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The Observation of Blast Disease and Its Effect to Rice Yield Using Existing Assessment Method to Support the Indonesian Agriculture Insurance

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Abstract

One of the causes for the low productivity of rice in Indonesia is the occurrence of rice blast disease. Blast disease is one of the main diseases of rice plants around the world. Therefore to minimize the risk of the lost yield by blast disease, the Ministry of Agriculture of the Republic of Indonesia has the agriculture insurance program. To support this program, the research about observations of blast disease in a fixed location are needed. The objective this research is to confirm pathogens causing the blast disease in the fields, to determine the development of blast disease and its effect to the rice yield (grain weight and straw weight). The study was conducted in a fixed paddy field at Subak Uma Dalem, Sobangan Village, Mengwi District, Badung Regency, Bali Province from February 2019 to April 2019. The data showed that the disease incidence of rice blast increased every week starting from 1st week (28 DAT) until 10th weeks (104 DAT). Our study confirmed that the fungus caused the blast disease in the field was Magnaporthe oryzae. The higher incidence of blast disease in the field resulted the reduce in rice yields by decreasing both straw and grain weights.

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INTRODUCTION

In agriculture production including rice farming the farmer have many problems, there are make the loss of yield. One of the factors that can cause yield loss in rice production is the presence of blast disease caused by the fungi Magnaporthe oryzae. If this pathogen is left without disease control efforts, it will cause rice plants to become empty (Widyantoro et al., 2007). Blast caused by M. oryzae is an important disease in rice plants (Wang et al., 2014). This disease infects both vegetative and generative stages. In the vegetative stage, the disease infects the leaves, whereas during the generative stages the infections is on stem or panicle neck which is often called the neck blast disease. Blast that infects the leaves will show lesions or spots shaped like eyes, oval with two tapered ends (Widiarta, 2009).

Initially spots are small with dark green, gray slightly bluish color. These spots continue to grow in susceptible varieties, especially when in moist conditions. Spots that have developed are visible on the edges of the brown and grayish white center (Asibi et al., 2019). Base on those data, The Ministry of Agriculture of the Republic of Indonesia has the agriculture insurance program, it was a mandate from Law 19 of 2013. The purpose of the program is to minimize the risk of the lost yield by the pests and diseases including blast disease (Ministry of Agriculture of the Republic of Indonesia, 2019). The observation of the damage of rice causing pests and diseases was conducted using exiting assessment method (calculating by ayes directly, ground base data) it was conducted by pest observer from Department of Agriculture (Kementerian Pertanian, 2018). Related with the agriculture insurance the farmer and pest observer reported the damage or disease severity to the JASINDO (Agriculture Insurance Agency) for insurance claim. The report only base on damage incidence from the rice field when the pest and disease were found but not using fix location. Therefore, on this research the observation of blast disease was conducted in fix location using exiting assessment method. The objective of this research is to identified of pathogen cause the blast disease, to determine the development of blast disease in the field and its effect to the rice yield (grain weights and straw weights). The observation will give the data of development of blast disease from vegetative and generative stage of rice. The data will be necessary for development of new damage assessment method using other method like drone or remote sensing.

RESEARCH METHODS

This research was conducted in fixed paddy field in Subak Uma Dalem, Sobangan Village, Mengwi District, Badung Regency, Bali, and isolation of pathogenic fungi carried out at the Phytopathology Laboratory, Faculty of Agriculture, Udayana University. This research was conducted for three months starting from February 2019 until April 2019.

Determination of the sampling location is done using GPS to obtain more accurate results, the coordinates of each sample are shown in Table 1. The characteristic of the symptom found on the location was observed and recorded properly. Three sample plots were used for measurement of blast disease percentage to represent the area of the Subak Uma Dalem, then in each plot 10 samples were taken diagonally.

