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RESEARCH PAPER

Spread of bacterial wilt disease on potato in three villages in Silimakuta District, Simalungun, North Sumatra, Indonesia

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ABSTRACT

Bacterial wilt disease caused by *Ralstonia syzygii* subsp. *indonesiensis* is an important disease in potatoes. This disease is a soil-borne pathogen that is difficult to control and becomes an obstacle in potato production. This study aimed to determine the distribution of bacterial wilt disease in potatoes caused by *R. syzygii* subsp *indonesiensis* in three villages in Silimakuta District, Simalungun Regency, North Sumatra. This research was exploratory research that was conducted using a survey method by calculating the incidence of disease in potatoes in 9 locations from three villages. The results showed that the intensity of bacterial wilt occurred with different percentages of disease incidence. The highest disease incidence of 100% was in Sibangun Meriah Village Location 2 and the lowest disease incidence of 22,5% was in Saribu Dolok Village Location 1.

Key words: bacterial wilt disease, plant disease survey, *Ralstonia syzygii* subsp. *indonesiensis*

INTRODUCTION

Simalungun Regency is one of the potato-producing areas in North Sumatra. Production of potato in Simalungun was 27843.2 tons in 2018 and increased to 28691.3 tons in 2019, then in 2020 decreased production to 22979.8 tons (BPS Simalungun, 2020). Plant-disturbing organisms, especially pathogens, are an obstacle in potato production (Wenas et al., 2017). One of the important diseases affecting vegetables and horticulture is bacterial wilt disease caused by *R. syzygii* subsp. *indonesiensis* (formerly named *Ralstonia solanacerum*) (Safni et al., 2014).

Bacterial wilt disease is a soil-borne disease. Plant diseases transmitted through the soil have more impact than plant diseases transmitted through seeds or air (Setiawan, 2019). These wilt bacteria interfere with the transport of water and nutrients by damaging plant cells and destroying plant cell walls using the enzymes cellulose and pectinase (Agrios, 2005).

The symptoms caused by bacteria include wilting of leaves from the top of the crown downward and drooping of leaves like drought stress (Choiriyah & Nurcahyanti, 2019). In addition, the symptoms of tuber look rotting and there are perforated lesions that look like circles that are moistened with water which will later turn brown (Karim & Hossain, 2018).

Bacterial wilt disease in potato plants has been found in Modoinding District, North Sulawesi (Wenas et al., 2017). Several control components are needed that are integrated into a control strategy, including preventive and curative/control actions to suppress the disease (Rahayu, 2012). Determination of disease incidence by making observations based on the symptoms is needed to evaluate the economic impact of and the benefits of the control strategies (Edy et al., 2017).

Therefore, a survey and observation of potato plant bacterial wilt disease was conducted in the Silimakuta District, Simalungun Regency, to provide an estimation of the incidence and prevalence in the nine locations observed, which have not been conducted previously.

MATERIALS AND METHODS

Research Site. The survey was conducted at nine potato planting sites in Silimakuta District, Simalungun Regency, North Sumatra (Table 1). Observations were made on eight plants per subplot. In total, five subplots were carried out in a diagonal pattern. After the observations, interviews to the farmers were conducted in the form of a questionnaire that included the identity of the respondent as well as some information related to the land such as the age of the plant, the type/variety used, the origin of the tubers, and the cultivation

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technique used.

Calculation of Disease Incidence and Prevalence. Disease incidence was calculated using the formula (Windriyati, 2015):

$$DI = \frac{a}{b} \times 100\%$$

DI = disease incidence (%);
a = number of diseased plants;
b = number of total plant.

Disease prevalence was calculated using the formula (Zeleke et al., 2019) :

$$DP = \frac{n}{N} \times 100\%$$

DP = disease prevalance (%);
n = number of infected locations;
N = total location.

Environmental Data Measurement. Soil temperature and soil pH were obtained using a soil survey instrument. The air temperature and humidity were obtained using hygrometer and monthly rainfall data (March–May 2021) from the Meteorology, Climatology and Geophysics Agency (BMKG).

RESULTS AND DISCUSSION

Symptoms of Bacterial Wilt Disease. Symptoms and damage caused by bacterial wilt disease on potatoes can be seen in Figure 1. In asymptomatic plants, the leaves grow perfectly without wilting and the stems are green. However, the symptomatic plants showed wilting plants that looked like they had been scalded by hot water (Figure 1B).

