Research Journal of Life Science
AUGUST 2021 Volume 8 No. 2 (112-119)
journal homepage: www.rjls.ub.ac.id

The Effect Of Weather Elements on the Intensity of Leaf Blight Disease Caused by *Phytophthora colocasiae* in Taro

Faishal Akbar, Ika Rochdjatun Sastrahidayat, Syamsuddin Djauhari

Department of Plant Pest and Disease, Faculty of Agriculture, University of Brawijaya

Email Address : faishal_akbar@yahoo.com

KEYWORDS

correlation;
phytophthora colocasiae;
taro leaf blight;
weather.

Abstract Leaf blight *Phytophthora colocasiae* is one of the main diseases in taro plants which can reduce production yield significantly. Weather is one of the main factors supporting the epidemic of leaf blight. Weather changes will affect the development of pathogens and affect the development of disease in the field. This research aimed to find out the effect of weather elements (air temperature, humidity, sunlight intensity, rainfall, number of rainy days) on the intensity of the taro leaf blight attack. The results showed that weather elements had a significant correlation with the intensity of taro leaf blight disease. Air temperature and sunlight intensity showed negative correlations while air humidity, rainfall and the number of rainy days were positively correlated with the disease intensity. The results of this path analysis showed that air humidity had the most significant effect of the weather elements on the intensity of taro leaf blight both directly and indirectly.

Introduction

Taro (*colocasia esculenta*) plants are tuberous crops cultivated in Indonesia. In several regions in Indonesia such as Maluku, the Mentawai Islands and Papua, taro is one of the staple foods. Even taro is a tropical plant that is important for millions of people in the developing countries. This plant has high starch content and is widely used as a vegetable ingredient. In addition, the nutrients contained in taro plants are higher compared to potatoes and other tubers (Misra *et al.,* 2008).

Similar to other plants, taro cultivation cannot be separated from various obstacles in increasing its production. One of them is plant diseases. Leaf blight caused by fungus *Phytophthora colocasiae* is one of the primary diseases in taro plants in various countries (Singh *et al*., 2012). Damage caused by leaf blight can reach 100% (Mbong *et al*., 2013), thus it has potential to reduce production. Noviana (2015) reported that leaf blight was the main disease in taro cultivation in several areas in Bogor Regency.

Although some fungicides have been reported to be effective in controlling the disease, the costs required are too high for farmers (Padmaja *et al*., 2016). As a consequence, there is a need for other control techniques that do not require high costs. To get the right control technique and continuity, information is needed on how the interactions exist among pathogens and the environment and host. Mbong *et al.* (2013) state that the key factors for controlling the cycle and development of the disease are rainfall, humidity and temperature.

Environmental factors in air and soil greatly determine the development of plant pests and diseases. They are influenced by the growth and susceptibility of plants, development, and pathogenic activity (Agrios, 2005). Besides,

How to cite this article : Akbar, F., Sastrahidayat, I. R., Djauhari, S. (2021). The Effect of Weather Elements on the Intensity of Leaf Blight Disease Caused by *Phytophthora colocasiae* in Taro. Research Journal of Life Science, 8(2), 112-119.
https://doi.org/10.21776/ub.rjls.2021.008.02.6

global climate change that affects changes in weather conditions can cause failure in agricultural cultivation (Sastrahidayat, 2016). Weather changes cause escalation and an increase in the status of a disease that was previously minor becomes significant and detrimental (Wiyono, 2007). By far very little information is available about the biology and ecology of *P. colocasia* (Misra *et al*., 2008). Therefore, further research is required to study the development of taro leaf blight disease to obtain more information as a basis for managing the agroecosystem. One of them is by examining the effect of physical environmental factor (weather elements) on the development of leaf blight disease.

Materials and methods

Location and Time of Research

This research was carried out in a taro land in Bendo Village, Pakisaji District, Malang Regency and the Central Laboratory of Life Sciences, University of Brawijaya, from December 2017 to July 2018.

Tools and Materials

The tools needed were a thermo hygrometer, lux meter, ombrometer, digital camera, microscope, stationery and masking tape. Meanwhile, the materials used were samples of taro leaves with leaf blight symptoms, label paper, raffia ropes and taro plants

Method

This research was carried out by conducting direct observation on taro plants located in Bendo Village, Pakisaji District, Malang Regency. On the taro land, there was no application of fungicides or other pesticides to control disease attacks. Observation was carried out for two months since the emergence of new leaves on 30 plants being observed. The measured and observed variables were the intensity of leaf blight disease and the weather elements including air temperature, relative humidity, intensity of sunlight, rainfall, and the number of rainy days.