Table 1. Samples coordinates

	Plot I		**Plot II**		**Plot III**	
	X	**Y**	**X**	**Y**	**X**	**Y**
Cluster 1 (R1)	0300749	9061429	0300691	9061446	0300692	9061433
Cluster 2 (R2)	0300742	9061428	0300684	9061445	0300687	9061431
Cluster 3 (R3)	0300736	9061426	0300677	9061444	0300681	9061430
Cluster 4 (R4)	0300732	9061426	0300669	9061443	0300675	9061429
Cluster 5 (R5)	0300726	9061425	0300662	9061442	0300669	9061428
Cluster 6 (R6)	0300720	9061424	0300655	9061441	0300663	9061427
Cluster 7 (R7)	0300714	9061423	0300648	9061440	0300656	9061426
Cluster 8 (R8)	0300708	9061422	0300643	9061439	0300650	9061425
Cluster 9 (R9)	0300702	9061421	0300637	9061438	0300643	9061423
Cluster 10 (R10)	0300696	9061420	0300632	9061436	0300637	9061423

Note: X = vertical axis, Y= horizontal axis

Observation of the percentage of blast disease was carried out by the fixed plot method and the percentage of blast attacks was observed in rice plant parts including leaf and stem. Measurement of the disease infection percentage following the formula by Rahardjo and Suhardi, (2008).

$$PS\ (\%) = \frac{Nh}{Nt} X\ 100$$

Note:
PS = disease percentage (%)
Nh = number of infected tillers
Nt = number of total tillers.

Pathogen isolation was done by cut the leaf area between the infected and uninfected part with a size of 1 cm2, then dipped into 70% alcohol. The cuttings of the plants are then rinsed by dipping them in sterile distilled water 3 times and drained with sterile tissue paper followed by growing in Potato Dextrose Agar (PDA). Purification was carried out immediately after mycelia grew 3 days after inoculation (DAI). After obtaining the pure culture of blast disease pathogen, then the culture was morphologically identified by observing the spore shape and culture character on PDA.

The relation between disease percentage with the yield (grain weights and straw weights) were analyzed using regression analysis to find out how the dependent variable/criteria can be predicted through independent variables or predictor variables individually. Y = subject in the predicted dependent variable, a = value of Y if X = 0 (constant value), b = direction number or regression coefficient, which indicates an increase or decrease in the dependent variable based on the independent variable. If b (+) then increases, and if (-) there is a decrease, X = subject on the Independent variable that has a certain value. Technically, value of b is the tangent of (comparison) between the length of the independent variable and the dependent variable, after the regression equation is found. Regression and correlation analysis following the formula:

$$\acute{Y} = \boldsymbol{a} + \boldsymbol{b}\,\boldsymbol{X}$$

Note:
Ý = criterion variable
a = constant variable
b = coefficient of linear regression direction
X = predictor variable

RESULT AND DISCUSSION

Pathogen Isolation and identification

The symptoms of rice blast disease found in Subak Uma Dalem were diamond shaped lesions occurred on the leaves. The middle of the lesions was gray which surrounded by brown to reddish brown color. Symptoms found in the field indicate that blast infected every stage of the development of rice plants. Starting from the initial vegetative phase of 0-35 days (Figure 1a), at the initial generative phase of 60-80 days (Figure 1b), and the late generative phase 80 days after trasplanting (Figure 1c). M. oryzae causal agent of blast disease spread through the air, stick to the leaves through splashing water, then infect the leaves and cause lesion on the leaves. Spores are produced 6 days after inoculation and generally released in the early morning around 02.00 - 06.00 a.m. At Tropical regions spores can also release during the day (Semangun 2008).

Figure 1. Symptom of blast disease. (a) Symptom of blast disease at the initial vegetative phase, (b) symptom of blast disease at the initial generative phase, (c) symptom of blast disease at the late generative phase.

The isolation results showed that there was only one type of fungus which was isolated from rice plants with symptomatic blast. On macroscopic identification, white mycelium characteristics began to grow at 3 DAI. Mycelium growth at 6 DAI of M. oryzae was white and then at 10 dpi it will slowly turn greyish black after two weeks. According to Wicaksono et al., (2017), morphology of M. oryzae colony is greyish black, thin-shaped without air mycelium, forming a ring-like circle after growing almost filled petri dishes in PDA media, whereas according to Harmon and Latin (2003) M. oryzae when growing in pure culture, the colonies appear white, light grey to dark grey.

Microscopic identification showed the fungi has pear shaped conidia with size around 10 μm, 2-septate (3-celled) and some are 1-septate. These results were consistent with the research conducted by Semangun (2008) and Riana (2011), where M. oryzae conidia have 2-septate (three-celled), shaped like a pear/avocado and the conidial sizes ranging from 0-22 x 10-12 µm, and the hyaline's colour was brownish. Therefore, it was confirmed that the pathogen that cause blast disease in Subak Uma Dalem, Sobangan Village was M. oryzae.

