DEVELOPMENT OF BROWN PLANTHOPPER RISK PREDICTION MODEL

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ABSTRACT

Brown planthopper (Nilaparvata lugens) is a theat to paddy field. If the initial population of brown planthopper is not controlled or control measures are taken slowly, there is a possibility of 'hopperburn' that can cause significant yield losses. Precisely and early warning of pest population incidence would help farmers in planning to control the brown planthopper population. In this study, risk model was developed taking into account weather factors as a significant variable that affects the number of brown planthopper populations in the light trap. A case study is carried out on risk assessment of brown planthopper in Batu 17, Yan, and Kedah. The results of the model analysis will be displayed as BPH risk forecast map. Risk evaluation classified into low, medium and high level. The risk model can help farmers in particular to make crop protection plans from brown planthopper attacks where early warning allows the use of timely brown planthopper control measures while reducing production costs by minimize the use of insecticides.

Key words: Risk Model, early warning, brown planthopper.

INTRODUCTION

Insect pests are among the factors influencing the loss of rice crops in Asia (Bottrell and Schoenly, 2012). The Nilaparvata lugens (Stål) is a pest of rice plants (Oryza sativa L.). Brown planthopper attacks start from the vegetative stage until the ripening phase (Fujita et al., 2013) that can result in a loss of yield of around 30-100%. The age of the rice plant appears to have a very significant effect on the insect population (ALAM 1971). Generally, there are three peaks of brown planthopper population during the rice planting season (Figure 1.0). The presence of brown planthopper is usually at the vegetative phase (G1), the booting phase (G2) and the reproductive phase (G3). The number of brown planthopper in the early stages (G1) is very low. However, if the initial population (G1) exists and is allowed to reproduce without restriction, it may be able to form a growing generation (G2) population and the number of populations will increase although usually the G2 generation has not been able to cause 'hopperburn'. However, if there are conducive environmental factors that will cause the growth of the brown planthopper to increase and uncontrolled, then the population of this G2 generation will multiply and subsequently the number of G3 at the rice level will continue to increase and peak. Generation G3 can be easily detected and most likely this G3 will also cause 'hopperburn' and loss of yield on rice crops. The findings also show that the number of brown planthopper tends to increase after 60 days, especially during the dry season (Bae and Pathak 1969). Therefore, intensive monitoring of the number of brown planthopper and environmental weather needs to be done in the G1 and G2 generations, starting from 31- 60 days after sowing. Doing the detection of brown planthopper at an early stage can help determine the appropriate and accurate time for insecticide spraying.

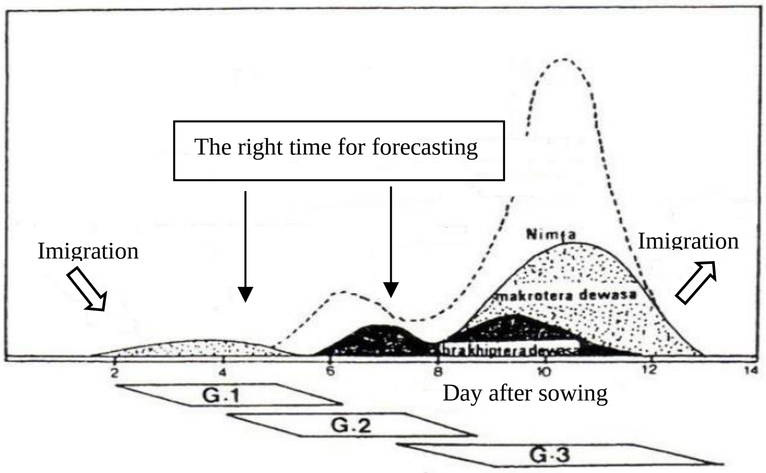

Figure 1: Estimated brown planthopper at the rice planting stage (Holt et al. 1987)

METHODOLOGY

Study area

Population data of brown planthopper from light traps that have been installed at 4 locations of the study plot which is located in Padang Lumat, Batu 17, Titi Batu and Kuala Sedaka, Yan, Kedah from the year 2015 to 2017 have been collected and analyzed to obtain the number of populations/traps/week and used to get trends throughout the rice planting season. The location of study area in the range of 5.7950° N latitude , 100.3727° E longitude to the north of Peninsular Malaysia. The varieties planted in this study are MR Clearfield 2. The area has two cropping seasons in a year, which are March to May and September to November.

Weather data collections

IMETOS electronic weather station is used to collect weather data. Data is automatically sent daily to a computer that can be accessed through a web server on the internet. Weather data was collected from 2015 to 2017 for model development. The weather station is located about 60 m from the light trap. Air temperature (° C), dew point temperature (° C) relative humidity (%), wind speed (m/s) and rain (mm) were measured by the sensor at 3-m above ground.

