



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF TEMPERATURE AND RELATIVE HUMIDITY ON
GROWTH OF GREEN LEAFHOPPER (*Nephotettix virescens* DISTANT)***

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GROWTH OF GREEN LEAFHOPPER (*Nephotettix virescens* DISTANT)**

By

TUAN NORIZAN BINTI TUAN YUSOF

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Master of Science**

June 2018

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Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2018

Chairman : Aimrun Wayayok, PhD
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Green leafhopper (GLH), *nephotettix virescens* is one of the insects that attacks paddy plants in Malaysia. This species carries tungro virus that could damage the paddy plant. Early detection is important in order to manage and control the spreads of this virus. This study was conducted in order to find out the effect of weather parameters such as temperature and relative humidity (RH) to the population growth of green leafhoppers. A total of 27 samples of paddy plants at the age of 30 Days After Planting (DAP) were investigated. An instrument that consists of an embedded system was used to control temperature and RH. Fans and humidifiers were also installed to the embedded system to detect and control the level of temperatures and RH. Population number of GLH were counted and recorded on daily basis from nymph until adult stages. The sizes of GLH were also taken by using a digital camera (resolution of 750 pixels by 1334 pixels). The data was analyzed in MATLAB, whereas the sizes of GLH were monitored and discriminated based on controlled temperature and RH. The number of paddy leaves were also recorded to find out the relationship between the number of paddy leaves hosted by GLH with the temperature and RH. Statistical analysis was then performed to find out the significance differences between the treatments. Results indicated that there were differences between the treatments but not on the number of paddy leaves. Temperature and RH obtained from the instrumentation system indicated that higher GLH populations were found when the temperature was 30°C and RH was 80%. However, there were no relationship between the number of leaves attached by GLH with the weather parameters, and this indicated that at any values of temperatures and RH, GLH might be anywhere on the leaves. Based on the number of death of GLH, the mortality rate was counted. The survivability of GLH reduced when the temperature goes higher. There were higher mortality between day 19 to day 21 especially for the interactions of INT7 (temperature 40°C, RH 70%), INT8 (temperature 40°C, RH 80%), and INT9 (temperature 40°C, RH 90%). This study concluded that by knowing the

meteorological data of temperature and RH, the GLH pest population can be forecasted in advance as an early warning mechanism to allow farmers to manage this pest in their farms. This preventive method of pest management can minimize the loss of yield in rice production due to pest and disease attack.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN SUHU DAN KELEMBAPAN TERHADAP POPULASI BENA HIJAU
(*Nephotettix virescens* DISTANT)**

Oleh

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Serangga Bena Hijau (GLH) adalah salah satu serangga yang menyerang tanaman padi di Malaysia. Spesies ini membawa virus tungro yang boleh merosakkan tanaman padi. Pengesanan awal adalah penting untuk mengurus dan mengawal penyebaran virus ini. Kajian ini dijalankan untuk mengetahui kesan parameter cuaca seperti suhu dan kelembapan relatif (RH) kepada pertumbuhan populasi bena hijau. Sebanyak 27 sampel tanaman padi pada usia 30 Hari Selepas Penanaman (DAP) telah disiasat. Peralatan yang terdiri daripada sistem terpendam digunakan untuk mengawal suhu dan RH. Kipas dan pelembap juga dipasang pada sistem ini untuk mengesan dan mengawal tahap suhu dan RH. Bilangan populasi GLH dikira dan direkodkan setiap hari dari nymph hingga tahap dewasa. Saiz GLH juga diambil dengan menggunakan kamera digital (resolusi 750 piksel dengan 1334 piksel). Data dianalisis dengan menggunakan MATLAB, yang mana saiz GLH dipantau dan diskriminasi berdasarkan pada suhu dan RH yang dikawal. Bilangan daun padi juga direkodkan untuk mengetahui hubungan antara jumlah daun padi yang dihinggapi oleh GLH dengan suhu dan RH. Analisis statistik kemudiannya dilakukan untuk mengetahui perbezaan penting antara suhu dan RH. Keputusan menunjukkan bahawa terdapat perbezaan di antara suhu dan RH kecuali jumlah daun padi yang dihinggapi oleh GLH. Suhu dan RH yang diperolehi dari sistem instrumentasi yang dibangunkan menunjukkan bahawa GLH dikesan apabila suhu 30°C dan RH 80% adalah populasi GLH yang lebih tinggi. Walau bagaimanapun, tidak terdapat hubungan antara bilangan daun yang dilampirkan oleh GLH dengan parameter cuaca dan ini menunjukkan bahawa pada mana-mana nilai suhu dan RH, GLH mungkin berada di mana sahaja di daun. Berdasarkan bilangan kematian GLH, kadar kematian dikira. Kehidupan GLH berkurang apabila suhu semakin tinggi. Terdapat kematian yang lebih tinggi antara hari ke-19 hingga hari ke-21 terutamanya untuk interaksi INT7 (suhu 40°C, RH 70%), INT8 (suhu 40°C, RH 80%), dan INT9 (suhu 40°C, RH 90%). Kajian ini merumuskan bahawa dengan pengetahuan data meteorologi tentang suhu

