Wallacea Plant Protection Journal
Vol. 1 No. 1 (2025)
Page: 15–18
DOI: https://doi.org/10.64128/wppj.v1i1.42071

Online ISSN 3090-5079
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Published by Department of Plant Pest and Disease,
Faculty of Agriculture, Hasanuddin University

Original Article

Analysis of the severity of foot rot disease (*Phytophthora* sp.) on pomelo (*Citrus maxima*) in Pangkep Regency, South Sulawesi

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ARTICLE INFORMATION

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Citation: Patandjengi, B., Kuswinanti, T., & Fauziah, N. (2025). Analysis of the severity of foot rot disease (*Phytophthora* sp.) on pomelo (*Citrus maxima*) in Pangkep Regency, South Sulawesi. *Wallacea Plant Protection Journal, 1*(1), 15–18. https://doi.org/10.64128/wppj.v1i1.42071

Editor handling: Asti Irawanti Azis

Received : 14 November 2024
Revised : 5 May 2025
Accepted : 6 May 2025
Published : 10 May 2025

ABSTRACT

Foot rot disease (FRD) on citrus plants is suspected to be caused by a *Phytophthora* spp., characterized by yellowish-brown stem discoloration and cracking or peeling bark. FRD spreads rapidly and can be fatal to citrus crops. The purpose of this study was to determine the intensity of FRD on pomelo (*Citrus maxima*) in Ma'rang, Segeri, and Labakkang Districts, Pangkep Regency. Symptomatic tissues were collected and examined microscopically at the Plant Disease Laboratory at Hasanuddin University. The highest disease intensity was observed in Ma'rang (27%), followed by Labakkang (21%) and Segeri (17%). The study also found that disease intensity was inversely related to light penetration under the canopy. Denser foliage with limited pruning resulted in lower light intensity and higher disease severity. The low intensity of light that enters under the trees canopy of pomelo plantations is affected by tree stands that have relatively denser crowns due to the infrequent pruning of less productive branches.

Keywords: Brown stem discoloration; Disease intensity; Light intensity; Light penetration; Pruning; Trees canopy

1. Introduction

Citrus fruits (*Citrus* spp.) are a popular and widely available fruit in Indonesia, highly favored by the public for their rich vitamin C content and accessibility in the market. The pomelo (*Citrus maxima* (Burman) Merrill) is suitable for cultivation at altitudes below 700 meters above sea level (Badan Penelitian dan Pengembangan Pertanian, 2007; Khairani et al., 2017). The pomelo also known as the largest citrus fruit and are often called as a shaddock. It is recognized for producing the largest fruits among citrus varieties. The pomelo is a type of citrus that can adapt well to dry areas (Cakrawati & Handayani, 2014). In addition, a previous research Wang et al. (2014) reported that pomelo peel contains pectin in concentrations ranging from 16.68% to 21.95%, making it valuable for applications in the food and beverage industry.

One of the largest pomelo production centers in South Sulawesi is Pangkep Regency. At first, this plant was cultivated by the community as a garden plant. According to the Dinas Pertanian Kabupaten Pangkep (2015) it was recorded that it covered an area of 1,1614 ha with a productivity of 15,441 tons/ha, but in the next 2 years until 2017, it continued to decline, with productivity levels ranging from 14 tons/ha. In Ma'rang District, the production of pomelo in 2016 was 31,036 tons, and in 2017 was 30,861 tons. In Labakkang District, the production of pomelo in 2016 was 6,331 tons, and in 2017, it was 3,900 tons.

The low production, productivity, and quality of pomelo are suspected to be due to the inefficient production process and the inadequate ability of farmers to manage farming, as well as pest and disease severity, causing high opportunities for production failures (Marhawati, 2019). The foot rot disease (FRD) is known to kill citrus plants and spread very quickly (Retnosari et al., 2014). Citrus plants attacked by FRD show symptoms of rot at the base of the stem and dark wet spots on the bark of the stem.

Decay starts from the base of the stem near the soil surface to the grafting point (40 cm). The bark tissue and even the surface of the skin, cambium, and infected wood will change color, and over time, the skin will peel off and fall off, causing wide wounds, especially in advanced severity. The purpose of this study was to determine the intensity of FRD (*Phytophthora* sp.) of pomelo in Pangkep Regency.