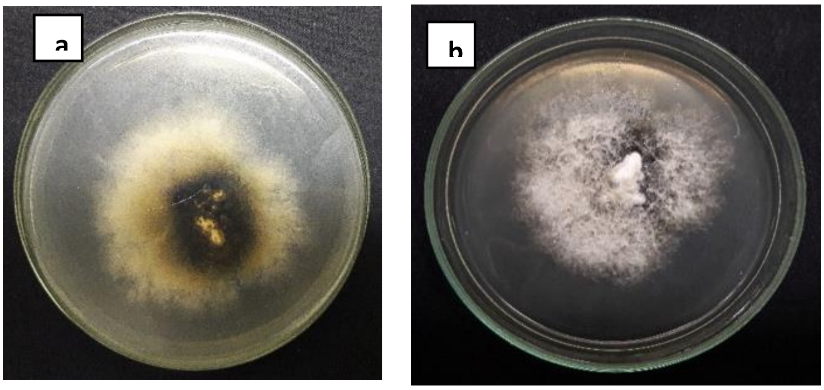

Figure 2. Macroscopic observation of fungal colonies isolated from symptomatic rice plants at room temperature on PDA medium (25-30oC). (a) Bottom view at 6 dpi shows greyish white colour of colony, (b) Top view at 6 dpi shows white colour of colony

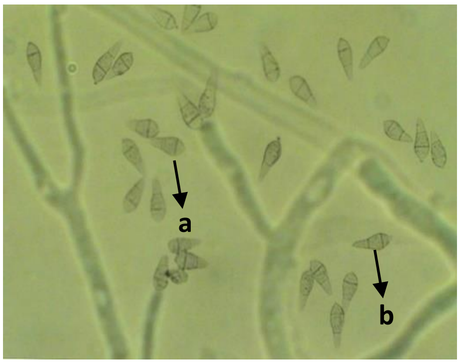

Figure 3. The characteristic of M. oryzae observed microscopically by 40x magnification. (a) pear shaped conidial, (b) 2-septate conidia (3-celled)

The development of blast disease in the field (Percentage of blast disease)

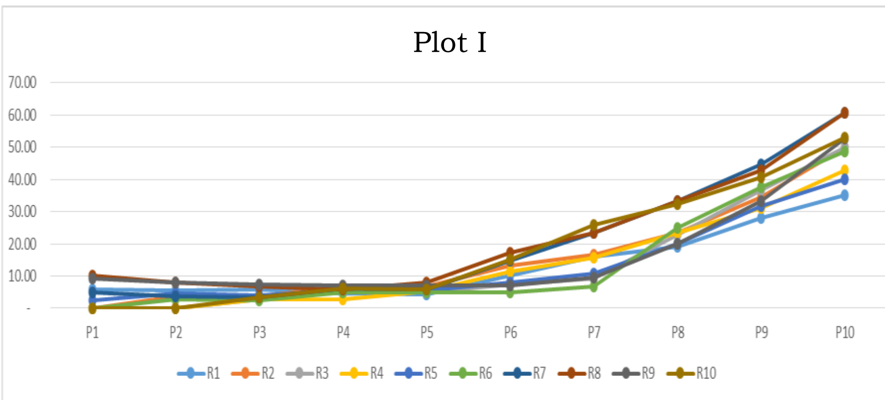

Figure 4. Graph shows weekly observation of disease percentage on Plot 1. P1-P10 indicates 1-week interval of the observation periods (P1 (28 days after transplanting (DAT)), P2 (33 DAT), P3 (41 DAT), P4 (51 DAT), P5 (64 DAT), P6 (71 DAT), P7 (79

DAT), P8 (88 DAT), P9 (95 DAT), P10 (104 DAT). R1-R10 indicates clusters. P1-P5 were the observation in the vegetative phase, P6-P10 in the generative phase.

The results in Figure 4 show that the percentage of blast disease in the vegetative phase from 1st week to 5th weeks was relatively low. However, when entering the generative phase at 6th to 10th weeks of observation, the percentage of blast disease continue to increase presumably due to the support of heavy rainfall during these periods. Moreover, in early reproductive phase rice is susceptible to biotic stresses such as pathogens that cause blast disease. The highest percentage observed at the 10th observation on R7 and R8 with the percentage of 60.71% while the lowest percentage on plot I was on R5 with the percentage of 35%. Based on the category of qualitative assessment of disease percentage by Kementerian Pertanian (2018), the highest percentage of Plot I belong to the "heavy" category.