The symptoms of bacterial wilt disease on potatoes in the field showed yellowing and withering of some leaves, the color of the vessels changing to brown, and releasing a bacterial mass (ooze) when the plant is cut crosswise (Figure 1C). Suhendar (2005) described that the symptoms of the disease usually start from young leaves followed by severe wilting accompanied by the collapse of the stem.

Incidence of Bacterial Wilt Disease. The percentage of disease incidence from nine locations can be seen in Table 1. The variety of percentage of disease incidences

Figure 1. Symptoms of bacterial wilt disease at the observation site. (A) Asymptomatic; (B) Symptoms with plant wilting followed by leaves rolling down; (C) Bacterial ooze from the stems of symptomatic plants.

Table 1. The incidence of bacterial wilt disease and the age of potato plants in three villages in Silimakuta District, Simalungun Regency, North Sumatra

Observation Location	Disease Incidence (%)	Plant Age (months)
Saribu Dolok Village Location 1	22.5	2
Saribu Dolok Village Location 2	32.5	1.5
Saribu Dolok Village Location 3	60	2
Sibangun Meriah Village Location 1	60	2.5
Sibangun Meriah Village Location 2	100	1.5
Sibangun Meriah Village Location 3	72.5	2.5
Sinar Baru Village Location 1	42.5	2
Sinar Baru Village Location 2	37.5	2
Sinar Baru Village Location 3	60	2

is caused by plant age, use of harvested seeds, control measures, and environmental factors. The highest percentage of disease incidence was in Sibangun Meriah Village Location 2 with a plant age of 1.5 months or 6 weeks with a 100% disease incidence. The lowest percentage of disease incidence was in Saribu Dolok Village Location 1 with a plant age of 2 months or 8 weeks with an incidence percentage of 22.5%.

A high percentage of disease incidence can occur due to the use of seeds gained from the previous harvest season. The seeds can be carriers for disease transmission due to contact between healthy plant roots and diseased plant roots. According to Irawan et al. (2015), one of the efforts to increase potato crop production is to use potato seeds that are free from disease. In addition, the incidence may occur repeatedly due to the history of land use previously planted by plants of the *Solanaceae* family and other hosts of *R. syzygii* subsp. *indonesiensis* such as Elephant Foot Yam, Bottle gourd and *Bougainvillea* sp. (Mondal et al., 2011).

Another factor that can influence the occurrence of bacterial wilt disease is environmental factors. Based on the observations, the environmental conditions in nine locations were suitable for the growth and development of *R. syzygii* subsp. *indonesiensis* especially Sinar Baru Village Location 2 (Table 2). As stated by Sun et al. (2017), the pH range for the development of *R. solanacearum* is 5.5–8.0 with an optimum pH of 6.5. In addition, Sabrina et al. (2020) stated that bacteria can live at temperatures of 25 to 35 ºC, but these bacteria are not able to live at high temperatures of 41 ºC. In addition, the condition of rainfall at the location is in the middle class (166 mm) which is directly related to the level of humidity (Table 3). According to Liu et al. (2021), rainfall intensity has the most direct impact on soil water content compared to several other environmental factors.

The speed of appearance or onset of symptoms of wilt disease can be seen from the virulence of the invading bacteria. Aeny (2001) stated that the pathogenicity of bacteria was based on the ability of the inoculated bacteria to cause symptoms in the tested plants. This wilt disease is endemic (evenly and occurs all the time) and quickly grows and spreads from infected plants to other plants and from one area to the surrounding area.

Disease Prevalence. Based on the results of observations that have been carried out at nine locations, it was found that the prevalence of the disease from all locations was 100% (Figure 2). This could be due to the presence of bacterial wilt symptoms found at each potato planting location.