2. Materials and Methods

This research was conducted in the pomelo planting area in Pangkep Regency, South Sulawesi Province, and at the

Plant Disease Laboratory, Department of Plant Pest and Disease, from March to May 2022.

This study employed a two-staged research approach: (1) Field research, which involved selecting the research plot, scoring disease symptoms on plants, and measuring the light intensity and temperature around the plantations; and (2) Laboratory research, which focused on identifying the causal agent of FRD on pomelo.

2.1. Sampling Layout

The sample layout is determined using purposive random sampling and is shown in the Figure 1.

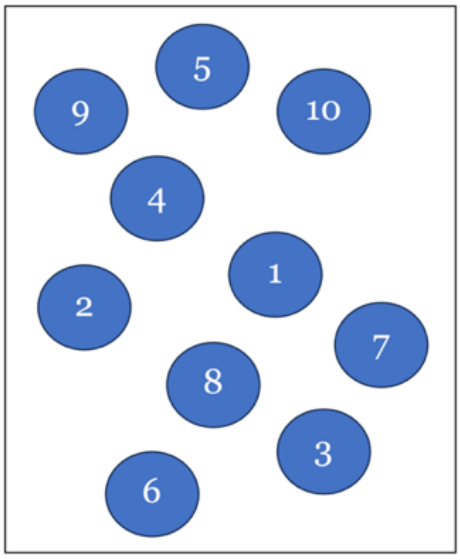

Figure 1. Sampling layout for pomelo trees.

2.2. Symptom-based Diagnosis

The disease severity observation was carried out on pomelo plants, focusing on severe symptoms that are visible at the base of the stem. Disease severity was determined by calculating the percentage of FRD damage using a qualitative scoring method on a scale of 0 to 4 (Table 1).

Table 1. Severity score of foot rot disease on pomelo

Score	Percentage of damage (%)	Description
1	0 ≤ 5	Healthy
2	5 ≤ 20	Low disease severity
3	20 ≤ 40	Moderate disease severity
4	40 ≤ 60	Major disease severity
5	60 ≤ 100	Extreme disease severity

The disease severity/intensity (%) was determined according to the following formula:

$$I = \frac{\Sigma (n \times v)}{Z \times N} \times 100\% \quad (1)$$

Description
I : Disease severity/intensity (%)
n : Number of stems/branches that are attacked in a certain category
v : Score of certain attack category
Z : Scale value of the highest category
N : Number of stems/branches observed first

2.3. Light Intensity and Temperature Measurements under the Canopy of a Pomelo Plants

A lux meter is used to measure the intensity of sunlight and a thermometer is used to measure the temperature condition. The device was held 75 cm above the ground, and the display screen shows the light level at the measurement point. Measurements were conducted at 08:00, 12:00, and 16:00 of local time for approximately a week.

2.4. Isolation of Pathogens from Symptomatic Plants

The samples with FRD symptoms were brought to the laboratory for identification. Plant parts that show symptoms or damage are cut and placed in plastic sheets and newspapers. Pieces measuring 5–10 mm containing both diseased and healthy tissue were prepared. The pieces were surface sterilized using a 0.2% NaOCl solution for 2–3 minutes, rinsed with water, and air-dried on filter paper. The mycelia from the stem bark were taken and placed on a sterile object glass with a drop of sterile distilled water, covered with a coverslip, and observed under a microscope for identification.

2.5. Data Analysis

Data analysis used in this study included qualitative descriptive analysis to describe the symptoms of FRD on pomelo plants and quantitative descriptive analysis to describe the intensity of FRD.

3. Results

The symptoms of FRD on pomelo from three districts in Pangkep Regency are shown in Figure 2. Across all three locations, the observed symptoms were generally similar, with the most distinct characteristics being rot on the rootstock or around the root crown near the soil surface.

3.1. Microscopic Identification of the Causal Agent of FRD

The results of the microscopic observation of the fungus *Phytophthora* sp. are presented in Figure 3. In the figure, the hyphal structure, sporangium, and chlamydospore of the pathogen are visible.

