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Disease Severity of Geminivirus Infection on the Chili Plants at Baki, Sukoharjo

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Abstract. Geminivirus a virus family commonly infecting vegetable crops such as chili peppers (Capsicum annuum L.). The initial symptoms for the infections are bleaching, vein clearing, leaves thickening, cupping, leaves mosaics, and leaves malformations. This virus infection has been reported to cause serious disease and yield losses. This research was aimed to know the disease severity of the infected chili plants in three plantations in Sukoharjo. A direct survey was used as the research method. The result showed the disease severity has reached a high level. The percentage of disease severity was 90.64% in the first location, 93.01% in the second location, and 71.99% in the third location.

Keywords: *chili pepper, Gemini Virus, disease severity.*

INTRODUCTION

The chili pepper is one commodity that helps boost the national income through agriculture. Although chili is not a staple food ingredient, its role as a condiment or spice has a strong influence on the community. This was evidenced in the 2006–2015 period, chili production tended to increase, with an average increase of 4.16% or the equivalent of 34,349 tons per year (Yanuarti & Afsari, 2016). Chili production dropped by 8.46% in 2007, or from 736.06 thousand tons (2006) to 673.8 thousand tons. A drop in production also occurred from 1.07 million tons in 2014 to 1.04 million tons in 2015 (Yanuarti & Afsari, 2016).

The decline in chili production is influenced by various factors, such as climate anomalies. Climactic anomalies can cause the spread of pests and diseases, which can lead to crop failure (Andayani, 2016). Microorganisms such as bacteria, fungi, and viruses also interfere with production by affecting plant health.

Anomalous climatic conditions make the seasonal prediction gone awry. The cycle of rainy and dry seasons, which should be predictable, becomes hard to determine. Such conditions have effects on physical factors (temperature and humidity) and water availability in the plantations. Also, long dry conditions can affect the spread of vector insect populations, for example, the vector of diseases caused by Geminiviruses (Sulandari et al., 2006).

Geminivirus has been reported to cause epidemic disease in Indonesia since 2000 (Sulandari, 2006). Geminivirus knew as Geminiviridae as a family virus. The members of Geminiviridae were distinguished by their genome organization, insect vector, host ranges, and grouped into four genera. The genera of Geminiviridae are Mastrevirus, Curtovirus, Begomovirus and Topocuvirus (Fauquet & Stanley, 2003). Each genus causing many diseases that

infected vegetable crops, for example, Pepper Yellow Leaf Curl Disease which infection chili pepper (Baroo et al., 2008; Sulandari, 2006).

Geminivirus causes huge yield losses and a decrease in vegetable crop production (Thakur et al., 2018). Therefore, proper countermeasures to control disease caused by Geminivirus are needed. To formulate the proper countermeasures, disease severity analysis in the plant population should be conducted. Disease Severity is the percentage or proportion of the sampling area showing the symptoms of a disease. (Bock et al., 2010). Disease severity is important for predicting yield loss, monitoring, and forecasting epidemics, assessing crops' germplasm for disease resistance, and understanding fundamental biological processes such as coevolution (Bock et al., 2010). This research was aimed to know the disease severity ofthe infected chili plants in three plantations in Sukoharjo.

METHOD

Time and Place

The research was conducted in July 2020. Place of the research was conducted in three chili pepper plantations at Baki, Sukoharjo.

Samples

The samples consisted of 25 chili pepper plants chosen by using the purposive sampling method from each plantation. The samples were chosen according to the virus symptoms shown in chili plants. Symptoms of Geminivirus infection were observed directly.

Data Collection

The percentage of Disease Severity was calculated by counting the number of infected leaves and the total number of leaves in a plant. Disease Severity of Geminivirus can be calculated with the following formula:

$$\text{Disease Severity (\%)} = \frac{\text{number of yellowing (infected leaves)}}{\text{total number of leaves in a plant}} \times 100\%$$

(Suranto, 2004)

The severity of each individual plant was categorized into a scale of 0 to 4 based on the percentage of the infected leaves: 0 = 0%, 1 = 1% to 33%, 2 = 34 to 66%, 3 = 67% to 100%, and 4 = dead plants. (Trapero-Casas & Jimenez-Diaz, 1985). Also, interviews with farmers were conducted to obtain supporting data about land conditions.

