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INFLUENCE OF RAINFALL ON DOWNY MILDEW INTENSITY, PRODUCTIVITY, AND SYMPTOMS OF Peronosclerospora spp. ATTACK IN MAIZE CROPS IN SIMALUNGUN REGENCY

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Abstract

Maize is one of the world's food crops, and Simalungun Regency is one of the corn production centers in Indonesia. Corn production in Simalungun Regency has decreased due to various factors including downy mildew. Downy mildew disease is caused by Peronosclerospora spp. its development is increasingly rapid supported by a high humidity environment, while the purpose of the study was to examine the effect of rainfall on downy mildew disease intensity, productivity, production, and symptoms of corn plant attack in different locations.Research method: Observations of correlation and regression tests of rainfall on disease intensity, productivity, production, and harvest area of corn were analyzed using Minitab statistical application.The results showed that there is a relationship between rainfall and downy mildew intensity, production, productivity, and harvest area of corn plants. The intensity of downy mildew was highest in Tanah Jawa sub-district with an average disease intensity of 7.81%, this was due to the fact that no eradication was done on plants infected with Peronosclerospora spp. The symptoms of attack found at each observation location had the same symptoms.

Keywords: ***Peronosclerospora spp., Downy mildew, Corn, productivity, rainfall,***

INTRODUCTION

Maize is one of the world's most important food crops, alongside wheat and rice. Residents of some areas in Indonesia (e.g. in Madura and Nusa Tenggara) also use maize as a staple food. Maize is a multipurpose commodity, which has many derivative products when processed. It is estimated that 2-3% of maize production is for household consumption while the rest is for industry, such as animal feed, maize flour, cornstarch, maize oil, maize sugar and ethanol (biofuel ingredient). Because of its many uses as animal feed, human food and fuel, the world demand for maize is huge (Ivan Setyastiawa, et al., 2010). Simalungun Regency is one of the corn production centers in Indonesia, especially North Sumatra, where corn is widely grown in Purba Sub-district and Pamatang Sidamanik Sub-district.

Maize production in Simalungun Regency in 2019 reached 234,681.00 tons, but in 2020 maize production was 256,944.00 tons and in 2021 it was 175,419.00 (Badan Pusat Statistik Simalungun, 2022). Fluctuations in corn crop production in Simalungun Regency are caused by various factors, including downy mildew. The area of downy mildew attack, especially in North Sumatra, is estimated to reach 47 ha in 2022. (Balai Besar Peramalan Organisme Pengganggu Tanaman, 2022). Typical symptoms of downy mildew on corn plants are chlorotic elongated parallel to the leaf bone, stunted plant growth, and in the morning a white powdery coating can be seen under the leaf surface (Jatnika et al., 2013). Corn plants attacked by P. maydis can experience a reduction in production of 80%-100%. This is because corn plants attacked by P. maydis cannot produce seeds (Ridwan et al., 2015). Downy mildew is caused by the fungus Peronosclerospora spp. whose spores are transmitted to corn plants by the wind in the morning. Downy mildew on corn plants generally causes systemic symptoms that extend to all

parts of the plant and cause local symptoms. This depends on the extent of the disease-causing pathogen in the infected plant. Systemic symptoms occur when the pathogen infection reaches the growing point, so that all leaves are infected. While P. sorghi that attacks young plants will produce conidia on the leaves, if it attacks older corn plants the pathogen will often produce oospores on the leaves. Plants are usually able to withstand this infection and will survive until harvest (Muis et al. 2018).

Early symptoms of spots and chlorosis extend parallel to the leaf bone with clear boundaries between healthy, whitish-yellow leaves. Chlorosis occurs due to a decrease in chlorophyll due to closure of leaf stomata by the fungus. Growth is stunted, cob formation is disrupted, and cobs cannot be produced. Symptoms of chlorotic P. philippinensis tend to be more striped; the stem is less elongated so that the plant is shaped like a fan. Plants infected since young <1 month usually die. On the surface of the leaves, especially on the underside of the leaves, there is a powdery white spore growth which is a collection of conidiophores and conidia, very clearly visible in the morning (Rustiani et al. 2015). The intensity of downy mildew in maize plants can be influenced by environmental factors, especially related to high rainfall which indirectly increases the humidity of the growing environment and these conditions affect the increase in downy mildew intensity. Sumarlin et al. (2018) mentioned that environmental factors such as humidity and temperature also play a role in the development of downy mildew, conditions that support the growth of this fungus often occur during the rainy season, where high humidity can increase the risk of infection. The purpose of this study is to examine how rainfall affects downy mildew intensity, productivity, production, and symptoms of attack experienced by corn plants in different locations.