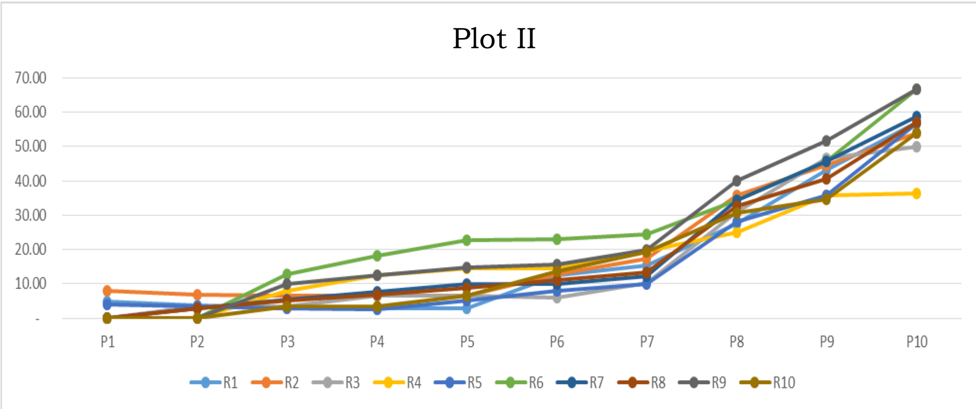

Figure 5. Graph shows weekly observation of disease percentage on Plot II. P1-P10 indicates 1-week interval of the observation periods. R1-R10 indicates clusters. P1-P5 were the observation in the vegetative phase, P6-P10 in the generative phase.

Based on observations of the percentage in plot II the data obtained shows the number of the highest percentage at 10th weeks was on R9 with 66.67%, while the lowest percentage was on R4 with the percentage of 36.21%. Based on the category of qualitative assessment of disease percentage by Kementerian Pertanian (2018), the highest percentage of Plot II belong to the "heavy" category.

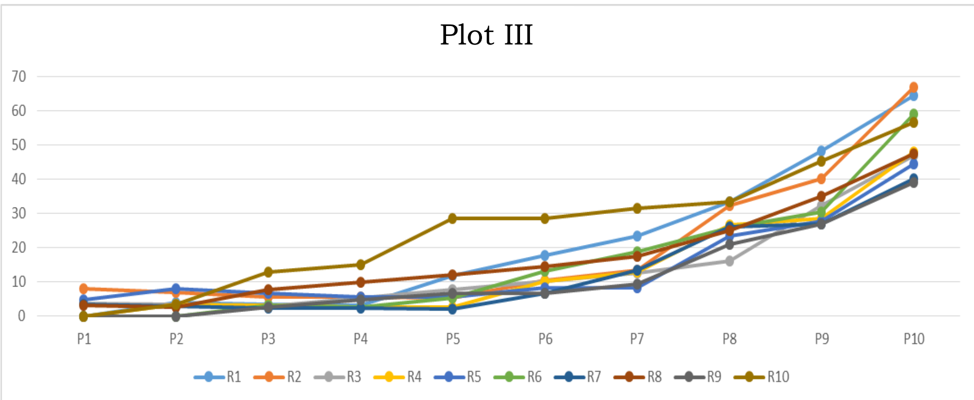

Figure 6. Graph shows weekly observation of disease percentage on Plot III. P1-P10 indicates 1-week interval of the observation periods. R1-R10 indicates clusters. P1-P5 were the observation in the vegetative phase, P6-P10 in the generative phase.

Figure 6 shows the percentage of blast disease in the vegetative phase from 1st week to 5th weeks was lower than the generative phase at 6th weeks to 10th weeks. Heavy rainfall during the generative phase also supports the development of pathogenic blast disease. The highest percentage on the 10th observation was R2 with 66.67% while the lowest percentage in plot III was R9 with 39.02%. Based on the category of qualitative assessment of disease percentage by Kementerian Pertanian (2018), the highest percentage of Plot III belong to the "heavy" category.