RESULT AND DISCUSSION

Symptoms of Geminivirus

Based on the direct observations, the infected plants showed many symptoms such as bleaching, vein clearing, leaves thickening, curved leaf bones (cupping), leaves mosaics, and leaves malformations. Geminivirus-infected plants showed noticeable yellowing of the leaves. In severe infection, leaves yellowing might have occurred in all of the leaves in one plant, so there was a clear difference between the infected and healthy plants (Figs. 1 and 2).

Figure. 1. Infected plant

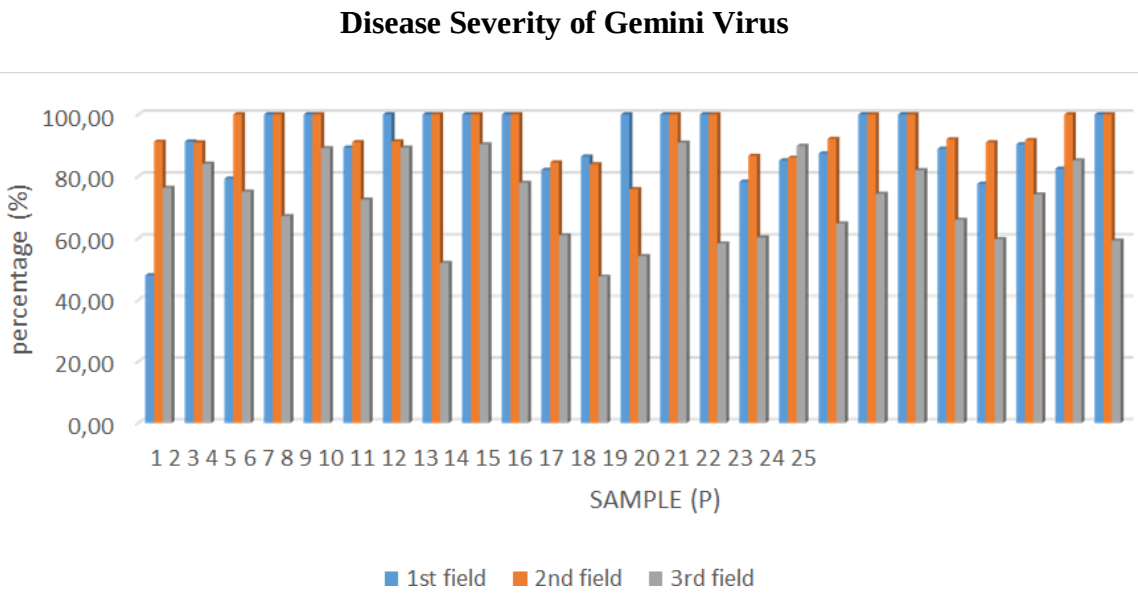
Figure. 2. Healthy plant

Symptoms shown in the infected can have some variations, influenced by various factors, both internal and external. The internal factors were ages and genotype, while external ones were soil fertility, environmental conditions, and the local climate (Hannum *et al*., 2019). These symptoms were similar in most leaves infected with viruses, such as PYLCV, TMV, and CMV. Some viruses that attack chili plants in Indonesia such as CVMV (*Chili Veinal Mottle Potyvirus*), CMV (*Cucumovirus Cucumber Mosaic*), PMMV (*Mild Mottle Potyvirus Peppers*), and PYLCV (*Yellow Leaf Curl Begomovirus Peppers*).