Observation on the leaf blight intensity

Observation of the intensity of leaf blight disease was carried out once in a week for two months. Observation of disease progression used the following scoring system: 0) 0% leaf area attacked; 1) 1–7% leaf area attacked; 2) 7–25% leaf area attacked; 3) 25-50% leaf area attacked; 4) 50–75% leaf area attacked; 5) 75–90% leaf area attacked; and 6) 90-100% leaf area attacked (Little and Hills 1978 in Misra, 2011). Meanwhile, to determine the size of leaf area attacked by the disease, a standard diagram of taro leaf blight was applied as shown in Figure 1.

Disease intensity was calculated using the following formula:

$$IP = \frac{\sum vi\ x\ ni}{\mathrm{Z\ x\ N}} \text{ x } 100\ \%$$

where,

IP	=	disease intensity (%)
n_i	=	number of plants in the *i*-st attack category
vi	=	score of the *i*-st attack category
N	=	number of plants observed
Z	=	highest score for attack category

E-ISSN 2355-9926

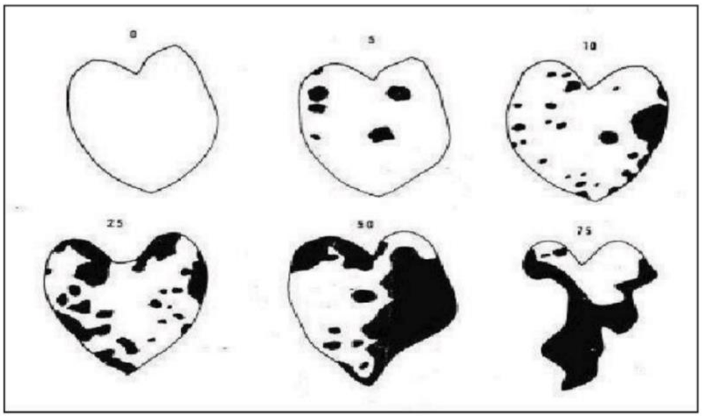

Figure 1. Standard area diagram for estimating the percentage of leaf damage by taro leaf blight. (Source: Gollifer and Brown, 1974)

Observation of Weather Elements

Observation and measurement of the weather elements were carried out every day at 07.00 a.m. (Western Indonesian Time) for two months.

Data analysis

Correlation and path analysis was done using the help of SPSS 20 and LISREL9.30 statistical software.

Results and discussion

The Relationship between Weather Elements and Leaf blight Intensity

The results of correlation analysis (Table 1) show that all weather elements observed had an strong correlation with the disease intensity. Further, air temperature and sunlight intensity had negative correlations with the r values of -0.925 and -0.757 respectively. This indicated that the reduction of air temperature and sunlight intensity values caused an increase in the disease intensity, meaning that severity of the disease was higher. While in other weather elements namely air humidity, rainfall and the number of rainy days, the results showed significant correlations with positive r values of 0.976, 0.681 and 0.818 respectively. This showed that the increased value of each of these elements caused increased intensity of leaf blight attack.

Table 1. Correlation between Weather Elements with Leaf Blight Intensity

	Y	X1	X2	X3	X4	X5
Y	1.000					
X1	-0.925**	1.000				
X2	0.976**	-0.938**	1.000			
X3	-0.757*	0.688	-0.794*	1.000		
X4	0.681	-0.504	0.623	-0.824*	1.000	
X5	0.818*	-0.684	0.723	-0.686	0.627	1.000

**correlation is significant at the 0.01 level (2-tailed)
* correlation is significant at the 0.05 level (2-tailed)

Remaks: X1= air temperature (°C), X2= air humidity (%), X3= sunlight intensity (x1000 Lux), X4= rainfall (mm), X5= number of rainy days, Y= disease intensity (%)