LITERATURE REVIEW

Corn plants (Zea mays) are annual plants of the graminae species which have single and monoceous stems (Karim, et al. 2020). Corn plants are very important food crops in meeting the nutritional needs of the community and world livestock, but currently the production of corn plants has decreased, especially in the Simalungun Regency area (Badan Pusat Statistik Simalungun, 2022), one of the influencing factors is the development of the spread of downy mildew disease (Balai Besar Peramalan Organisme Pengganggu Tanaman, 2022). Downy mildew is caused by the pathogen Peronosclerospora spp. its taxonomic arrangement according to Salcedo et al. (2020) as follows: Domain (Eukaryota); Superkingdom (Chromalveolata); Kingdom (Chromista); Infrakingdom (Heterokonta / Stramenopiles); Phylum (Pseudofungi (Oomycota)); Class (Peronosporea); Order (Peronosporales); Family (Peronosporaceae); Genus (Pseudoperonospora); Species (P. maydis; P. sorghi; P. Phillipinensis). Downy mildew can reduce corn crop production by 80%-100% (Ridwan et al., 2015). Symptoms of downy mildew attack on corn plants can cause elongated chlorosis on the leaves of the plant, stunted growth, and there is a layer of white powder under the surface of the leaves (Jatnika et al., 2013). The intensity of downy mildew will increase with high humidity (Sumarlin et al. 2018) due to Peronosclerospora spp. including fungi which of course with high humidity environmental conditions will make it easier to develop.

Fungi cannot live saprophytically. In addition, fungi do not form ospores. There are no signs that the fungus survives in the soil. Plantings in heavily infested former crops can be completely healthy. The fungus must therefore survive from season to season on living plants. The fungus can be carried in the seeds of diseased plants. However, this only occurs in young, wet seeds of susceptible maize species. The conidium forms at night when the leaves are dewy and the conidium is immediately dispersed by the wind. This is because dew only occurs when the air is calm. In general, the conidium cannot be transported far by the wind. The conidium germinates immediately by forming sprouting vessels that will infect young leaves of young plants through the stomata. The sprouting vessels form an apresorium in front of these stomata. The conidium cannot be transported far by the wind. The conidium immediately germinates by forming sprouting vessels that will infect young leaves of young plants through the stomata. Sprouting vessels form an apresorium in front of these stomata Semangun (2004) in Rustiani et al. (2015).

METHOD

The research was conducted in October 2024, for the observation of symptoms of corn plant infestation by directly observing and documenting samples of vegetative phase corn plants with symptoms of downy mildew infection (chlorosis with white powdery underside of leaves) in four villages in two sub-districts, namely Hutabayu Raja sub-district (Silak Kidir village and Sipintu-door village), Tanah Jawa sub-district (Bosar Galugur village and Balimbingan village). Meanwhile, the correlation and regression test observations of rainfall on disease intensity, productivity, production, and harvested area of maize were analyzed using the statistical application Minitab version 22, with data collected from relevant agencies.

RESULTS AND DISCUSSION

This section presents the results with clear descriptions. Results can be supplemented with tables, graphs (pictures), and/or charts. The discussion section describes the results of processing data or information, interpreting the findings logically, linking them to relevant reference sources, and the implications of the findings. [Times New Roman, 12, normal].

1. Symptoms of Peronosclerospora spp. causing downy mildew on corn (Zea mays L.) in two districts of Simalungun Regency.

The results of research in four locations in Simalungun Regency based on the symptoms of attack in the field showed that the symptoms of attack that cause downy mildew in the research locations are symptoms of downy mildew in corn characterized by the presence of chlorotic (pale yellow) spots extending parallel to the leaf bones, with clear boundaries between diseased and healthy leaves. In addition, in the morning, a white powdery coating can be seen on the leaf surface, both above and below. Infected plants also experience growth retardation, and may not even have cobs, and young infected leaves often die.

The survey was conducted in Silak Kidir village, Hutabayu Raja sub-district (+ 3.015352 + N 99.304900 E Altitude: 800 m), the corn variety planted in the village is Bisi 18, the number of infested plants is 4 stems, the plant area is 0.3 Ha, the age of the plant is 48 HST. Survey conducted in Sipintu village - the door of Hutabayu Raja sub-district (+2.944509 N 99.273139 E Altitude: 1, 356 m), the corn variety planted in the village is Pioner 18, the number of infested plants is 2 stems, the plant area is 4 hectares, the age of the plants is 50 days after transplanting (DAT). Survey conducted in Bosar Galugur village, Tanah Jawa sub-district (+2.944509 N + 99.233432 E Altitude: 38.9m) the corn variety planted in the village is BISI 18, the number of infested plants is 2 stems, the plant area is 3 Ha, the age of the plants is 62 HST. The survey was conducted in Balimbing village, Tanah Jawa sub-district (+2.295066228N + 99.17500990E Altitude: 74.2 m) the corn variety planted in the village was Pioneer P32, the number of infested plants was 3 stems, the plant area was 2 hectares, the age of the plants was 85-90 DAT.

