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PROMOTING THE ROLE OF PHYTOPATHOLOGY BASED ON THE ADVANCED BIOTECHNOLOGY FOR ECHANCING THE SUSTAINABLE AGRICULTURAL PRODUCTION

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BIOLOGICAL CONTROL OF PLANT DISEASES

PLANT DISEASES CAUSED BY FUNGI

DECAY FEATURES OF THE XYLEM CELLS OF A *SHOREA GIBBOSA* STEM CANKER

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ABSTRACT

Xylem decay of a serious stem canker of Shoreagibbosa found in Bukit Soeharto Educational Forest of Mulawarman University, East Kalimantan has been investigated. Fungi infection into the standing tree is suspected as a causal main factor of the disease and xylem decay. Colonization of fungal hyphae and cell wall degradation were clearly observed under scanning electron microscopy (SEM). Xylem fibers, rays and parenchyma cells of were degraded, however most of vessel elements remain intact. Penetration of the fungal hyphae into the xylem cells induced the numerous holes on fiber and axial parenchyma cell walls, and pits of vessel elements become distorted and enlarged. The loss of few axial parenchyma cell walls and the fiber wall thinning were also detected.

Keywords: canker, decay, cell wall, hyphae, microscopy

INTRODUCTION

Many studies have reported fungal stem canker diseases associated with wood decay in various species of tropical forest trees, either in plantation forest, e.g. *Eucalyptus* spp. [9], *Shorea smithiana* [7], *Acacia mangium* [8], *Gmelina arborea* [3], *Eucalyptus urograndis* [2] and [3], or in natural forest and rubber plantation e.g. *Hevea brasilie*nsis [1; 4] and *Shorea gibbosa* [5]. Generally, the trees exhibit localized dead areas in the bark, cracks and ruptures on the surfaces of the bark near to canker zone and apparently decayed exposed sapwood. Decay in the xylem of living trees is long-known problems and until now many tree species, which with decayed xylem has not been characterized. One of them is yellow meranti (*Shorea gibossa*) with basal stem canker found in natural dipterocarps of Bukit Soeharto in East Kalimantan, Indonesia.Because the tree species being managed for timber production, decay that develops on the stem caused by fungi give rise to reductions in grade quality or losses of timber, thus it becomes a serious economical problem. In general way, information regarding the characteristic features of xylem degradation on this commercial species will be importance for understanding of decay problems in forest trees.

In this study, microscopic observations have been conducted to reveal the anatomical features of the xylem of *Shorea gibbosa* (yellow meranti) infected with fungal-stem canker. Although microscopic observation techniques are not currently directly applicable for field use, they can provide valuable information for understanding the altered properties of infected xylem. By microscopic observation, the decay pattern of the infected xylem also can easily be categorized and a preliminary identification made of the causal microorganism.

MATERIALS AND METODHS

Wood sample collections

Wood samples were collected from a Shorea gibbosa cankerous tree [diameter at breast height (DBH) approximately 40 cm] growing in a natural dipterocarp stand at the Bukit Soeharto Educational Forest of Mulawarman University, East Kalimantan, Indonesia. The tree with decayed xylem was formed on the stem from ground level up to 40 cm (Figure 1).

Three disks 5 cm thick were cut from the cankered stem of *S. gibbosa*. which used for microscopic observations of the anatomical characteristics of the sound and decayed xylem. The transverse view of the stem canker of *S. gibbosa* shows that appear to be decayed in the

exposed xylem at the canker margin. The decay appeared to extend from outside to inside and also tangentially.

Figure 1. Appearance of longitudinal canker on exposed wood Shoreagibbosa.

From each of the three cankered stem disks, a wood sample (approximately 15 x 15 x 15 mm) was taken from each of the four sites of decayed xylem and sound ones.

SEM Observations

Each of the decayed xylem samples was fixed in 2.5% glutaraldehyde in 0.1 M phosphate buffer (pH 7.2) at 4 ^{o}C overnight, washed four times in 0.1 M phosphate buffer at pH 7.2 for 15 minutes each, and rinsed three times in distilled water for 5 minutes each.