Relation between disease percentage with Grain Weight and Straw Weight

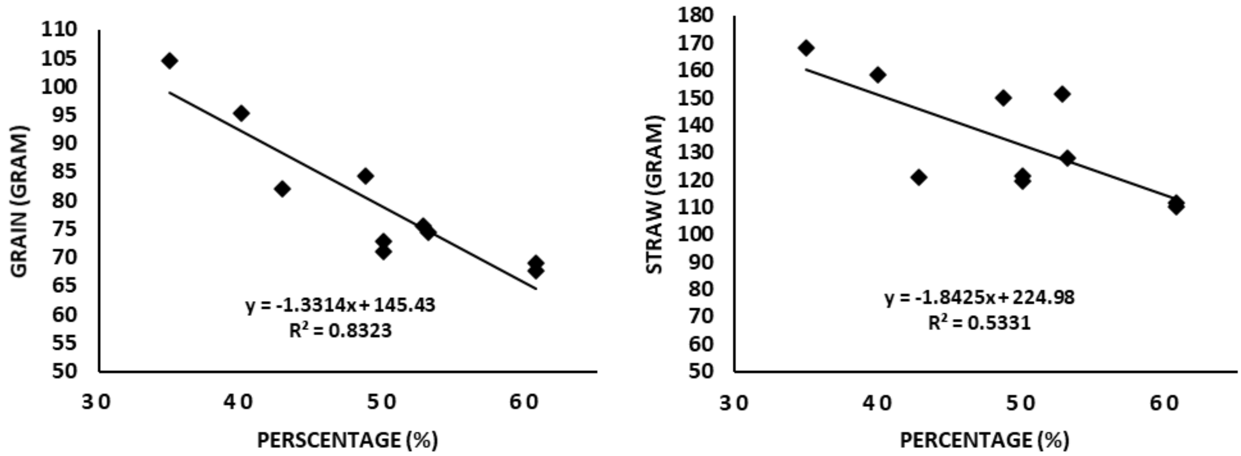

Figure 7. Relations between disease percentage with grain weight and straw weight of Plot I

The higher the percentage of blast disease in the field, the grain and straw weight of rice will be lower. Conversely, if the percentage of blast disease is low, the grain and straw weight of rice will be higher. Following the regression y = -1.3314x + 145.43 and the coefficient of determination R2 = 0.83 as presented in Figure 7a and following the regression y = -1.8425x + 224.98 and the coefficient of determination R2 = 0.53 as presented in Figure 7b.

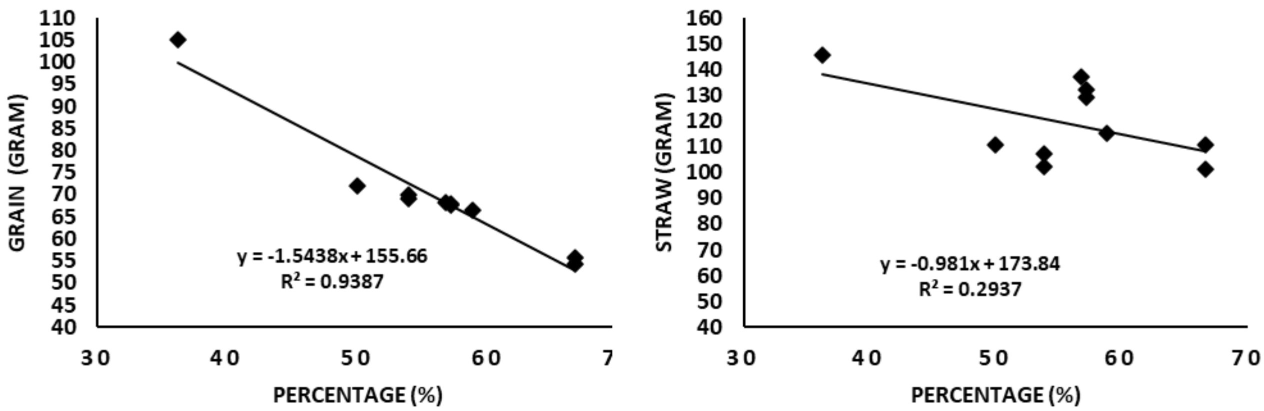

Figure 8. Relations between disease percentage with grain weight and straw weight of Plot II.

