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Anatomical Study of Leaves Infected with Sooty Mold on Various Plants

Kajian Anatomi Daun yang Terinfeksi Kapang Embun Jelaga pada Berbagai Tanaman

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Abstract

Sooty mold is a parasitic fungus that attacks plants. Sooty mold has black mycelium that spreads and covers the surface of leaves, forming black spots. These black spots then merge, thicken, and spread to cover the entire surface of the leaves. The purpose of this study was to determine the anatomy of leaves infected with sooty mold on various plants. This study used a descriptive observational research method. The research was conducted at the Microbiology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Malang. The results of observing the anatomical structure of leaf tissue infected by sooty mold on various plants through cross-sectioning showed that the anatomy of the leaves of the sawo kecik and mango plants indicated that the hyphae only penetrated the upper epidermal tissue, while in coffee plants, the hyphae penetrated the upper epidermal tissue, palisade tissue, spongy tissue, and lower epidermal tissue.

Embun jelaga merupkan salah satu kapang parasit yang menyerang tanaman. Kapang embun jelaga (*sooty mold*) memiliki miselium berwarna hitam yang tersebar dan menutupi permukaan daun membentuk bercak hitam. Bercak hitam tersebut kemudian menyatu, menebal dan meluas menutupi seluruh permukaan daun. Adapun tujuan dari penelitian ini adalah untuk mengetahui anatomi daun yang terinfeksi kapang embun jelaga pada berbagai tanaman. Jenis penelitian menggunakan metode penelitian deskriptif observasional. Penelitian dilaksanakan di Laboratorium Mikrobiologi, Jurusan Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Negeri Malang. Hasil pengamatan struktur anatomi jaringan daun yang terinfeksi oleh kapang embun jelaga pada berbagai tanaman tersebut melalui pembuatan irisan melintang didapatkan hasil pengamatan anatomi daun tanaman sawo kecik dan mangga menunjukkan bahwa hifa hanya menembus sampai jaringan epidermis atas, sedangkan pada tanaman kopi menunjukkan hifa menembus jaringan epidermis atas, jaringan palisade, jaringan sponsa sampai ke jaringan epidermis bawah.

Article Information

Keywords:
Leaf Anatomy; Descriptive Observation; Sooty Mold; Parasite

Kata kunci:
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A. INTRODUCTION

Sooty mold is a type of parasitic fungus that attacks plants. Sooty mold has black mycelium that spreads and covers the surface of leaves, forming black spots (Wescott, 1971; Bassey, 1979; Chomnunti et al., 2014; Flessa et al., 2021; Arun et al., 2021). These black spots then merge, thicken, and spread to cover the entire leaf surface (Semangun, 2007). At severe levels of attack, the leaves will turn yellow and fall prematurely (Asmaliyah et al., 2015). The adaxial surface infected by the fungus does not cause physical damage to the leaves, but it has the potential to reduce sunlight penetration and inhibit photosynthesis (Wood et al., 1988). The spread of sooty mold is aided by insect pests that produce honeydew.

Sooty mold grows on honeydew media produced by plant sap-feeding insect pests (Hughes, 1976; Reynolds, 1999; Georgiev et al., 2008; Chomnunti et al., 2014; Zhiyuan et al., 2023). Pest insects secrete honeydew as nutrients for the growth of sooty mold (Venita, 2010; Lv et al., 2023). Honeydew contains sugars, amino acids, proteins, minerals, and vitamins and serves as a medium for the growth of sooty mold (Kessler, 1992). Insects that carry honeydew cause sooty mold to grow easily on plant leaves (Nelson, 2008; Lamborn, 2009), so that sooty mold colonies effectively form black spots that cover the leaf surface. The black spots will disappear if the insect pests are controlled. Efforts to eliminate insect pests on plants can be done by spraying insecticides or light horticultural oils, such as neem oil (Lamborn, 2009).

Sooty mold is solid and rubbery and can be easily removed by rubbing the blackened leaves with your fingers or washing the leaves with a strong spray of soapy water (Hodges & Braman, 2004; Agrios, 2005). Sooty mold has a wide distribution on various types of plants, occurring most frequently in tropical and subtropical regions (Kessler, 1992; Agrios, 2005; Chomnunti et al., 2014). Observations conducted by researchers in the village of Solorejo, Malang City, East Java Province, found that coffee, orange, sapodilla, mango, and guava plantations were mostly attacked by pests that resembled black spots attached to the leaves, which are characteristics of sooty mold attacks. Sooty mold disease can be found on citrus plants (Ningsih et al., 2012; Labib et al., 2015), guava (Fadila, 2024), castor bean (Laksono et al., 2010), oil palm (Venita, 2010), mango, guava, sapodilla, and coffee (Tarigan, 2016).

