davidson, 1954).

In *A. mangium*, heart rot is classified as white rot caused by hymenomycetes (Mohammed *et al*., 2006).

The work of Lee and Zakaria (1992) showed that out of 25 different Hymenomycete fungi found associated with heart rot of *A. mangium*, only 1 was positively identified as *Phellinus noxius*. In*G. arborea,* the fungal pathogens which have been implicated in the pathogenesis of G. arborea include *Fomeslignosus* and *Heterobasidium annosum* that cause butt and root rot of this plant (Inyang, 1990) but Orwa*et al.,* (2009) specifically identified *Ganoderma spp* the causal agent of *G. arborea* heart rot (orwa *et al.,* 2009).

*Implication to Forest management*

Based from the result as discussed earlier, improper management of the plantation forest may have caused this 100 percent occurrence of hear trot. Silvicultural practices may provide entry point for wood decay fungi. Wounds caused by pruning and injury from thinning activity are attacked by fungus causing decay (Vasiliauskas, 2001; Tarigan *et al.,* 2011). According to Mahmud *et al.,* (1993), heart rot occurrence in some plantation of *A. mangium* in Sabah, Malaysia originated from thinning wounds. However, in this study the effects of silvicultural practices to heart rot occurrence were not considered. In addition, the said silvicultural practices were not readily applied in all forest plantation of CMU.

The severity of heart in *A. mangium* and *G. arborea*in this study can be associated to the age of the tree. Zakarika *et al.,* (1994) found out that there is a positive correlation between heart rot incidence and tree diameter. Lower heart rot incidence is expected to occur in younger trees (Mohammed *et. al.,* 2006) thus confirming this age related trend.

**Table 3.** Mean gross and cull volume of logs.

| | Mean gross volume (m3)* | Mean cull volume (m3)* | Mean % cull* | Qualitative rating |
|---|---|---|---|---|
| *A. mangium* | .279 ± .047 | .019 ± .004 | 8.770 ± 2.211 | low |
| *G. arborea* | .095 ± .013 | .001 ± .001 | .746 ± .357 | low |

*mean± SEM.

In Vietnam they followed 6-7 year rotation for pulp wood and 15-20 year for sawn timber (Orwa*et al.,* 2009; Sein & Mitlohner, 2011). However, the optimum age considering the mean annual increment is 9.8 years (Jusoh *et al.,* 2017).

Furthermore Krisnawati *et al.,* (2011) noted that growth of *A. mangium* generally declines rapidly after 8 years. For *G. arborea,* a 7-10 year old rotation is practiced in Indonesia (Roshetko & Purnomosidhi, 2004) while in Nigeria a rotation of 8-12 years is practiced (Onyekwelu *et al.,* 2003) and 5 to 7 years in the Philippines (Magcale *et al.,* 1999). In the present study the trees were already mature reaching more than 20 years already about 10 year older than the recommended rotation cycle.

In addition the CMU-FREO practiced a selective logging system which is not ideal for plantation forest setting hence leaving over mature trees in the field. Considering the positive relationship between age and heart rot occurrence as discussed earlier, the CMU-FREO should reconsider their practice and follow the recommended rotation cycle to lessen culls in logs.

**Conclusion**

100 percent occurrence of heart rot was observed in *G. arborea* and *A. mangium* logs. Although generally the heart rot severity is low reaching only less than 10% of the gross volume of log. However, Moderate and high level of heart rot intensity were observed in some *A. mangium* logs in which a cull volume of 20% and 38% of the gross volume were recorded. The plantation forest of CMU is believed to be over mature which caused this severity of heart rot. Hence, reconsidering their practice to follow the recommended harvesting method and rotation of each plantation species is recommended.

**Acknowledgement**

The authors wished to thank the CMU CFES-BSF, FBS 78 class of 2018 for their help during data gathering.

**References**

**Arhipova N.** 2012. Heart rot of spruce and alder in forests of Latvia. 1652-6880. 2012:49. Retrieved from https://pub.epsilon.slu.se/9094/

**Eusebio MA.** 1998. Pathology in Forestry. Ecosystems Research and Development Bureau, Department of Environment and Natural Resources.

**Gilbertson RL, Ryvarden L.** 1986. North American polypores. 1 Abortiporus-Lindtneria. North American polypores. **1,** Abortiporus-Lindtneria.

**Harrison SR, Venn TJ, Sales R, Mangaoang EO, Herbohn JL.** 2005. Estimated financial performance of exotic and indigenous tree species in smallholder plantations in Leyte Province. Annals of Tropical Research **27(1),** 67-80.

**Heineman KD, Russo SE, Baillie IC, Mamit JD, Chai PPK, Chai L, Ashton PS.** 2015. Influence of tree size, taxonomy, and edaphic conditions on heart rot in mixed-dipterocarp Bornean rainforests: implications for aboveground biomass estimates. Biogeosciences Discussions **12(9),** 6821-6861. http://dx.doi.org/10.5194/bgd-12-6821-2015

**Hennon PE.** 1995. Are heart rot fungi major factors of disturbance in gap-dynamic forests. Northwest Scicnce **69(1),** 284-293.

**Inyang LD.** 1990. Fungal butt and root diseases: threats to bio conservation of Nigeria forest. Nigerian Journal of Science Bio conservation **1,** 98 – 115.

