Distribution of sheath blight disease (*Rhizoctonia solani* Kuhn) on rice (*Oryza sativa* L) in Northern Sumatera, Indonesia

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Abstract. Sheath blight is one of the most important fungal rice diseases worldwide as well as in Indonesia, caused by *Rhizoctonia solani* Kuhn. Yield losses caused by sheath blight disease in the tropics reached 6%. This research was conducted by survey technique to measure the disease incidence and disease severity on rice plants in 13 (thirteen) locations representing 12 (twelve) districts in Northern Sumatra, Indonesia. Variable values of disease incidence and disease severity were found in surveyed locations. The results showed that Sumber Tani Talawi in Batubara district had both the highest disease incidence (99.48%) and the highest disease severity (12.36%).

1. Introduction

Rice (*Oryza sativa* L.) is a major staple grain for almost two-thirds of the population in the world. In particular, people in several Asian countries consume approximately 75% of their daily calorie intake [1]. Similarly, rice is an important food crop commodity in Indonesia. Rice production in Indonesia from January to September 2018 was 49.65 million tonnes of milled dry unhulled rice. The highest production occurred in March, amounting to 9.46 million tons, while the lowest production was in January, which was 2.71 million tons [2].

Plant diseases are physiological or structural disorders caused by living organisms that affect the plant growth and plant production [3]. Sheath blight is one of the most serious fungal rice diseases caused by *Rhizoctonia solani* Kuhn [4]. The fungus is a soil-borne pathogen that persists in the soil in the form of sclerotium and mycelium, especially on soils that contain lots of organic matter and have a wide host range. In several production centers for maize and sorghum, sheath blight spreads evenly, especially if planted during the rainy season. This fungus does not produce spores, therefore identification is carried out based on the characteristics of the hyphae [5].

Initial symptoms were usually visible on the leaf sheath, however the leaf blade may also be damaged. At the initial step of disease development, the symptoms show an oblong, water-soaked lesions on the leaf. On the few days, the lesions become grayish-white centre surrounded by dark purplish- or reddish-brown margins [6]. On the leaves and stems there are large spots, irregular edged, elliptical, with reddish-brown edges, while the center is straw-colored, light ochre or greenish yellow [7]. The disease causes sheath blight symptoms that can extend to the upper part of the flag leaf, so that panicle filling is disturbed [8]. Damage is usually greatly aided by gusts of wind, crop residues that were cut when the beds were prepared for irrigation [9].
In Japan, the disease causes yield losses as high as 20% and affects an estimated 120,000-190,000 hectares. Yield losses can be as high as 25% if the flag leaf is infected. Research at International Rice Research Institute shows that sheath blight causes 6% yield loss in the tropics [10]. Sheath blight is an endemic disease in intensive rice farming in Central Java and Yogyakarta, Indonesia. The disease progressed well in all rice planting locations, with higher severity in low areas (0-200 masl). The disease progresses more severely in the short, multi-bred rice varieties [11].

There is limited information with regard to the incidence of sheath blight in North Sumatra, Indonesia, therefore accurate evaluation is required for further control approach. The objective of this study was to decide how the sheath blight disease on rice distributed within thirteen sites in Northern Sumatra, Indonesia.

2. Materials and methods

2.1. Location

Thirteen sampling sites in Northern Sumatra, Indonesia were observed on the basis of data from the Central Bureau of Statistics Indonesia to acquire a survey of the site location, as well as information from the local farmers. The locations include 1) Suka Maju village (Deli Serdang), 2) Pahlawan village (Binjai), 3) Sumber Tani village (Batubar), 4) Dolok Parmanan village(Simalungun), 5) Siabalabal II village (North Tapanuli), 6) Huta Bagasan village (Humbang Hasundutan), 7) Lumban Lobu village (Tobasa), 8) Juhar Ginting Sada Nioga village (Karo), 9) Rawang Pasar V village (Asahan), 10) Ujing Bandar village (Labuhan Batu Induk), 11) Pantai Cermin village (Langkat), 12) Baru Pasar 8 village (Langkat), and 13) Padang Bulan village (Medan).

2.2. Sampling method

The sampling plants were sampled in a diagonal pattern. Twelve plots were obtained in a diagonal site which each measured 1m x 1 m containing 16 clumps of rice. Each plots were examined at nine spots: the four corners, the centre, and midway along each edge [12,13].