3.2. Severity of FRD

Figure 4 shows the percentage of FRD severity. The results showed the high intensity of FRD in three districts in Pangkep Regency. The highest percentage of advanced disease severity was in Ma'rang District, at 27%, followed by Labakkang District, at 21%, and the lowest intensity in Segeri District, at 17%.

3.3. Light Intensity and Temperature Measurements

Figure 5 shows the average percentage of light intensity measured under the canopy of pomelo plantations. The highest percentage of light intensity was obtained in Segeri District, which ranged from 9,084–10,774 lux. Then, in the Labakang District, it ranged from 8,090–9,137 lux, and the lowest light intensity was in the Ma'rang District, which ranged from 4,344–5,150 lux.

The average temperature around the pomelo plant can be seen in Figure 5. The measurement shows that the Segeri District recorded the highest average temperature at 32 °C, followed by the Labakkang District at 30 °C, and the Ma'rang District at 28 °C. Ma'rang District, which recorded the highest severity of FRD, exhibited low light intensity.

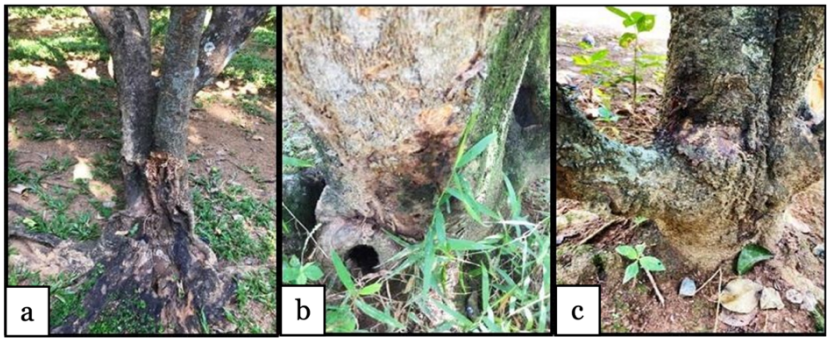

Figure 2. Symptoms of foot rot disease in (a) Ma'rang, (b) Segeri, and (c) Labakkang Districts.

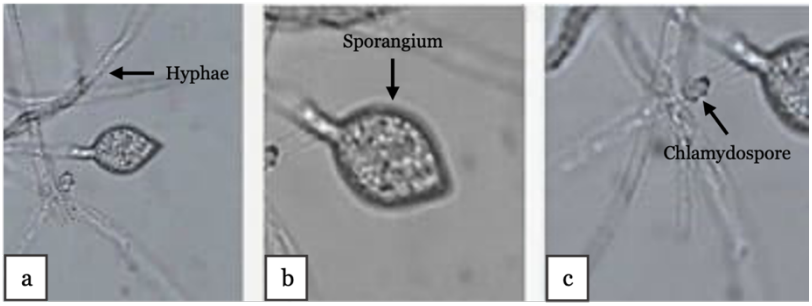

Figure 3. Microscopic characteristics of *Phytophthora* sp. (a) Hyphae, (b) Sporangium, and (c) Chlamydospore.

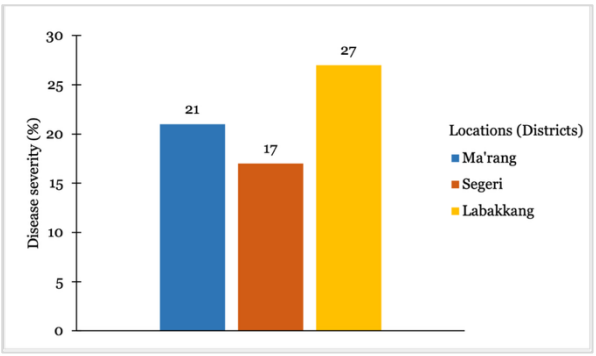

Figure 4. Severity of foot rot disease on pomelo from three locations.