dan RH, populasi serangga GLH dapat diramalkan terlebih dahulu sebagai mekanisma ramalan awal untuk membolehkan petani mengurus serangga padi ini dalam sawah mereka. Kaedah pencegahan bagi pengurusan serangga ini dapat mengurangkan kerugian hasil pengeluaran beras yang disebabkan oleh serangan serangga dan penyakit.



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I certify that a Thesis Examination Committee has met on 5 June 2018 to conduct the final examination of Tuan Norizan binti Tuan Yusof on her thesis entitled "Effects of Temperature and Relative Humidity on Growth of Green Leafhopper (*Nephotettix virescens* Distant)" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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TABLE OF CONTENTS

	Page
ABSTRACT	i
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
CHAPTER	
1 INTRODUCTION	1
1.1 General Overview	1
1.2 Problem Statements	2
1.3 Objectives of Study	2
1.4 Scope and Limitations of the Study	3
1.5 Thesis Layout	3
2 LITERATURE REVIEW	4
2.1 Green leafhopper	4
2.2 Rice tungro diseases	5
2.3 Rice damage due to insect	6
2.4 Control of green leafhopper in paddy plants	7
2.5 Effect of Temperature and Relative Humidity on Insects	8
2.6 How Other Use the Instruments Consists of Microcontroller	8
2.7 Summary of Literature Review	10
3 MATERIALS AND METHODS	11
3.1 Materials Preparation	13
3.2 Control Parameter Setup	13
3.2.1 Control Algorithm	13
3.2.2 Hardware Preparation	13
3.3 Sheltered House Setup	14
3.4 Preliminary Study	15
3.4.1 Study Area	15
3.4.2 Setup of the Cages	15
3.4.3 Data Collection for Comparison of Inside and Outside Cage	16
3.5 Rearing GLH Preparations	16
3.5.1 Design of Rearing Cages	17
3.5.2 Soil Preparations and TN1 Seedling Preparations	18
3.5.3 Fertilizer Application	19
3.5.4 Replacement of TN1 Plant in Cage	20
3.6 Experiment on GLH Growth under Different Temperature and RH	20

3.6.1	Treatment Details	20
3.7	Site layout	20
3.8	MR219 Cultivation Practices	21
3.8.1	Seedling Preparations	21
3.8.2	Fertilizer Applications	22
3.8.3	Seedling transplanting	22
3.8.4	Pots irrigation	22
3.9	Transferring GLH to MR219	22
3.10	Data collections	23
3.10.1	Population Count	23
3.10.2	Determination of GLH Size	23
3.10.3	Number of Paddy Leaves Hosted by GLH	24
3.11	Mortality Rate of GLH	24
3.12	Statistical Analysis	25
4	RESULTS AND DISCUSSIONS	26
4.1	Introduction	26
4.2	Development of instrumentation	26
4.3	Temperature & RH measurement Using DHT22 Inside and Outside Cage	27
4.3.1	Control of Fans and Humidifiers	28
4.4	Effect of treatments on GLH Population, Size and Number of Paddy Host leaves	30
4.4.1	Effect of Temperature and RH on GLH Population	30
4.4.2	Size of GLH	35
4.4.3	Number of Leaves Hosted by GLH	37
4.5	Mortality rate of GLH	38
5	CONCLUSION AND RECOMMENDATION	40
5.1	Conclusion	40
5.2	Recommendations	40
	REFERENCES	41
	APPENDICES	46
	BIODATA OF STUDENT PUBLICATION	61
		62