A **B** **C** **D**

Figure 1. Symptoms of Peronosclerospora spp. infestation in the field: Bosar Galugur – Tanah Jawa (A); Silak Kidir - Hutabayu Raja (B); Sipintu-Pintu - Hutabayu Raja (C); and Balimbingan - Tanah Jawa (D).
Source: Radiah Research Collection (2024).

The picture above shows the symptoms of Peronosclerospora spp. attacking the corn plant which is characterized by chlorosis extending parallel to the leaf bones, whitish yellow leaves can also result in stunted plant height growth (stunted plants). This is in line with the results of Tarigan's research (2024) which reported that the symptoms of Peronosclerospora maydis attack are characterized by the appearance of spots (the initial phase of the attack) then chlorosis occurs which extends parallel to the leaf bones with clear boundaries between healthy leaves, this chlorosis is whitish yellow due to a decrease in chlorophyll levels caused by leaf stomata covered by fungi. Based on observations in the field, it also shows that downy mildew attacks corn plants in the vegetative phase, namely the age of 0-35 HST which results in inhibited plant height growth, inhibited plant growth will certainly have an impact on crop production. Kalqutny et al. (2020) stated that in the vegetative phase (0-14 days after planting) is a risky period for downy mildew-infected corn plants, infected plants when they are still very young result in plants not being able to form perfect fruit. Part of the leaves that are diseased due to the attack of Peronosclerospora maydis leaf surface initial symptoms of spots and Chlorosis extends parallel to the leaf bone

with a clear boundary between healthy leaves, whitish yellow leaves. Chlorosis occurs due to a decrease in chlorophyll due to the closure of leaf stomata by the fungus. Growth is stunted, cob formation is disrupted, can not produce cobs.

2. Correlation and Regression between Downy Mottle Intensity and Rainfall, Production, Productivity and Harvest Area in Maize (Zea mays L.) Crops in Two Districts of Simalungun Regency.

Observations of rainfall, productivity, harvested area, production, and downy mildew intensity in Simalungun District are presented in the table below.

Table 1. Observation Data on Rainfall, Productivity, Harvested Area, Production, and Disease Intensity in Simalungun District.

Subdistrict	Rainfall	Productivity	Harvested Area	Production	Disease Intensity (%)
H22	1742	60,13	2.279,16	13.705,00	5,2
H23	1472	61,73	8.061,21	49.761,87	3,87
T22	3437	60,43	1.869,52	11.298,00	7,12
T23	2911	61,16	8.085,66	49.451,90	8,5

Description: H22 (Hutabayu Raja in 2022); H23 (Hutabayu Raja in 2023); T22 (Tanah Jawa in 2022); T23 (Tanah Jawa in 2023).

Based on the table above, the intensity of downy mildew in the two sub-districts in Simalungun District shows that the highest intensity of downy mildew is in Tanah Jawa sub-district at 7.12% and 8.50% in 2022-2023, while the lowest is in Hutabayu Raja sub-district at 5.2% and 3.87% in 2022-2023, but based on the correlation analysis that has been carried out, it shows that the intensity of the disease does not have a significant relationship with rainfall, productivity, and production of corn crops but there is an increasing trend in disease intensity due to high rainfall which can be seen more clearly in (Figure 3). Although the p value = 0.139 (not significant), the r value = 0.861 means that there is a strong relationship between rainfall and downy mildew intensity.