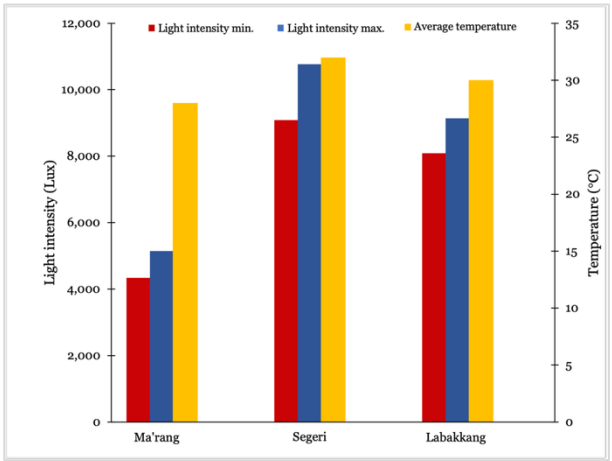

Figure 5. Light intensity under the canopy of pomelo plantations.

4. Discussion

The symptoms of the FRD disease found in this study were primarily observed as color changes at the base of the stem, which appeared dark brown and were accompanied by cracked and peeling bark. These findings are consistent with a previous study Ploetz (2003), which described the initial symptoms as dark, wet lesions on the stem bark. The decay typically begins at the base of the stem near the soil surface to the grafting point (approx. 40 cm). As the disease progresses, the bark tissue, including the cambium and xylem, becomes discolored, eventually leading to bark detachment and extensive wounding. In advanced stages, affected bark often appears sunken and exudes gum, and the plant may initiate callus formation.

Microscopic observation of the fungus *Phytophthora* sp. revealed non-septate hyphae, sporangia with round to ovoid shapes, and chlamydospores that are round with relatively thick walls. This is about the previous research Retnosari et al. (2014), which states that the hyphae of *Phytophthora* sp. are non-septate and oval or lemon-shaped sporangia formed on sporangiophores.

The severity level of FRD is relatively high, presumably due to the relatively denser tree canopy, which reduces the intensity of light reaching the ground, thereby lowering surface temperature and increasing soil moisture. Excessive light intensity, on the other hand, can disrupt plant growth and even lead to the death of tolerant species (Herdiana et al., 2008). Light is essential for plants as it drives the process of photosynthesis. Optimal photosynthesis leads to better growth and development of plants (Omon & Adman, 2007). This is per another

research Naveed & Hussain (2017), which states that decreased temperature and high humidity can increase the intensity of the disease.

High humidity strongly supports the development of disease. *Phytophthora* sp. is a soil-borne pathogen. Its spores spread via soil use and are active in water. Its rapid development in moist conditions makes root damage particularly prevalent during the rainy season. This is under research Bartholomew et al. (2003), which states that the lack of light intensity reaching the soil surface can create damp conditions around the planting area. In the study, it was reported that *Phytophthora* sp. will begin to germinate and infect plant tissues in high soil moisture and poorly drained soils.

Pruning and land sanitation are essential to prevent moisture buildup. Pruning helps regulate branch growth, reduce tree density, lower humidity levels, and allow plants to receive adequate sunlight. This reduces damp conditions, minimizing the risk of fungal infections that cause diseases. As a result, plant health improves, and crop production is enhanced (Widya, 2015).

5. Conclusion

This study concluded that the pathogen causing the foot rot disease (FRD) in three districts in Pangkep Regency is *Phytophthora* sp. The severity of the disease is significantly influenced by factors such as light intensity reaching the pomelo planting area, the surrounding temperature, and cultivation practices, particularly pruning, which have not yet met the ideal standards for pomelo farming. *Phytophthora* sp. spreads rapidly in moist soil conditions.

Author Contributions: **Baharuddin Patandjengi**: Conceptualization, Methodology, Validation, Resources, Writing–original draft, Writing–review and editing, Supervision, Funding acquisition. **Tutik Kuswinanti**: Conceptualization, Validation, Investigation, Writing–review and editing, Supervision. **Nurul Fauziah**: Software, Validation, Formal analysis, Data curation, Visualization, Project administration. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors would like to thank the Department of Plant Pest and Disease, Faculty of Agriculture, Hasanuddin University and all the pomelo farmers in Pangkep Regency to conduct this study.

Conflicts of Interest: The authors declare no conflict of interest.

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