LIST OF TABLES

Table		Page
2.1	Species of leafhopper and planthopper that attack paddy plants	6
3.1	Treatment details of this study	20
4.1	Mean value of temperature and RH inside and outside the cage	28
4.2	Two-way ANOVA on population of nymph stages GLH	30
4.3	Two-way ANOVA on population of adult stages GLH	30
4.4	Two-way ANOVA on size of GLH	35
4.5	Two-way ANOVA on paddy leaves	37
4.6	Two-way ANOVA on mortality of GLH	39

LIST OF FIGURES

Figure	Page	
2.1	Biology of GLH	5
2.2	(A) The Arduino UNO external appearance. (B) A simplified schematic of the digital and analog input/output ports	10
3.1	Flowchart of the Study	12
3.2	Connections of the sensors with the breadboards	14
3.3	Setup of the cages under sheltered house	15
3.4	Cage attached with fans, humidifier, and DHT22 sensor	16
3.5	Life cycle of GLH	17
3.6	GLH feeds on TN1 plants	17
3.7	Rearing cage for GLH	18
3.8	Flowchart of soil preparation	19
3.9	Randomized Complete Block Design (RCBD) of cages in the greenhouse	21
3.10	Transferring of the GLH on MR219 seedlings	23
3.11	Image of GLH processing using MATLAB	24
4.1	(a). Temperature readings, (b) RH readings inside and outside the cage placed at Ladang 2, UPM	27
4.2	Flow chart for temperature control	29
4.3	Flow chart for relative humidity (RH) control	29
4.4	The number of population of GLH in the nymph stage based on temperature comparison	31
4.5	The number of population of GLH in the adult stage based on temperature comparison	32
4.6	The number of population of GLH in the nymph stage under different RH conditions	32

4.7	The number of population of GLH in the adult stage under different RH conditions based on RH comparison	33
4.8	The number of population of GLH in the adult stage based on interaction of temperature and RH comparison	34
4.9	The size of the GLH based on temperature comparison	36
4.10	The size of the GLH based on RH comparison	36
4.11	The number of leaves hosted by GLH on temperature comparison	37
4.12	The number of leaves hosted by GLH on RH comparison	38
4.13	Graph of mortality rate of GLH	39

CHAPTER 1

INTRODUCTION

1.1 General Overview

Paddy is an important crop in Malaysia and it is essential for national food security. Apart from this, the statistic has also proven that paddy industry in Malaysia has generated stable income for the country (Zaim et al., 2013). Subsequently, it reflected the accomplishment of this industry. Malaysian paddy and rice industry regularly get consideration and truly emphasized by the government because of its vital significance as the primary staple food. Moreover, rice has supported a greater number of people for a longer period of time than any other crop since it was domesticated between 8,000 to 10,000 years ago (Greenland, 1997). At present, rice is the staple food for more people than wheat, and 90 percent of total rice production is grown and consumed in Asia (Evans, 1998). Paddy is cultivated in at least 114 countries, mostly for developing countries and is the main source of wages and employment for more than 100 million households in Africa and Asia (FAO, 2014). There are many parameters that can influence the economics of rice cultivation, and the appropriate control of pest for maintaining the crop is one of them.

Green leafhoppers (*Nephotettix virescens*) are the most common leafhoppers in rice fields and are primarily harmful because these insect spread the viral disease tungro (Takahashi et al., 1993). Both nymphs and adults feed by extracting the plant sap with their needle-formed mouthparts. Green leafhoppers are common in rained and irrigated wetland environments but not predominant in upland rice. Both the nymphs and adults eat the dorsal surface of the leaf blades instead of the ventral surface. GLH like to feed upon the lateral leaves as opposed to the leaf sheaths and the middle leaves. In addition, these pests prefer toward rice plants that have been treated with large amount of nitrogen. It was reported that the nitrogen content in rice plant is one of the main causes that attract pests to host under the canopy (Lu et al., 2005).

Basic climate parameters, such as temperature and humidity influence insects both directly and indirectly (Tomasv, 2013). Insects are cold blooded organisms and hence the temperature of their bodies is approximately the same as that of the environment. Therefore, temperature is probably the single most important environmental factor influencing insect behavior, distribution, development, survival, and reproduction (Ramya et al., 2012). However, Relative Humidity (RH) is also important to plant growth. It affects size and thickness of leaves, stems and fruits. Abiotic factors like temperature and relative humidity play a vital role in the development of insect pests infection fluctuation.