The higher the percentage of blast disease in the field, the grain and straw weight will be lower. Conversely, if the percentage of blast was low, the grain and straw weight of rice will be high. Following the regression y = -1.5438x + 155.66 and the coefficient of determination R2 = 0.93 as presented in Figure 8a and following the regression y = -0,981 x + 173.84 and the coefficient of determination R2 = 0.29 as presented in Figure 8b.

The higher the percentage of blast disease, the weight of grain and straw will be lower. Conversely, if the percentage of blast was low, the weight of grain and straw of rice will be high. Following the regression y = -1.5858x + 158.34 and the coefficient of determination R2 = 0.97 as presented in Figure 9a and following the regression y = -1.4616 + 204.41 and the coefficient of determination R2 = 0.60 as presented in Figure 9b.

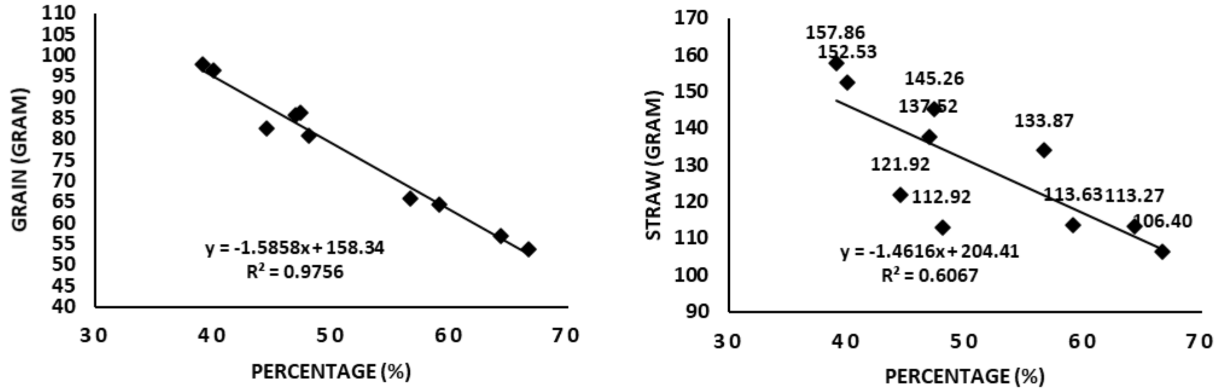

Figure 9. Relations between disease percentage with grain weight and straw weight of Plot III.

The data indicated the incidence of blast disease was increase from vegetative stage to generative stage, the most incidence of disease will be optimum in generative stage. Based on those data the control management of blast disease is needed, as well as to minimize the risk using agriculture insurance. The Ministry of Agriculture the Republic of Indonesia has the program for agriculture insurance especially for rice farming (Surning et al., 2018; Ministry of Agriculture of the Republic of Indonesia, 2021).

Based on the data the farmer or pest observer can forecasted the heaviest damage of blast disease in one planting season, the blast diseases will be increase from 64 days after transplanting, the data can use to make the control decision. For agriculture insurance the data is useful for farmer to report the disease incidence to the pest observer or government (Department of Agriculture) and continue to JASINDO (Agriculture Insurance Agency) to make insurance claim. The ground base method using eyes directly is necessary for damage assessment method, however the method has some weakness because the ability of people/pest observer different each other, therefore it is needed some improving assessment method such as utilizing spectroradiometer, drone and remote sensing data analysis. Some approach to improve the damage assessment method were reported. According Yudarwati, et al., 2020 reported a method for detecting rice crop damage due to bacterial leaf blight (BLB) analyzed using a handheld spectroradiometer. On the other hand, Giamerti et al., 2021 evaluated multispectral imaging for assessing bacterial leaf blight damage for agriculture insurance purpose.

CONCLUSION

Base on macroscopic and microscopies recognition that fungi caused the blast disease was confirmed is Magnaporthe oryzae. The disease incidence of blast disease increasing every week started from 1st week observation (28 days after transplanting) until 10th weeks observation (104 days after transplanting). The higher incidence of blast disease in the field made the decrease of grain and straw weight of rice.

RECOMMENDATION

The existing method to assess the incidence and severity of blast disease is need to be improve to the modern method such as utilized spectroradiometer, drone and remote sensing data analysis for supporting agricultural insurance.

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REFERENCES

Asibi, A. E., Chai, Q. and Coulter, J. A., (2019). Rice Blast: A Disease with Implications for Global Food Security. Agronomy 9, 451.