The samples were dehydrated in 50, 70, and 95% ethanol, each for 20 minutes, then three times in 100% ethanol. The dehydrated samples were freeze-dried, mounted on stubs, and then coated with gold-palladium using Jeol JFC-1200 Fine Coater.

The coated samples were examined under a JEOL Scanning Microscope (JSM-5310) and SEM images were obtained using the EDAX (energy dispersive X-ray analyzer) application program.

RESULTS AND DISCUSSION

The first anatomical feature observed of the early stage of decay in *S. gibbosa* was the presence of large holes or rounded pit erosion. Large holes were observed in parenchyma cells and vessels, and fibers (Figs. 2). As previously mentioned, the presence of pit erosion and bore hole formation in xylem cell walls indicated that the hyphae of decay fungi could penetrate transversely from one cell to another through natural openings as well as through bore holes via enzymatic degradation [6;10]. In this decay stage, the cell walls show no signs of degradation such as thinning of the wall or erosion troughs.

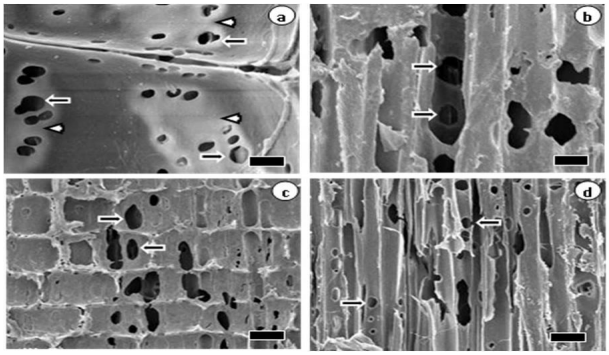

Figure 2. Early stage of xylem decay in *S. gibbosa.* (a) Rounded erosion of vessel pits (arrows) and obvious lysis zones around pits (head arrows). Bar 10 μm; (b-d) Bore holes in parenchyma cells, rays and fibers (arrows). Bar 10 μm, 20 μm, 20 μm.

In the intermediate stage of decay, thinning of the cell walls could be observed in some fiber and axial parenchyma cells (Figure 3). It appeared that the cell walls were thinned, and the cells were collapsed and deformed. The progressive thinning of the cell walls of S. gibbosa also showed that the secondary walls were occasionally removed; only the middle lamella and cell corners remained.

In the late stage of decay, the typical features of the simultaneous removal of all cell components of S. gibbosaxylem were readily apparent. As previously mentioned, because of the complete removal of all cell components, the remaining wood cells appeared to be separated from each other, resulting in many large voids that appeared in transverse sections of the decayed xylem.

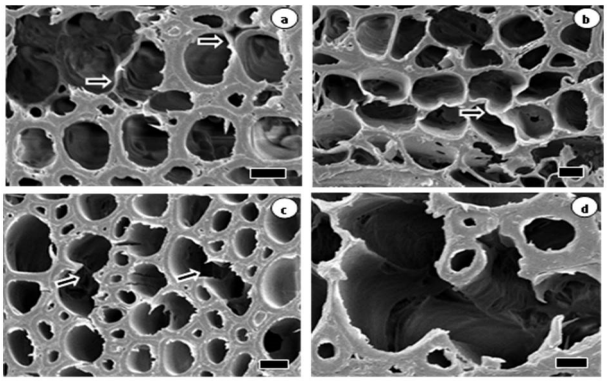

Figure 3 Intermediate and late stages of xylem decay in *S. gibbosa*. (a) Thinning of cell wall in fibers (arrows). Bar 10 μm; (b) Collapse of the thinner cell walls (arrow). Bar 10 μm; (c) Channel erosion of cell walls (arrows). Bar 10 μm (d) Complete removal of cell walls. Bar 5 μm.

CONCLUSIONS

Xylem cells of S. gibbosacankerous tree have been heavily degraded. Cell wall thinning, bore hole formation, rounded pit erosion and eroded channel opening were clearly observed under scanning electron microcopy. In transverse view, large voids resulting from the complete removal of all cell components of xylem tissue appeared in the decayed canker zone.

All these observations suggest the well-known simultaneous decay pattern caused by white-rot fungi.

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