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The effect of physical environmental factors of on the development of in field rice blast disease incidence.

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Abstract

Relationship between physical environmental (temperature maximum, temperature minimum, relative humidity maximum, relative humidity minimum and rainfall) and blast disease incidence was studied during four growing season (Main season 2012-2013, Off season 2013, Main season 2013-2014 and Off season 2014) in rice fields located in Mardi, Seberang Perai, Pulau Pinang. Direct visual estimation of lesion on leaves was scored. Correlation analysis between study variables (Disease Incidence) and physical environmental factors revealed that there was significantly positive correlation. During all the monitored seasons, correlation statistical analysis data appeared to be useful and reliable in predicting the leaf blast disease. Such predictions can be used to in advising on fungicide application.

Keywords: physical environment, correlation, leaf blast, predicting, disease incidence

INTRODUCTION

Rice blast caused by *Pyricularia oryzae* is the most destructive rice disease in Malaysia as well as other rice growing regions in the world. In Malaysia alone, the estimated yield loss caused by the disease is about 90 000t/season which is valued at about RM 72 million (Saad et al., 2003). This loss should be minimized in order to help the marginal and poor farmers. The potential yield of rice in Malaysia is around 10 tons ha^{-1} (Abdullah et al., 2010). Unfortunately, until now the rice production in Malaysia has not met the national demand (Ghee-Thean et al., 2012). Prabhu and Fillippi (2001) observed that grain loss due to rice blast caused by *P. oryzae* was directly related to the prevailing climatic conditions.

The importance of the environment on the development of plant diseases has been known for over two thousand years. Studies pertaining to environmental effects on incidence and severity focus primarily on temperature, relative humidity, rainfall, and leaf wetness effects (Barksdale and Asai, 1961; Hashioka, 1965; Chiba et al., 1972; Yoshino, 1972; Kato and Kozaka, 1974; Kato, 1974, 1976; Suzuki, 1975; El Refaei, 1977; Bhatt and Chauhan, 1985; Kim and Yoshino, 1987). Despite of all current scientific research that has been conducted at the moment, the defense strategies against the disease is still mainly based on variatal resistance with the support of chemical control. However, the issue is when is appropriate time and situation that require chemical treatment intervention to ensure its effectivess

MATERIAL AND METHODS

Field plots, land preparations and planting materials

Experiment was conducted at field plot at MARDI Research Station, Seberang Perai, Pulau Pinang during Off season 2012: March – Sept 2012. Field lay out was done according to the experimental design of RCBD with 4 replications (28 plots) with the plot size 5m X 5m. MR219 was used because it is a popular variety and widely grown which susceptible to

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blast disease. Fertilizers were applied accordingly as described in Manual Penanaman Padi Lestari MARDI, 2008. Varieties MR219, susceptible to rice blast were used throughout this study. Soil fertility status of experimental site as shown in Table 1.

Table 1. Soil fertility status of experimental site.

Parameter	
pH	4.73
Organic carbon	1.06 %
Nitrogen	0.18 %
Soluble phosphorus	7.90 ppm
Cation Exchange Capacity (%)	8.42 me %
Ex potassium	0.20 me %
Ex sodium	0.45 me %
Ex calcium	2.08 me %
Ex magnesium	1.00 me %

A completely randomized design was employed. Plot size was 5 m x 5 m.

Disease assessment

The severity was assessed by visual observation and scoring the percentage leaf area/plot affected by blast disease lesions. These were read on the scale (0-9) of the Standard Evaluation System designed by International Rice Research Institute (IRRI, 1996).Disease progress was evaluated by infectious lesion production, and represented as the percentage of infectious lesions per affected plant part.

Environmental Data

Climate Data will be collected from the adjacent meteorological department facilities and by using mobile temperature and humidity recorder. The climatic parameters to be taken will include rainfall (precipitation), day and night relative air humidity (maximum, minimum), day and night temperature (maximum, minimum).

Regression model

The relationship effect of meteorological parameters on leaf blast was correlated and the significance different were analyzed with Pearson Correlation at 0.05, 0.01 probability level of Independence and nonparametric analysis of variance (ANOVA) by using SPSS. Linear multiple regression analysis were used to find out on disease incidence.

RESULTS AND DISCUSSION

Table 2. Correlation of different factors with disease incidence (leaf blast).