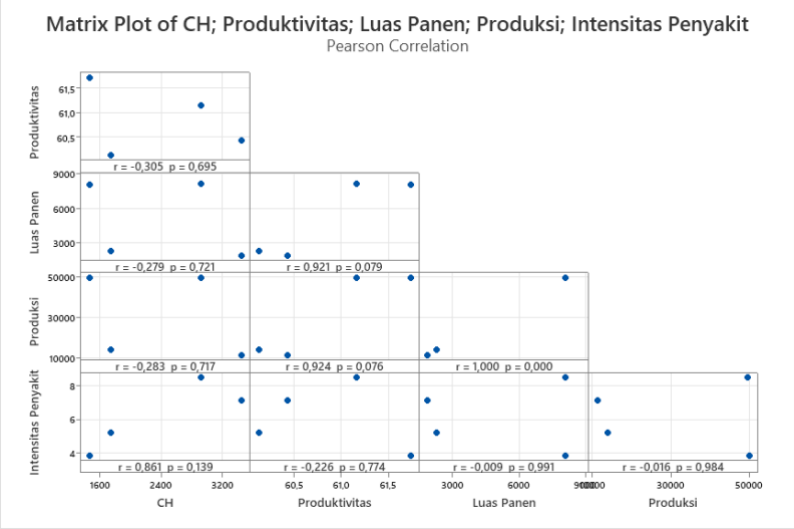

Figure 2: Correlation graphs and P-values for the observed variables.

Based on the correlation analysis between rainfall and production, harvest area, and productivity in the form of negative linear values of r = -0.283, r = -0.279, r = -0.305 respectively (Figure 3.) meaning that the higher the rainfall, the lower the production, harvest area, and productivity of maize plants. Based on the correlation analysis between disease intensity and productivity, harvest area, and production in the form of a negative linear value of r = -0.226, r = -0.009, r = -0.016 respectively, meaning that the higher the disease intensity, the productivity, harvest area, and production will decrease (Figure 3.) Based on the correlation analysis between harvest area and corn crop production in the form of a positive linear value of r = 1.000, and a p value = 0.000 (Figure 3.) meaning that there is a significantly strong relationship between harvest area and production, the more extensive the harvest, the higher the resulting production. Based on the correlation analysis between harvest area

and productivity, the positive linear value of r = 0.921 (Figure 3) means that the wider the harvest area, the higher the productivity of the corn crop produced.

Based on the results of regression analysis between rainfall and disease intensity with the equation Y = -41 + 394 with a coefficient of determination (R2) = 74.11%, meaning that 74.11% of the intensity of downy mildew on corn plants is influenced by rainfall factors and 25.89% is influenced by other factors. Based on the regression analysis between rainfall and production, harvest area, and productivity, there is a coefficient of determination (R2) = 100%, meaning that the greater the R-sq value, the closer the relationship between the influencing factors, namely 100% of rainfall affects the production, harvest area, and productivity of corn plants. Based on the correlation data, observations show that there is a strong relationship between rainfall and disease intensity, where the higher the rainfall, the higher the disease intensity, while production, harvest area, and productivity decrease (Appendix 7). Sumarlin et al. (2018) mentioned that environmental factors such as humidity and temperature also play a role in the development of downy mildew, conditions that favor the growth of this fungus often occur during the rainy season, where high humidity can increase the risk of infection. Karim et al. (2020) stated that Peronosclerospora spp. infection only occurs if there is water (dew water; rain water; or guttation water) and at night in the leaf funnel of young corn plants there is always guttation water, this increases the percentage of infection. Ambient temperature at night until early morning is below 24°C and dewy leaf conditions trigger high sporangia formation.

Based on interviews in the field, it is known that the high intensity of the disease in Tanah Jawa Sub-district compared to Hutabayu Raja Sub-district is due to the lack of understanding of farmers in Tanah Jawa Sub-district about downy mildew, especially in the matter of handling/controlling the disease, where farmers when downy mildew attacks just let it go or spray fungicides, this is certainly not effective with the consideration that currently no fungicides have been found that can repair plant damage due to downy mildew attacks, especially if it is just left alone, it will certainly cause the spread of Peronosclerospora spp. which is increasingly widespread. Currently, effective control of downy mildew is still preventive (using downy mildew-resistant varieties) or directly destroying plants (eradication) infected with Perenosclerospora spp. to prevent the spread of the disease in corn fields. Widiantini et al. (2017) reported that there was a decrease in the effectiveness of using fungicides made from the active ingredient Fenamidon to suppress the development of Perenosclerospora spp. even this pathogen is indicated to be resistant to the application of fungicides made from the active ingredient Metalaxil, this can be seen in the germination of Perenosclerospora spp. conidia whose results are not significantly different from the control.

CONCLUSION

There is a relationship between rainfall and downy mildew intensity, production, productivity, and harvest area of corn plants. The highest intensity of downy mildew was found in Tanah Jawa Subdistrict with an average disease intensity of 7.81%, which is thought to be due to the lack of eradication of plants infected with Peronosclerospora spp. The symptoms of attack found in each observation location have the same symptoms such as the presence of yellowish-white elongated chlorosis, and abnormal plant growth (stunted).

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