1.2 Problem Statements

Based on previous researches, tungro virus disease is one of the main diseases in rice farming and it is carried by Green leafhopper (Yoshito, 1992). Both nymphs and adults feed by extracting plant sap with their needle-shaped mouthparts. Tungro viruses give symptoms such as stunting and yellow or orange yellow discoloration of the leaves, plant stunting and reduced in yield (Azzam and Chancellor, 2002). More than that, pest population in paddy field is specified to be related with synoptic weather conditions. Unselective use of fertilizers and pesticides and double cropping, extensive rice cultivation can lead to the existence of pests. Besides, GLH can exist for about 25-28 days in temperature of 25-30°C and it consists of three growth stages; egg, nymph and adult.

Disease detection during the early stage of infection is important for preventing the reduction of yield in crop production and offering better solution to the farmers. Rice has been the staple food for humans in many countries. Over half of the humans depend on rice as an energy source for daily lives (Bhullar and Grisse, 2013). A number of factors have been suggested as being related to the risk of tungro problems (Thresh and Chancellor, 1996). Rice cultivars infected with tungro diseases show typical symptoms such as severe arrested growth, yellowing of the leaves and reduced tillering (Jefferson and Chancellor, 2002). Nowadays, the farmers apply the pesticide or insecticide for the pests in their farms based on farming schedule such as age of the rice, without having the information about the insects in paddy field and the factors leading the GLH insects to the paddy field. Pest prevention method is a costly act and on the other hand, using inappropriate content of pesticide has many harmful consequences on paddy, particularly, when it uses in inappropriate time (Faranak et al., 2014). Early detection on the factors that affect the growth of GLH in paddy plant and the understanding of the factors surrounding such as temperature and RH could be a potential solution to overcome the attacks of the GLH in paddy plant. At the same time, it could overcome the problem in tungro virus brought out by GLH. Study on the population build-up of paddy pests and their relationship with weather parameters is an important component of pest managements since it gives information that can be utilized to improve cultural, mechanical, and chemical and behaviors method of insect control. With the knowledge in understanding the relation between the growth behaviors of GLH and some weather parameters, tungro virus brought out by GLH could be early predicted to prevent a severe loss in rice production.

1.3 Objectives of Study

The main objective of this research is to study the effect of environmental temperature and RH on the growth of green leafhopper (*nephotettix virescens*) on paddy leaves

This study embarks on the following specific objectives:

- i. To develop an instrumentation system to study the effect of temperature and RH on growth of GLH.
- ii. To determine the effect of temperature and relative humidity on the growth, size of GLH and number of paddy leaves attacked by GLH.
- iii. To study on the mortality rate of the GLH.

1.4 Scope and Limitations of the Study

The study is focused on the developing of the instrumentation to control the weather parameters such as temperature and relative humidity (RH). Then, focused on the populations of the GLH and related with the weather parameters designated. The temperature and RH were categorized into three levels: For temperature, (T1; 30°C, T2; 35°C, T3; 40°C). For relative humidity, three levels were assigned (RH1; 70%, RH2; 80%, RH3; 90%). The data collection was conducted about 4 weeks at 30 days after planting (DAP) until 60 DAP. The sample used in this study is limited to *Malaysian indica rice* (MR219) variety.

Some specific limitations are:

1. This study did not cover on the aspect of other effect such as nitrogen levels
2. The study was at an experimental plot only and was not tested at the actual field because, it needs to be controlled.
3. The observation on the growth of GLH was only at one cycle

1.5 Thesis Layout

There are five chapters reported in this thesis. Chapter one highlights the background of the paddy plants and populations of GLH in paddy plants, problem statements, scope of the study, and the objectives of the study. Then, chapter two followed by outlining the literature review about the damage of paddy plants and related with the populations of the GLH. More than that, in this chapter discussion on the control of the GLH in paddy plants was reviewed. In addition, chapter three explains the methodology used in this project. The methodology includes developing control system, planting rice plant, rearing of the GLH, and the method of data collections. In chapter four, the results that are obtained are presented and discussed thoroughly. Lastly, summary and conclusions from this study as well as recommendations for further studies are derived in chapter five.

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