Model Development

The development of a predictive model that determines the BPH risk index is as potential for a brown planthopper outbreak is by considering the factors/criteria that affect the number of brown planthopper. These factors/criteria need to be aggregated into one value so that this value can be used to support the critical decision-making process in the BPH risk assessment. The list of parameters is considered from the expert knowledge as well as the expertise gained from the various streams of simulation models that have been developed from the literature review

RESULT AND DISCUSSION

The data brown planthopper collection study was conducted for three season of rice cultivation, which is off season 2015, off season 2016 and the main season 2016/2017 using modular light trap. Farmer survey data has also been collected. Collection of survey data was obtained by conducting surveys using questionnaires and interviews with farmers. From quantitative data the survey is categorized to discrete data. Descriptive analysis is used to analyze data from survey forms and transform them into statistical data. The information obtained through this survey can be used to identify pesticide use, number of insecticide spraying, and spray insecticide below 40 day after sowing and crop stages and farmers' response to whether they have been affected by the brown planthopper. While weather data is categorized as continuous data. A correlation between weather parameters (maximum temperature, minimum temperature, relative humidity, rainfall, wind speed) and brown planthopper population data in the light trap was conducted (Table 1.0)

Table 1: Linear correlation between criteria influence by population of brown planthopper

Criteria	Number of brown plant hopper	
	Farmer's survey data	**Data from 2015 to 2017**
Temperature maximum (^{0}C)	NA	0.68**
Temperature minimum (^{0}C)	NA	-0.65**
Relative Humidity (%)	NA	0.61**
Rainfall (mm)	NA	0.69**
Wind Speed (m/s)	NA	-
No of insecticide spaying	-0.27**	NA
Spray insecticide below 40 Day after sowing	0.51**	NA
Crop Stages (Day after sowing)	0.53**	0.77**

** at significant 1% ; * at significant 5%

The results of the correlation study showed maximum temperature, relative humidity, rainfall distribution and had significant positive correlation and minimum temperature had significant negative correlation in relation to the number of brown planthopper populations in the light trap. From the findings of the study and analysis, there are criteria that most influence the risk of brown planthopper including the maximum temperature, relative humidity and rainfall distribution. Similar results have been reported that climate factors such as temperature, rainfall and relative humidity greatly influence the change in insect populations (Mohd Fitri, M. et al 2017 and Heong et al 2007). According to Bae et al 1968, the development of brown planthopper is optimal at 25^{0}C -29^{0}C, however at 33^{0}C it will affect all stages of brown planthopper development in Asia. Meanwhile, the results of the analysis for discrete data that is insecticide spray before 40 day after sowing, the age of rice shows a significant positive correlation with the number of brown planthopper population in the light trap but the number of insecticide spray has a significant negative correlation where when the number of insecticide spray increases the number of brown planthopper populations will decrease.

Table 2: Brown planthopper risk index calculation criteria

Criteria	Real Value	Qualitative Value	Converted values	Standardized Value Xi^{new}	Risk Index BPH (*wi*)
rbph	>200	High	3	1	0.30
BPH population data from	100-200	Moderate	2	0.5	
light trap	<100	Low	1	0	
rvarieti	MRQ74	High	3	1	0.27
Variety vulnerability status	MR12H, MR297, MR303,	Moderate	2	0.5	
	MR307	Low			
	MR286		1	0	
rcstage	1-30 DAS	Low	1	0	0.21
Crop stages (HLT)	31-59 DAS	Moderate	2	1.5	
	60-120 DAS	High	3	1	
rsuhu	29^{0}C-32^{0}C	High	3	1	0.14
Temperature Maximum (^{0}C)	>32^{0}C	Low	1	0	
rhum	80% - 86%	High	3	1	0.08
Relative Humidity (%)	<80% or 86%	Low	1	0	

The total of BPH index where calculated using the following equation:
W (irBPH) = (W1rbph + W2rvarieti + W3rcstage + W4rsuhu + W5rhum) (W1rbph)
Where:
W1rbph = Risk from component of BPH population data from light trap
W2rvarieti = Risk from component of variety vulnerability status
W3rcstage = Risk from component of crop stage
W4rsuhu = Risk from component of temperature maksimum
W5rhum = Risk from component of relative humidity

Standadized value is as follow:
W1rbph = 1, 0.5 or 0, which is high, moderate and low
W2svarieti = 1, 0.5 or 0, which is susceptible, moderate susceptible dan resistance
W3scstage = 1, 0.5 or 0, which is 1-30, 31-59 atau 60-120 day after sowing
W4rsuhu = 1 or 0, which is <32^{0}C and >32^{0}C
W5rhum = 1 or 0, which is 80% - 86% and <80% or >80%

Table 2 show that Brown planthopper risk index calculation criteria. Criteria are selected from statistical methods which is correlation analysis (Table 1) and from opinions of experts and existing rice pest studies. A set of criteria is constructed to determine the BPH risk index and the set of criteria can vary depending on the location and aggregation of the number of brown plant hopper populations on the light trap. The probability density function method is commonly used to calculate the weight of each OWA (Ordered Weightage Averaging) criteria (Yager et al, 1993).

CONCLUSIONS

Therefore, knowledge of insect catching in light traps can also be used to develop brown planthopper prediction models. The present study provides scientific information on brown planthopper population against light traps influenced by specific environmental weather conditions. The findings of the study have shown that the density of brown planthopper populations is strongly influenced by temperature, relative humidity and rainfall. Therefore, data on the number of brown planthopper in light traps, maximum temperature, relative humidity, rainfall, variety and crop stages will be considered as parameters for the development of early warning system for brown planthopper.

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