E-ISSN 2355-9926

The correlation between air temperature and disease intensity was negative, which is in line with the research conducted by Sarkar *et al.* (2017), showing a negative correlation between air temperature and the intensity of taro leaf blight. Mbong *et al.*'s (2015) study found out that air and light temperatures greatly influenced the growth of mycelium and sporulation of fungus *P. colocasiae*. At temperatures of 15°C and 33°C the fungus *P. colocasiae* did not produce sporangium at all, but the mycelium could still grow even though its growth was slower than that at 24°C. Thus, it can be concluded that air temperature influences the spread of disease through spore production and influences the severity of the disease through the growth of mycelium when an infection has occurred in the host plant. Tarla *et al.* (2016) reported that taro production was higher in the dry season compared to the rainy season, because the intensity of leaf blight attacks in the dry season was lower than in the rainy season. Thus, it is clear that during the dry season the air temperature is higher that makes low intensity of the attack. Conversely, in the rainy season the air temperature is low which causes the increased intensity of the disease. Cold air temperature affects the release of zoospores which causes more infection in plants (Singh *et al.*, 2012), and the process of *P. colocasiae* infection that occurs directly or indirectly is strongly influenced by air temperature (Mbong *et al.*, 2013).

Light either from the sun or from other sources is an important element for the growth and development of every living thing including microorganisms and plants. Therefore, the role of light as an environmental factor that has potential to support the interactions between pathogens and hosts needs more attention. From the results of the correlation analysis it was identified that the intensity of sunlight had a close and actual relationship with the intensity of leaf blight. In this case, the correlation of two variables were negative, which means that the higher the sunlight intensity, the lower was the disease intensity. On the contrary, if the sunlight intensity was low, the rate of disease intensity got increasing. This is in accordance with the results of Shakywar *et al.*'s (2013) research which showed that sunlight had a negative effect on the intensity of taro leaf blight. The duration of radiation had a strong influence and reacted negatively to vine rust leaf disease (Sastrahidayat, 2013).

Based on the field observation, it can be seen that the lowest and highest humidity recorded were 88 and 99%. Additionally, the results of the correlation analysis also showed an actual relationship between air humidity and the disease intensity. Both variables had a positive relationship, meaning that the increase in air humidity was followed by an increase in the intensity of leaf blight. Likewise, if the humidity dropped, the disease intensity would decrease. As a matter of fact, at night the air temperature reaches its minimum and there is no sun exposure at all, thus that the air humidity reaches 100% during the night. In addition, at night there is condensation which causes air humidity to remain high. It can be assumed that the severity of the disease occurs due to the condition of humidity that is beneficial during the day, especially if there is rain. Sonogoa and Ji (2013) state that *P. capsici* mycelium grows rapidly and sporangium is produced in greater amounts when in humid conditions. Besides, sporangium will release zoospores only if there is free water and sporangium can germinate directly at 100% relative humidity. Based on the statement, it is very possible if the increasing intensity of leaf blight disease in taro plants, especially during the rainy season, is due to an increase in the number of inoculums that are larger than during the dry season. In addition, if each sporangium of fungus *P. colocasiae* is capable of producing 15-20 zoospores (Singh *et al.*, 2012), each of the zoospores produced also

E-ISSN 2355-9926

has the same potential to infect the host. In other words, if each sporangium can produce 15-20 zoospores, in the rainy season the potential for an increase in the number of pathogenic inoculums reaches 20 times larger than in the dry season. Such condition is ecologically very beneficial for pathogens because the possibility of infection to the host is much greater. In this condition it is reasonable if the disease intensity increases rapidly during the rainy season.

Most epidemics are related to free water. Free water on the leaf surface can come from rain, irrigation, condensation and exudation. Water found on the leaf surface can have a different effect on the fungus. Water can be a stimulus or inhibit the production and germination of spores. In *P. colocasiae* the presence of free water is very influential on the release of zoospores, as they will only be released when there is free water. When in dry conditions, sporangium forms a sprout tube to infect (Mbong *et al*., 2013). Thus the presence of rainwater on the leaf surface is very beneficial for pathogens because it can increase more inoculums by releasing the zoospores. Shakywar *et al*. (2013) point out that the period of regular rainy season such as in the tropics can lead to an epidemic of taro leaf blight where such condition affects the spread of pathogens, infections and the development of disease. Leaf blight develops more rapidly when in long-term drizzle. Therefore the occurrence of epidemics often occurs during the rainy season because this condition makes the leaves wet longer.