CONCLUSIONS

Bacterial wilt disease in potato plantations has spread to three villages in Silimakuta District with different percentages of disease incidence. The highest

Table 2. Soil temperature and soil pH, air temperature and humidity at the observation site

Observation Location (month)	Soil Temperature (°C)	Soil pH	Air Temperature (°C)	Air Humidity (%)
Saribu Dolok Village Location 1	23.8	6.82	30.6	63.4
Saribu Dolok Village Location 2	27.4	5.38	39.08	42.2
Saribu Dolok Village Location 3	24.2	6.34	23.68	99
Sibangun Meriah Village Location 1	23.2	6.16	21.96	88.4
Sibangun Meriah Village Location 2	22.8	6.1	30.48	53.6
Sibangun Meriah Village Location 3	22.6	6.16	24.76	73.2
Sinar Baru Village Location 1	25.2	6.6	32.42	54
Sinar Baru Village Location 2	28.0	6.52	23.58	91.2
Sinar Baru Village Location 3	27.0	6.28	24.08	86.4

Table 3. Monthly rainfall data of Simalungun Regency, North Sumatra (March–May 2021)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021			171	194	134							

Source: Meteorology, Climatology and Geophysics Agency (2021).
Latitude of 02° 56' 00.6" N; Longitude of 098 ° 35' 00.6" E

percentage of disease incidence of 100% is in the village Sibangun Meriah Location 2. While the lowest percentage of disease incidence of 22.5% is located in Saribu Dolok Village Location 1.

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AUTHORS' CONTRIBUTIONS

NR, MIP, and IS considered and planned the experiment. NR carried out the survey and sampling including observation of disease symptoms on potato cultivations in Silimakuta District, North Sumatera. NR, MIP, IS provided response and comments on the research flow, data analysis and interpretation as well as prepared the manuscript. All authors have read and approved the final version of the manuscript.

COMPETING INTERESTS

The authors declare that we have no conflicts of interest related to the publication of this manuscript.

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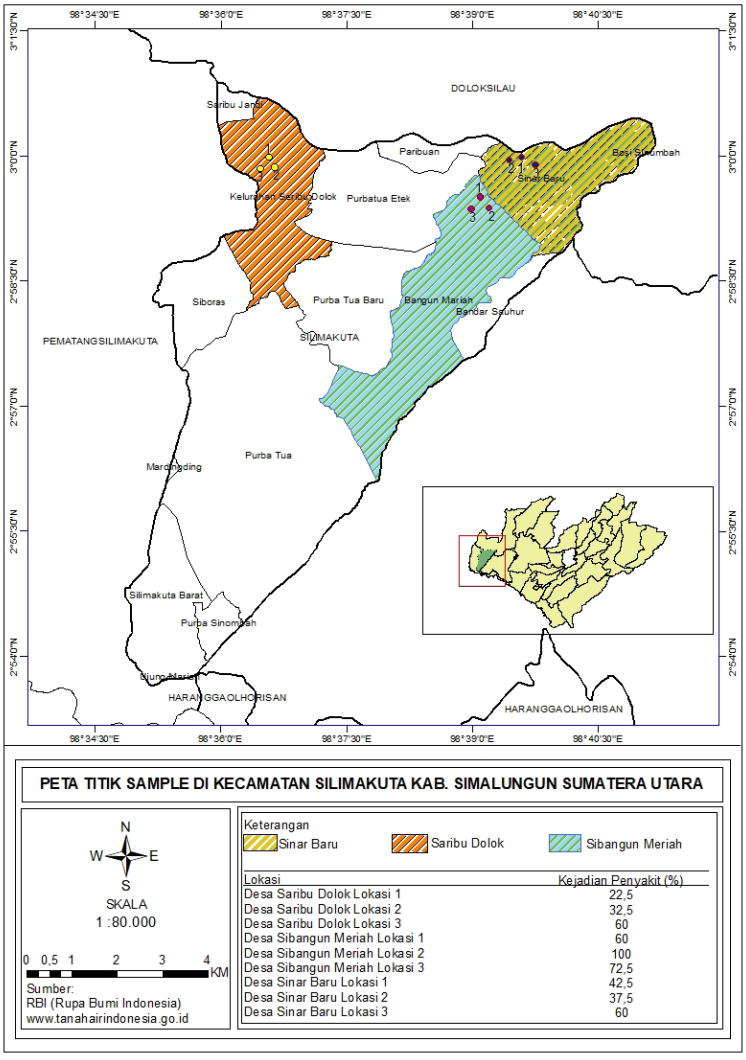

Figure 2. Map of the spread of bacterial wilt disease on potato in three villages in Silimakuta District, Simalungun Regency, North Sumatra

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