2.3. Determination of disease incidence and disease severity

Disease incidence was determined by observing the visual symptoms of disease status of plant units in one sampling unit. The rice plants were assessed for disease incidence rate (DI), which is the presence or absence of disease that calculated on the percentage of infected leaves on the rice plant, as well as disease severity index (DSI), which DSI is the severity percentage of plant disease damage. Disease incidence rate was calculated as the following formula [14]:

\[ DI = \frac{\text{number of infected plant unit}}{\text{total number of plant assessed}} \times 100 \]  

Disease incidence was also determined as the quantity of rice plants showing visual symptoms, expressed as a percentage of the amount of plants evaluated. Disease severity index was calculated using the following formula [15]:

\[ DSI = \frac{\sum (n \times v)}{N \times Z} \times 100\% \]  

Note:
- DSI: Severity of sheath blight disease
- N: Number of tillers per clump
- V: Scale value for each symptom category
- Z: Highest scale value
- N: Number of tillers in the same symptom [15].
The scale that shows the severity of rice sheath blight is:

- Scale 0: no infection
- Scale 1: symptoms only 20% in plants
- Scale 3: 20-30% in plants
- Scale 5: 31-45% in plants
- Scale 7: 46-65% in plants
- Scale 9: more than 65% [10]

The disease prevalence was calculated from all observed locations with the following formula [13]:

\[
\text{Disease prevalence} = \frac{\text{number of fields with the disease}}{\text{Total number of fields assessed}} \times 100
\]  

(3)

2.4. Interview

After the locations were determined, interviews were conducted with local farmers to observe information about the sample rice fields. The information included farmer identity, varieties used, plant age, spacing, plant origin, previous crop, and treatment, as well as GPS reading of each field.

3. Results and discussion

3.1. Disease incidence rate

The surveyed results that showed that the percentage of disease incidence rate at each location varies (table 1a and 1b). The highest percentage of disease incidence rate was found in Sumber Tani village (Batubara), which was 99.48% and the lowest disease incidence rate was found in Rawang Pasar V village (Asahan) (3.13%).

The number of tillers affects disease progression, because the number of tillers has correlated directly to the number of leaves [16]. This affects the temperature and humidity under the plant canopy. The number of tillers and the number of leaves of surveyed rice in Sumber Tani village (Batubara) were quite high, which were 19.57 and 78.53 respectively, and these values is congruent with the highest disease incidence and disease severity found in this village. Disease development is controlled by the appropriate environmental temperature and humidity. Therefore, leaf blight is spread evenly in lowland rice field ecosystems with a generally severe category [16].

Table 1a. Data collected on the surveyed locations in Northern Sumatra, Indonesia

| Locations                          | Rice varieties | Average rainfall (mm) | Number of Tillers | Number of Leaves | Disease incidence (%) | Disease severity (%) |
|------------------------------------|----------------|-----------------------|-------------------|------------------|-----------------------|----------------------|
| Suka Maju village (Deli Serdang)   | Inpari 32      | 2                     | 27.14             | 81.61            | 12.24                 | 0.08                 |
| Pahlawan village (Binjai)          | IR 64          | 231                   | 22.07             | 70.94            | 15.10                 | 0.15                 |
| Sumber Tani village (Batu Bara)    | Ciherang       | 107                   | 19.57             | 78.53            | 99.48                 | 12.36                |
| Dolok Parmonangan village, Dolok Panirbuan district, Simalungun Siabal-abal II village (North Tapanuli) | Ciherang       | 213                   | 12.67             | 38.04            | 18.75                 | 0.24                 |
| Huta Bagasas village (Humbang Hasundutan) | Si Boru Tambun | 141                   | 14.65             | 59.74            | 61.72                 | 0.85                 |
|                                    | Siharompong    | 285                   | 10.47             | 41.14            | 52.08                 | 1.32                 |
Table 1b. Data collected on the surveyed locations in Northern Sumatra, Indonesia (Continue)

| Locations                                                                 | Rice varieties | Average rainfall (mm) | Number of Tillers | Number of Leaves | Disease incidence (%) | Disease severity (%) |
|----------------------------------------------------------------------------|-----------------|------------------------|-------------------|------------------|------------------------|----------------------|
| Lumban Lobu village (Tobasa)                                              | Arias           | 170                    | 24.09             | 71.80            | 49.74                  | 0.92                 |
| Juhar Ginting Sada Nioga village (Karo)                                    | Ciherang        | 15                     | 32.80             | 98.83            | 4.69                   | 0.02                 |
| Rawang Pasar V village (Asahan)                                            | Inpari 32       | 63                     | 17.32             | 52.64            | 3.13                   | 0.02                 |
| Ujung Bandar village, South Rantau district, Labuhan Batu Induk            | Ciherang        | 103                    | 15.58             | 47.03            | 4.69                   | 0.07                 |
| Pantai Cermin village (Langkat)                                           | Ramos           | 153                    | 14.20             | 40.43            | 12.24                  | 0.14                 |
| Baru Pasar 8 village (Langkat)                                            | Ciherang        | 153                    | 16.39             | 49.71            | 5.47                   | 0.07                 |
| Padang Bulan village (Medan)                                              | Inpari 32       | 293                    | 15.62             | 58.62            | 59.90                  | 2.41                 |