The mold that causes sooty mold disease has the same colony characteristics, namely black powder-like spots on the surface of leaves. Although it attacks different plant species. Sooty mold generally belongs to the Capnodiaceae family, class Dothideomycetes (Batista & Ciferri, 1963; Hughes, 1972; Crous et al., 2009a, b; Chomnunti et al., 2011, 2014). The genus Capnodium is the most commonly found genus in sooty mold (Reynolds, 1999; Chomnunti et al., 2014). However, there are also sooty mold fungi that belong to other families, such as Capnodiaceae, Antennulariellaceae, Chaetothyriaceae, Coccodiniaceae, Euantennariaceae, Metacapnodiaceae, and Trichomeriaceae (Reynolds, 1998; Winka et al., 1998; Kirk et al., 2008; Lumbsch & Huhndorf, 2010; Hughes & Seifert, 2012; Chomnunti et al., 2014). Sooty mold causes a decrease in photosynthetic productivity and gas exchange (Hodges & Braman, 2004; Agrios, 2005), resulting in suboptimal plant production (Semangun, 2007). In general, sooty mold penetrates the surface of the epidermal tissue on leaves (Hughes, 1976; Lemos & Sousa, 2006), so it is necessary to conduct research through leaf anatomy observation to confirm which leaf tissues are infected with sooty mold. Observational research needs to be conducted through anatomical observation of cross-sectioned leaf preparations of plants infected by sooty mold.

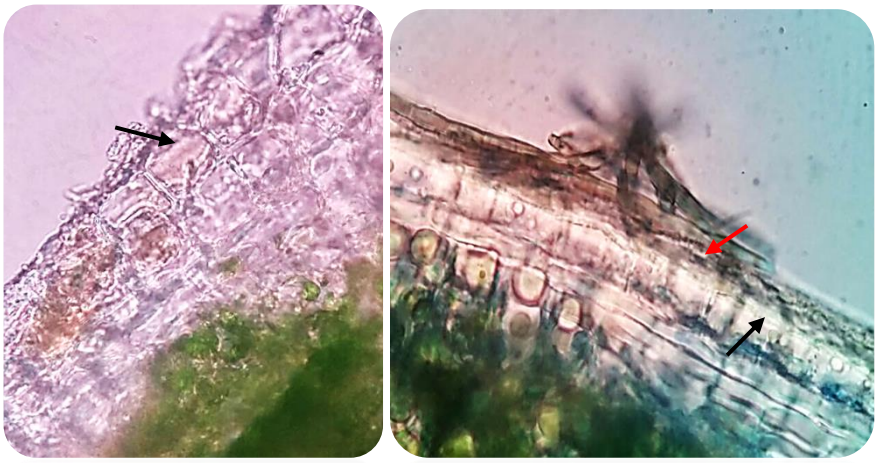
B. METHOD

The type of research used a descriptive observational research method. Observational research is conducted by observing or measuring various variables of the research subject (Afrizal, 2017). The descriptive observational research method is research that describes a condition or problem explored through observations in the field. Observation of the anatomy of leaves infected with sooty mold on mango, coffee, and small sapodilla plants. The research was conducted at the Microbiology Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Malang. The stages of observing the anatomy of leaves infected with parasitic mold are observing the morphological characteristics of the parts of the leaves infected by sooty mold; the leaves of plants infected with mold are cleaned on the underside using tissue with 70% alcohol; the plant leaves were sliced as thinly as possible crosswise using a razor blade and cork; the leaf slices were placed on a glass slide and dripped with distilled water, then covered with a cover glass; and the preparation was observed with a light microscope, especially the plant leaf tissue that had been damaged, then the results were photographed and recorded.

C. RESULTS AND DISCUSSION

Anatomical observations of leaves from several types of plants infected with sooty mold were conducted using cross-sectional leaf preparations to identify the leaf tissues penetrated by sooty mold hyphae, thereby determining the damage to leaf tissue structure caused by infection by this fungus. The results of anatomical observations of leaf tissue infected with sooty mold showed that the hyphae of sooty mold only penetrated the epidermal tissue (Figures 1 and 3) and penetrated the palisade and spongy tissues (Figure 2). These results indicate that sooty mold hyphae not only penetrate the epidermal tissue of the leaf, but can also penetrate into the inner leaf tissue, causing damage to the leaf tissue structure.

1) Leaves of the Sawo Kecik Plant (*Manilkara kauki* L.)

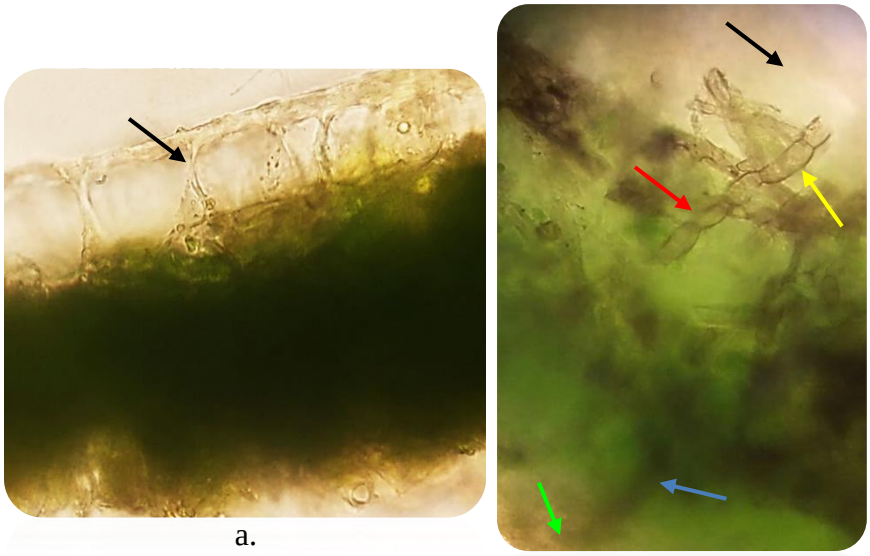


a. b.