**Jusoh I, Suteh JK, Adam NS.** 2017. Growth and Yield of *Acacia mangium* Based on Permanent Sampling Plots in a Plantation. Transactions on Science and Technology **4(4),** 513-518.

**Kumar P.** 2013. A New Heart Rot Disease in *Ailanthus excels* Roxb. Caused by *Navisporus floccosus* (Bres.) Ryvarden. International Letters of Natural Sciences. International Letters of Natural Sciences **6,** 1-7 http://dx.doi.org/10.18052/www.scipress.com/ILNS.6.1

**Lacandula L, Rojo MJA, Puno G, Casas J.** 2017. Geospatial analysis on the influence of biophysical factors on the gall rust prevalence in falcata (*Paraserianthes falcataria* L. Nielsen) plantation in Gingoog city, Philippines. Journal of Biodiversity and Environmental Science **11(4),** 18-24

**Łakomy P, Iwańczuk M.** 2010. *Phaeocryptopus gaeumannii* in douglas-fir stands in smolarz forest district. Phytopathologia **58,** 43-52. http://dx.doi.org/10.4067/S0717920020070001000011

**Lee SS, Zakaria M.** 1993. Fungi associated with heart rot of *Acacia mangium* in Peninsular Malaysia. Journal of Tropical Forest Science **5(4),** 479-484.

**Lee SS.** 2005. Diseases and potential threats to *Acacia mangium* plantations in Malaysia. Mortality **30(20),** 10.

**Magcale-Macandog DB, Menz k, Rocamora PM, Predo CD.** 1999. Smallholder timber production and marketing: the case of *Gmelina arborea* in Claveria, Northern Mindanao, Philippines. International Tree Crops Journal **10(1),** 61-78.

**Mahmud S, Lee SS, Ahmad H.** 1993. A survey of heart rots in some plantations of *Acacia mangium* in Sabah. Journal of Tropical Forest Science **6(1),** 37-47.

**Mohammed CL, Barry KM, Irianto RS.** 2006. Heart rot and root rot in *Acacia mangium*: identification and assessment. In Australian Centre for International Agricultural Research (ACIAR) proceedings **124,** 26.

**Old KM, See LS, Sharma JK, Yuan ZQ.** 2000. A manual of diseases of tropical acacias in Australia, South-East Asia and India. CIFOR.

**Onyekwelu JC, Biber P, Stimm B.** 2003. Thinning scenarios for *Gmelina arborea* plantations in south-western Nigeria using density management diagrams. Food, Agriculture & Environment **1(2),** 320-325.

**Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A.** 2009. Agroforestree database: A tree reference and selection guide (version 4.0). Kenya: World Agroforestry Centre.

**Philippine Forestry Statistics.** 2003. Department of Environment and Natural Resources, Forest Management Bureau.

**Roshetko JM, Purnomosidhi P.** 2004. *Gmelina arborea*–a viable species for smallholder tree farming in Indonesia?. New forests **28(2-3),** 207-215. http://dx.doi.org/10.1023/B:NEFO.0000040948.53797.c5

**Sein CC, Mitlöhner R.** 2011. *Acacia mangium* Willd: ecology and silviculture in Vietnam. Center for International Forestry Research (CIFOR). http://dx.doi.org/10.17528/cifor/003694

**Shortle WC, Dudzik KR.** 2012. Wood decay in living and dead trees: a pictorial overview. Gen. Tech. Rep. NRS-97. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station **97,** 1-26.

**Tarigan M, Wingfield MJ, Van Wyk M, Tjahjono B, Roux J.** 2011. Pruning quality affects infection of *Acacia mangium* and *A. crassicarpa* by *Ceratocystis acaciivora* and *Lasiodiplodia theobromae*. Southern Forests: a Journal of Forest Science **73(3-4)**, 187-191. http://dx.doi.org/10.2989/20702620.2011.639.498

**Tolentino EL.** 2008. Restoration of Philippine native forest by smallholder tree farmers. In Smallholder Tree Growing for Rural Development and Environmental Services Springer, Dordrecht. 319-346. http://dx.doi.org/10.1007/978-1-4020-8261-0_15

**Umana EJ, Akwaji PI, Markson AA, Udo SE.** 2015. *Gmelina arborea* Roxb: associated mycoflora and diseases in Cross River State, Nigeria. Global Journal of Science Frontier Research: C Biological Science **15(4),** 1-15.

**Vasiliauskas R.** 2001. Damage to trees due to forestry operations and its pathological significance in temperate forests: a literature review. Forestry **74(4),** 319-336.

**Wagener WW, Davidson RW.** 1954. Heart rots in living trees. The Botanical Review **20(2),** 61-134.

**Wingfield MJ, Robison DJ.** 2004. Diseases and insect pests of *Gmelina arborea*: real threats and real opportunities. New forests **28(2-3),** 227-243. http://dx.doi.org/10.1023/B:NEFO.0000040950.01256.ed

**Zakarira I, Wan Razali WM, Hashim MN, Lee SS.** 1994. The incidence of heart rot in *Acacia mangium* plantations in Peninsular Malaysia, FRIM. Research Pamphlet **114,** 1-5.