Weather Parameter	Disease Severity (%)			
	Main-Season 2012-2013	Off-Season 2013	Main-Season 2013-2014	Off-Season 2014
Maximum temperature (^{0}C)	- 0.231*	-0.33**	0.126	0.155
Minimum temperature (^{0}C)	-0.223*	-0.289**	-0.472**	0.324**
Maximum relative humidity (%)	-0.234*	0.052	-0.372**	0.166
Minimum relative humidity (%)	0.281*	-0.29	-0.367**	-0.225*
Rainfall (mm)	0.350*	0.21	-0.047	-0.37
Wind Speed (m/s)	-0.159*	-0.343**	0.399*	-0.269*

**, Correlation is significant at the 0.01 level
*, Correlation is significant at the 0.05 level

Weather Parameter	Disease Severity (%)			
	Main-Season 2012-2013	Off-Season 2013	Main-Season 2013-2014	Off-Season 2014
Maximum temperature (⁰C)	0.118	0.71	-0.645	-0.50**
Minimum temperature (⁰C)	-0.153	-0.125	0.551**	-0.322
Maximum relative humidity (%)	0.417*	0.117	0.735**	0.548**
Minimum relative humidity (%)	0.248	-0.154	0.839**	-0.021
Rainfall (mm)	0.351*	0.202	0.058	-0.084

Table 3. Correlation of different factors with disease incidence (panicle blast)

**, Correlation is significant at the 0.01 level
*, Correlation is significant at the 0.05 level

Table 4: Multiple regression model of disease severity for leaf blast incidence (Y_{lb})

Season	Model	r	R^2	F	DW
Main-Season 2012-2013	$Y_{lb} = 56.74 - 2.0T_{max} + 0.41T_{min} + 0.06RH_{max} - 0.05RH_{min} - 0.04Rainfall$	0.855	0.732	2.727	1.180
Off-Season 2013	$Y_{lb} = 40.1 - 0.21T_{max} - 0.14T_{min} - 0.16RH_{max} - 0.29RH_{min} + 0.004Rainfall$	0.716	0.512	1.049	1.963
Main-Season 2013-2014	$Y_{lb} = -6.48 + 0.34T_{max} - 0.27T_{min} + 0.03RH_{max} - 0.013RH_{min} + 0.026Rainfall$	0.849	0.721	2.575	1.971
Off-Season 2014	$Y_{lb} = -32.02 + 0.13T_{max} - 0.06T_{min} + 0.39RH_{max} - 0.07RH_{min} - 0.001Rainfall$	0.803	0.645	1.820	1.593

During main-season 2012-2013

Cross-correlations between disease incidence and weather parameters recorded, revealing a significant increase in disease incidence with decreasing minimum and maximum temperatures and maximum relative humidity whereas, there was significantly positive correlation between disease severity and minimum relative humidity. Rainfall also positively correlated with disease incidence, i.e 0.35. The positive relationship shown by rainfall on leaf and panicle blast is attributed to dispersion of propagules (Koizumi and Kato, 1991; Nakamura, 1971), in addition to providing free moisture in plant parts.

During off-season 2013

The maximum and minimum temperature, wind speed and disease incidence was negatively correlated i.e. -0.33, -0.289, -0.343 respectively, this indicated that the disease incidence increases with the decrease of temperature. The incidence was minimum during this season due to dry monsoon. Di Malaysia off-season kebiasaanya cuaca agak panas /monsoon kering. Berdasarkan laporan meterological data, suhu maksimum during this season adalah 36⁰C dan kuantiti hujan yang sangat sedikit. An increase in temperature, therefore reduces the viability of airbone spore (El Refaei, 1977; Hashioka, 1965).

During main-season 2013-2014

There was significantly positive correlation between disease incidence, whereas minimum temperature, minimum and maximum humidity showed negative though significant correlation. Maximum disease incidence was noticed during this season were favourable for the growth establishment and spread the pathogen. Munoz (2008) designed to investigate the effect of temperature and relative humidity on the airborne concentration of *Pyricularia oryzae* spores and the development of rice blast. They have reported that relative humidity of 95% and an average temperature of 26-27°C were optimum for infection and substantially favored spore release.

During off-season 2014

There was significantly positive correlation between disease incidence and minimum temperature, i.e 0.324. However, there are negatively correlated between disease incidence and minimum relative humidity.

The generalized multiple regression model indicated strong relationship between disease and viarables taken understudy. It also shows that, different season weather variables could influence blast disease incidence (Table 4). Regression equations developed for all season. The best fit equation was Y (leaf blast disease variable) = 56.74 -2.0T_{max}+ 0.41T_{min} +0.06RH_{max} -0.05RH_{min}-0.04Rainfall.

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