Figure 1. Cross-section of a Sawo Kecik leaf (a) Anatomy of healthy leaf, (b) Anatomy of a leaf infected with soory mold(1000x magnification) (Personal Documentation)

Description:
→: hyphae penetrate only as far as the upper epidermal tissue
→: upper epidermal layer

2) Coffee Plant Leaves (*Coffea arabica* L.)

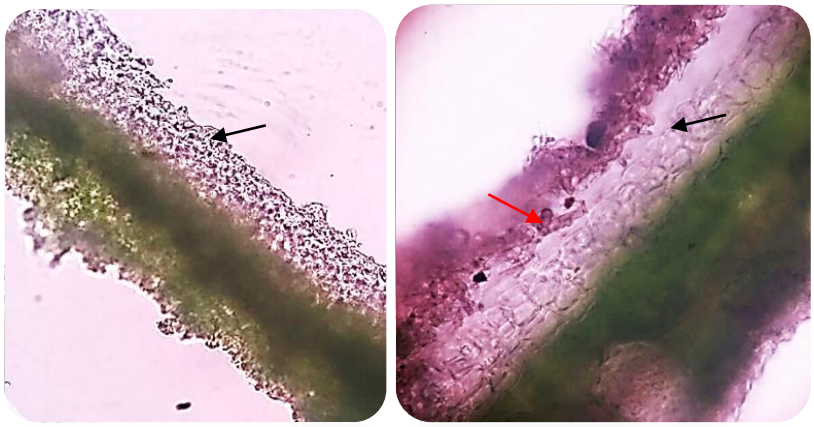


a. b.

Figure 2. Cross-section of a coffee leaf (a) Anatomy of a healthy leaf (b) Anatomy of a leaf infected with sooty mold (1000x magnification) (Personal Documentation)

Description:
Fungal hyphae (→).Hyphae penetrate the coffee leaf tissue starting from the upper epidermis **(→),**palisade tissue **(→),**spongy tissue **(→)**and lower epidermis **(→)**

3) Mango Tree Leaves (*Mangifera indica* L.)



a. b.

Figure 3. Cross-section of a mango leaf (a) Anatomy of a healthy leaf, (b) Anatomy of a leaf infected with sooty mold (400x magnification) (Personal Documentation)

Description:
→: hyphae penetrate only as far as the upper epidermal tissue
→: upper epidermis

Sooty mold is characterized by black powdery spots covering part of the leaf surface. These black spots can be easily removed by rubbing the infected leaf surface vigorously. Sooty mold infects older leaves. The black spots covering the leaf surface are harmful to the plant. They block sunlight from reaching the leaves, thereby reducing photosynthesis and gas exchange (Hodges & Braman, 2004; Kumar et al., 2021). Sooty mold infection causes abnormal flower and fruit formation, resulting in suboptimal plant production (Hodges & Braman, 2004; Semangun, 2007). Observation of the anatomical structure of leaf tissue infected by sooty mold on the three plants was conducted by making cross sections so that the observation of leaf tissue damage from the upper epidermis to the lower epidermis could be better understood.

The results of anatomical observations of sapodilla and mango leaves showed that the hyphae only penetrated the upper epidermis, while in coffee plants, the hyphae penetrated the upper epidermis, palisade tissue, spongy tissue, and lower epidermis. Previous information stated that sooty mold generally only infects the epidermal tissue of plant leaves (Hughes, 1976; Lemos & Sousa, 2006). The results of the research conducted by the researchers successfully proved that the hyphae of sooty mold fungus not only penetrate the epidermal tissue, but also the palisade tissue, spongy tissue, and even the lower epidermis. The fungus that penetrates the palisade and spongy tissue of the leaves causes chlorosis, so that over time the leaves wither and die (Ginting, 2013). Observation of the anatomy of leaves infected by sooty mold provides students with the opportunity to study the mechanism of infection and its impact on plant tissue damage, which results in stunted plant growth. The observation of the anatomy of leaves infected by sooty mold is expected to contribute to students' understanding of the concepts they have learned through verbal information in lectures.

D. CONCLUSION

The conclusion of this study is that observation of the anatomical structure of leaf tissue infected by sooty mold on various plants through cross-sectioning allows for a better understanding of leaf tissue damage from the upper epidermis to the lower epidermis. The results of anatomical observations of sapodilla and mango leaves show that the hyphae only penetrate the upper epidermal tissue, while in coffee plants, the hyphae penetrated the upper epidermis, palisade tissue, spongy tissue, and lower epidermis.

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