Giamerti, Y., Hongo, C., Saito D., Caasi ,O., Susilawati, P. N., Shishido, M., Sudiarta, I P., Wijaya I M. A. S., Homma, K. (2021). Evaluating Multispectral Imaging for Assessing Bacterial Leaf Blight Damage in Indonesian Agricultural Insurance. E3S Web of Conferences 232, 03008, 1-7.

Harmon, P. F., Dunkle, L. D. and Latin, R. (2003). A rapid PCR-based method for the detection of *Magnaporthe oryzae* from infected perennial ryegrass. Plant Disease 2003 (87), 9 1072-1076

Kementrian Pertanian. (2018). Petunjuk Teknis Pengamatan dan Pelaporan Organisme Pengganggu Tumbuhan dan Dampak Perubahan Iklim (OPT-DPI). Direktorat Perlindungan Tanaman Pangan. Jakarta.

Ministry of Agriculture of The Republic of Indonesia. (2021). Rice Farming Business Insurance, Harvest Failure Solution. https://www.pertanian.go.id/home/?show=news&act=view&id=1609. Diakses pada tangal 27 Februari 202.

Ministry of Agriculture of The Republic of Indonesia. (2019). Agricultural Insurance for the Protection of Farmers' Business. https://www.pertanian.go.id/home/?show=news&act=view&id=3668. Diakses pada tanggal 27 Februari 2021.

Rahardjo, I. B. dan Suhardi. (2008). Insidensi dan Intensitas Serangan Penyakit Karat Putih pada Beberapa Klon Krissan. Hort. 18(3), 312-318

Riana, E. (2011). Seleksi Dan Formulasi Konsorsium Bakteri Untuk Mengendalikan Penyakit Blas (*Pyricularia Oryzae*) Pada Tanaman Padi, https://docplayer.info/53847227-Seleksi-dan-formulasi-konsorsium-bakteri-untuk-mengendalikan-penyakit-blas-pyricularia-oryzae-pada-tanaman-padi-eko-riana.html. Diakses pada tanggal 27 Februari 202.

Semangun, H. (2008). Penyakit-Penyakit Tanaman Pangan di Indonesia (Edisi

Kedua).Yogyakarta: Gadjah Mada University Press.

Surning, NI N., Ambarawati, I G. A. A., Ustriyana, I N. G.. (2018). Willingness To Pay Petani terhadap Pelaksanaan Asuransi Usaha Tani Padi (AUTP) (Studi Kasus Subak Cepik Desa Tajen Kecamatan Penebel Kabupaten Tabanan). E-Jurnal Agribisnis dan Agrowisata 7(3), 364-373.

Wang, X., Lee, S., Wang, J., Ma, J., Bianco, T. and Jia, Y. (2014). Current advances on genetic resistance to rice blast disease. Chapter 7 in Rice-Germplam, Genetics and Improvement (W Yan and J Bao, eds.). Available online at: http://www. intechopen.com/books/ricegermplasmgeneticsandimproveme nt/current-adva nces-on-genetic-resistance-torice-blast-disease. Diakses 17 Oktober 2018. https://www.intechopen.com/books/rice-germplasm-genetics-and-improvement/current-advances-on-genetic-resistance-to-rice-blast-disease

Wicaksono, D., Wibowo, A. dan Widiastuti, A. (2017). Metode Isolasi *Pyricularia Oryzae* Penyebab Penyakit Blas Padi. https://media.neliti.com/media/publications /79836-ID-none.pdf. Diakses pada tanggal 5 Agustus 2019.

Widyantoro, Pane, H., dan Jtmiko, S.Y. (2007). Peningkatan Produksi Padi Gogo Melalui Pendekatan Model Pengolahan Tanaman Terpadu. http://www.litbang.pertanian.go.id/special/padi/bbpadi_2008_p2bn1_19.pdf . 265-282.

Widiarta, IN. dan Suharto, H. (2009). Pengendalian Hama dan Penyakit Tanaman Padi secara terpadu. http://www.litbang.pertanian.go.id/special/padi/bbpadi_2009_itkp_17.pdf. 469.

Yudarwati, R., Hongo C., Sigit G., Barus B. and Utoyo B. (2020). Bacterial Leaf Blight Detection in Rice Crops Using Ground-Based Spectroradiometer Data and Multi-temporal Satellites Images. Journal of Agricultural Science 12(2), 38-49.