The number of rainy days is influenced by the season. In dry season there is almost no rain at all, while in rainy season there is continuous rainfall every day with different rainfall intensities. These conditions lead to changes in microclimate which have an impact on the interaction between pathogens *P. colocasiae* and the host. From the results of the correlation analysis it can be seen that the number of rainy days had a close relationship with air temperature and air humidity. These two elements also affected the intensity of leaf blight disease.

Rain will affect the intensity of solar radiation as the intensity of solar radiation is negatively correlated with the rate of the disease intensity. Thus the presence of rain will suppress the negative influence of the sun on the rate of attack intensity. Meanwhile, rain causes air humidity to increase and to have a positive impact on the growth of pathogens, especially in sporangium formation and release of zoospores. The research of Bande et al. (2015) showed that the number of rainy days had a large direct effect on the intensity of pepper stem rot caused by *P. capsici.*

The Path Analysis between Weather Elements and the Intensity of Leaf Blight

Based on the results of this path analysis (Table 2), it can be seen that there were differences in the results from the correlation analysis, in terms of the values which tended to be larger or smaller values, and the changes from positive to negative values and vice versa. Thus it can be concluded that the high correlation coefficient is not necessarily followed by a high path coefficient and vice versa, the low correlation coefficient value is not necessarily followed by a low path coefficient value.

The path coefficient value of the direct effect from air temperature (X1) was the same as the negative correlation coefficient value. This showed the actual relationship between air temperature and the intensity of leaf blight. An increase in air temperature lowered the leaf blight intensity. On the other side, when the air temperature dropped, the disease intensity increased. This is in accordance with the study of Bande *et al*. 2015 which reported that the air temperature had a negatively direct effect on the intensity of stem rot disease in peppers.

E-ISSN 2355-9926

Table 2. Path Analysis between Weather Elements with the Intensity of Leaf Blight

Weather elements	Direct effect	Indirect effect					Total effect	Correlation (r)
		X1	X2	X3	X4	X5		
X1	-0.078		-0.791	0.213	-0.117	-0.151	-0.924	-0.925
X2	0.834	0.073		-0.245	0.145	0.160	0.976	0.976
X3	0.309	-0.054	-0.669		-0.192	-0.152	-0.757	-0.757
X4	0.233	0.039	0.525	-0.255		0.139	0.681	0.681
X5	0.221	0.053	0.609	-0.212	0.146		0.817	0.818

Remaks: X1= air temperature (°C), X2= air humidity (%), X3= sunlight intensity (x1000 Lux), X4= rainfall (mm), X5= number of rainy days, Y= disease intensity (%)

Regarding the variables of air humidity (X2), rainfall (X4) and the number of rainy days (X5), they had positive correlation coefficient in line with the positive correlation coefficient values. This informs that the increased humidity and the number of rainy days were followed by the increased disease intensity, whereas the decreases in the two variables reduced the disease intensity. Bande *et al.* (2015) reported that air humidity had a positively direct effect coefficient value on the intensity of stem rot in peppers. Moreover, the results of Nurhayati and Situmorang's (2008) investigation revealed that the pattern of rainy days affected the severity of Corynespora leaf fall disease in rubber plants.

Different thing was found from the light intensity (X3) variable where the coefficient value of direct effect from the sunlight intensity was positive but its correlation coefficient value was negative. Meanwhile, the coefficient value of direct effect from the rainfall was negative but the correlation value was positive. This showed that the correlation values of the two variables were based on the indirect effect of several other variables, thus these indirect variables needed to be considered in managing the disease.

All of the weather elements observed, air humidity had the greatest direct effect on the disease intensity, with a coefficient value of 0.843. Besides, the other weather elements had direct effects on low disease intensity. In addition, air humidity had an indirect effect on the disease intensity through other weather elements which were also high.

Conclusions and suggestion

Conclusions

Air temperature, air humidity, sunlight intensity, rainfall and the number of rainy days had strong correlation with the intensity of leaf blight disease with the correlation coefficient values r of = -0.925, 0.976, -0.757, 0.681 and 0.818 respectively.

Air humidity had the greatest effect on the intensity of leaf blight both directly and indirectly.

Suggestion

Further research is needed in different areas to determine the consistency of the effect of weather elements on the intensity of leaf blight disease attack.

Acknowledgements

We thank to the Ministry of Agriculture Republic of Indonesia for the scholarship. Marcelinus Alfasisurya S. A. for statistical analysis and Antok Wahyu S. has provided information related to research.