Global climate change which has an impact on local climate change is believed to trigger the development of disease. The rainy season or prolonged dry season can result in changes in disease progression. The prolonged rainy season can lead to disease epidemics [17]. The highest percentage of disease incidence is 99.48% (table 1a and 1b). This can be due to erratic seasonal changes. The average rainfall in Sumber Tani Village, Talawi District, Batubara Regency is 107 mm, while in Rawang Pasar V Village, Rawang Panca Arga District, Asahan Regency is 63 mm (table 1a and 1b). This is a condition where the rainfall in the dry season is at a normal level or above normal, which can be called a wet dry season. This can affect the progression of the disease as it increases, due to dry conditions with high temperatures and high rainfall and humidity.

Topography and altitude can influence disease progression. In the location with the highest incidence rate of disease, namely Sumber Tani village, Talawi district, Batu Bara at 99.48%, the land conditions tended to be wide spread without any obstructions and the wind was blowing very hard which could carry the source of the inoculum. The rice fields in low areas stretch between 25-70 ha and without any obstacles. The wind moves freely at a relatively high speed so that it can fly the disease inoculum in the form of infected leaves and sclerotium to a longer distance [18].

The rice variety also affects the percentage of blight incidence. Most of the locations with a high incidence of disease used seeds from previous harvests that were at risk of transmitting disease. The application of technological components in the lowland rice cultivation system causes changes in biotic and abiotic factors in the paddy ecosystem, so that the selection of superior varieties of rice can affect the development of blight directly or indirectly [19].

In lowland rice fields, the wind moves freely at a relatively high speed so that it can fly disease inoculums in the form of infected leaves and sclerotium over a longer distance. Especially if it is intensively planted with similar crops (monoculture) of rice, as a result the genetic variation of plants is more uniform and the spread of disease is faster [20].

3.2. Disease severity index

Similar to disease incidence data, the value of disease severity at each location also showed variable data (table 1a and 1b). The highest value of disease severity index was also found in Sumber Tani village, Talawi district, Batubara, which was 12.36% and the lowest percentage of disease severity...
index was found in several locations including Rawang Pasar V village, Rawang Panca Arga district, Asahan and Juhar Ginting Sada Nioga village, Juhar district, Karo (0.02 % respectively).

In this observation, the spacing greatly affects the percentage of disease severity. Sumber Tani village which apply the tile spacing system had the highest percentage of severity (12.36%), while Rawang Pasar V village and Juhar Ginting Sada Nioga village which both apply the *legowo* row spacing system had the lowest disease severity (0.02%). The spacing of rice that is quite loose will provide flexibility for the growth of rice tillers, the maximum sunlight is received by all the leaves for photosynthesis and producing grain. The number of productive tillers is one of the agronomic components that affect rice yields (productivity) [21].

A relatively high level of disease severity is found in rice plants that have entered the generative phase, while plants in the vegetative phase are relatively low (table 1a and 1b). This is because in the generative phase, blight develops more if the microclimate around the plant canopy is optimal for disease development. Different types of rice varieties affect the temperature and humidity under the plant canopy. The plant canopy closes tightly on short varieties, so that in a crop like this the temperature under the plant canopy warms up, because air movement is blocked [22].

In this study, it was found that the symptoms at each location were similar. The initial symptoms of sheath blight are greenish gray spots under the axillary of the leaves on the first midrib that touch the water surface are oval in shape (figure 1a), the symptom is then spread to the leaves (figure 1b), to the upper segments (figure 1c), and down to the flag leaves and panicles (figure 1d). The lesions usually appear first on leaf sheaths near the water surface, dark green with indistinct margins. This lesion will progressively enlarge to form an ellipsoid with an irregular shape and has a grayish brown color and light brown edges [23].

![Figure 1.](a) symptoms on fronds, (b) symptoms on leaves, (c) symptoms on Plants (d) symptoms on flag leaves and panicles.

### 3.3. The disease prevalence

The results showed that the disease prevalence was 100% because sheath blight symptoms were detected in all sampling locations, although the values of disease incidence rate and disease severity index were varied.

### 4. Conclusions

Sumber Tani village (Batubara) showed the highest value of disease incidence rate, which was 99.48%, while Rawang Pasar V village (Asahan) showed the lowest value of disease incidence rate, which was 3.13%. Similarly, Sumber Tani village (Batubara) showed the highest disease severity value (12.36%) while two villages including Rawang Pasar V village (Asahan) and Juhar Ginting Sada Nioga village (Karo) showed the lowest disease severity values (0.02% respectively).

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