Figure 3. Bleaching (bright yellow leaves)

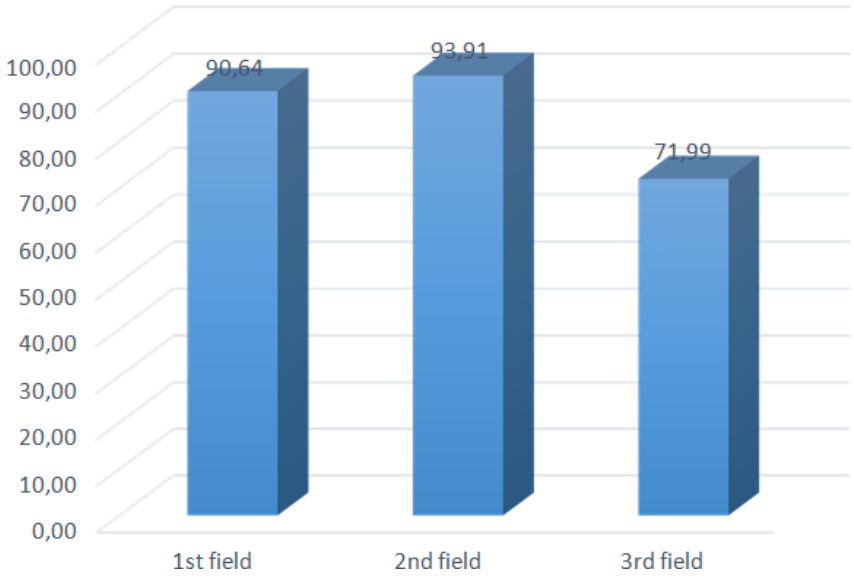
Figure 4. Mosaic (yellowish leaves)

Figure 4. Type of symptoms in leaves infected by Geminivirus: A. curly, B. bleaching, and leaf malformation, C. cupping, D. vein clearing, E. the yellowish-green leaf, F. the thickened leaf, H: the healthy leaf (control).



Graphic 1. Disease Severity of Geminivirus

Graphic 1 show the comparison of Disease Severity percentage from 25 plants samples at each plantation. The lowest percentage of Disease Severity was 47,51% that own by P12 from the third field, while the highest was 100% that own by twelve plant samples from the first and second field. The highese percentage of Disease Severity (100%) means that all of leaves were bleaching or bright yellow leaves (Figure 3).



Graphic 2. Average of Disease Severity of Geminivirus

The calculation of the Disease Severity showed the infection rates in all plantations were severe. It can be seen from the average percentage of disease severity from the three plantations was in the range between 71.99% - 93.91%. These average values were on a scale of 3 out of 4 in the categorization by Trapero-Casas & Jimenez-Diaz (1985). The third degree of severity means that each plant has 67–100% of its leaves were infected. This category was a red alert because if almost 100% of the leaves were infected, the plant can dry out and die.

Geminivirus infection can decrease chili production. It because in the infected plants, the flowers will fall off and cannot produce fruits (Sulandari, 2006). At first, there were only a few visible symptoms. However, as the plant ages, the symptoms will expand until the leaves turn yellow and fewer flowers bloomed.

Geminivirus cannot be transmitted mechanically, but it can be transmitted by vector insects, the whitefly (Bemisia tabacci). The interviews with farmers revealed that Geminivirus attacked only during the dry seasons, especially the long ones. This happens because the dry season creates suitable conditions for the whitefly to carry out the activities and breed. (Sulandari et al., 2006). Thus, Geminivirus attack is likely to be occurring during the dry season.

Apart from seasonal conditions, farming techniques also affect the severity of geminivirus infection. The interview also revealed that the monoculture cropping pattern was often carried out by farmers. Lands with a monoculture cropping pattern are more prone to widespread and severe infection and infestation (Sulandari, 2006). This because the monoculture lands have more stable environmental conditions, causing pathogens and their vectors to survive and reproduce more easily.

CONCLUSION

- The results showed the average percentage of Disease Severity from the three plantations was 90.64%, 93.01%, and 71.99%.
- The symptom severity of Geminivirus infection in the three plantations was in the third degree, with the average infection range of 67–100% for each plant.

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