E-ISSN 2355-9926

References

Agrios, G. N. (2005). Plant Pathology. Fifth Edition. USA : Elsevier Academic Press. 922 p.

Bande, L. O. S., Hadisutrisno, B., Somowiyarjo, S. and Sunarminto, B. H. (2015). Peran Unsur Cuaca Terhadap Peningkatan Penyakit Busuk Pangkal Batang Lada di Sentra Produksi Lada Daerah Sulawesi Tenggara (The Role of Weather Elements Toward Increased Foot Rot Disease on Black Pepper in the Production Center of Southeast Sulawesi). J. Manusia dan Lingkungan, 22(2), 187-193.

Fonoti, P. (2005). Breeding for Resistance to Taro Leaf Blight *(Phytophthora colocasiae)* In Samoa. Thesis. Department of Crop Science. The University of the South Pacific.

Gollifer, D. E. and Brown, J. F. (1974). Phytophthora Leaf Blight of *Colocasia esculenta* in the British Solomon Islands. The Papua New Guinea Agricultural Journal, 25, 6-11.

Mbong, G. A., Fokunang, C. N., Lum, A. F., Bambot, M. B. and Tembe, E. A. (2013). An Overview of Phytophthora Colocasiae of Cocoyams : A Potential Economic Disease of Food Security In Cameroon. Discourse Journal of Agriculture and Food Sciences, 1(9), 140-145.

Mbong, G. A., Fokunang, C. N., Manju, E. B., Njukeng, A. P., Tembe-Fokunang, E.A., and Hanna, R. (2015). Mycelia Growth and Sporulation of Phytophthora colocasiae Isolates under Selected Conditions. American Journal of Experimental Agriculture, 8(4), 193-201.

Misra, R. S., Sharma, K. and Mishra, A. K. (2008). Phytophthora Leaf Blight of Taro (*Colocasiae Esculenta*) - A Review. The Asian and Australian Journal of Plant Science and Biotechnology, 2(2), 55-63.

Nurhayati and A. Situmorang. (2008). Pengaruh Pola Hari Hujan Terhadap Perkembangan Penyakit Gugur Daun Corynespora Pada Tanaman Karet Menghasilkan. J. HPT Tropika, 8(1), 63-70.

Noviana, R. (2015). Pengelolaan Hama Dan Penyakit Tanaman Talas di Kecamatan Cijeruk dan Tamansari Kabupaten Bogor. Fakultas Pertanian IPB. Bogor.

Padmaja, G., Devi, G. U., Mahalakshmi, B. K., and Sridevi, D. (2016). In vitro screening of Taro Varieties against Phytophthora Leaf Blight Disease. Journal of Root Crops, 42(1), 57-60.

Sarkar, D., Adhikary, N. K. and Tarafdar, J. (2017). Field Management of Taro Leaf Blight using Promising Germplasm. Int. J. Curr. Microbiol. App. Sci., 6(12), 1399-1407.

Sastrahidayat, I. R. (2013). Epidemiologi Kuantitatif Penyakit Tumbuhan. UB Press. Malang.

Sastrahidayat, I. R. (2016). Peramalan Penyakit Tumbuhan. UB Press. Malang.

Shakywar, R. C., Pathak, S. P. and S. Kumar. (2013). Influence of Weather Factors on Leaf Blight of Taro Against Different Genotypes. J. Soils and Crops, 23 (1), 25-29

Singh, D., Jackson, G., Hunter, D., Fullerton, R. A., Lebot, V., Taylor, M., Losefa, T., Okpul, T., and Tyson, J. L. 2012. Taro Leaf Blight –

E-ISSN 2355-9926

A Threat to Food Security. Agriculture, 2(4), 182-203.

Tarla D. N., Bikomo M.R., Takumbo E.N., Voufo G. dan D.A. Fontem. 2016. Climate change and sustainable management of taro (Colocasia esculenta (L.) Schott.) leaf blight in Western Highlands of Cameroon. Revue Scientifique et Technique Forêt et Environnement du Bassin du Congo, 6, 10-19.

Wiyono, S. (2007). Perubahan Iklim dan Ledakan Hama dan Penyakit Tanaman. Makalah pada Seminar Keanekaragaman Hayati di Tengah Perubahan Iklim: Tantangan Masa Depan Indonesia. KEHATI. Jakarta, 28 June 2007.

E-ISSN 2355-9926