



UNIVERSITI PUTRA MALAYSIA

POPULATION ECOLOGY OF BROWN PLANTHOPPER (*Nilaparvata lugens* Stal) AND WHITE BACKED PLANTHOPPER (*Sogatella furcifera* Horvath) IN MYANMAR

**SAN SAN WIN
FP 2010 9**

**POPULATION ECOLOGY OF BROWN
PLANTHOPPER (*Nilaparvata lugens* Stal) AND
WHITE BACKED PLANTHOPPER (*Sogatella
furcifera* Horvath) IN MYANMAR**

SAN SAN WIN

**DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA**

2010



**POPULATION ECOLOGY OF BROWN PLANTHOPPER (*Nilaparvata lugens*
Stal) AND WHITE BACKED PLANTHOPPER (*Sogatella furcifera* Horvath)
IN MYANMAR**

By

SAN SAN WIN

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

June 2010



DEDICATION

I dedicate this thesis to my husband U Kyaw Htin Oo and daughter Myintzu Khin for their patience and support during my study in Malaysia

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirement for the degree of Doctor of Philosophy

**POPULATION ECOLOGY OF BROWN PLANTHOPPER (*Nilaparvata lugens*
Stal) AND WHITE BACKED PLANTHOPPER (*Sogatella furcifera* Horvath)
IN MYANMAR**

By

SAN SAN WIN

June 2010

Chairperson: Professor Rita Muhamad Awang, PhD

Faculty : Agriculture

The ecological studies on the brown planthopper (BPH) *Nilaparvata lugens* (Stal) (Hemiptera: Homoptera) and the white backed plant hopper (WBPH) *Sogatella furcifera* (Horvath) (Hemiptera: Homoptera) were carried out in Myanmar. BPH is one of the major pests of rice and damage by this pest could cause hopper burns due to intensive sucking of the plant. This suggested an urgent need for alternative control measures besides using chemical insecticides. This study was conducted with the objectives to establish the biological life tables of BPH and WBPH, investigate their feeding and movement behaviours and examine the relationships between population fluctuations, host plant, rainfall and humidity in the field. The studies were conducted in an unsprayed rice field at Hmawbe Research Area, Myanmar from July 2007 to May 2008. Age specific survival and fecundity rates of BPH and WBPH were measured under field conditions. A life table was constructed using single sex methods. The population parameters of BPH fed on rice showed that the intrinsic rate of natural increase (r_m) of BPH was 0.0677 per female per day. The daily finite rate

of increase (λ) was 1.07 females per female per day with mean generation time (T) of 34.64 days. The net reproduction rates (R_0) of the population was 10.02. The population doubling in time (DT) was within 10.42 days. The population parameter of WBPH fed on rice showed that the intrinsic rate of natural increase (r_m) of WBPH were 0.0699 per female per day. The daily finite rate of increase (λ) was 1.0255 females per female per day with mean generation time (T) of 34.97. The net reproduction rates (R_0) of the population was 9.2732. The population doubling time (DT) was within 10.88 days. Feeding behaviour studies suggested that in both choice and no choice experiments, the patterns of feeding lesions between BPH and WBPH were quite similar. Higher numbers of feeding lesions were observed on 30 day old plants than 45 day and 60 days old plants. More feeding on leaf sheath than on leaf blade was observed for both planthoppers. In the movement behaviour study, it was revealed that BPH adults were found to be more active than the nymphal instars. In older rice plants, the highest movement (4.7 cm per two hours) was observed on 60-day-old plants and lowest (2.7 cm per two hours) on 30-day-old plants. Increased movements of planthoppers were observed at 13:00hrs. Population fluctuation study revealed that BPH population was high at 64 and 74 DAT (in mid September 2007) associated with heavy rainfall, high temperature and high humidity. The population was lowest at 138 DAT (in the mid week of October 2007) suggesting that low rainfall and low humidity were, at least partially responsible for the decrease population of the BPH. During the dry season, the population was low at 8 DAT (early week of January 2008) and then increased at 31 DAT (first week of February 2008). However, the population declined at 56 DAT and increased to moderate numbers at 86 DAT. The population development trend of WBPH was almost similar to those observed for BPH. During the dry season, the highest WBPH population was



recorded at 90 DAT and the lowest at 33 DAT. During the first cropping coinciding with the rainy season, the fluctuation of planthoppers was correlated with temperature and rainfall. During the second cropping coinciding with the dry season, there was no rainfall and planthoppers population was observed to be correlated to temperature and relative humidity. Therefore, temperature, rainfall and relative humidity influenced planthopper populations during two different rice growing seasons.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

**POPULASI EKOLOGI BENAH PERANG (*Nilaparvata lugens* Stal) DAN
BENAH PUTIH
(*Sogatella furcifera* Horvath) DI MYANMAR**

Oleh

SAN SAN WIN

June 2010

Pengerusi : Profesor Rita Muhamad Awang ,PhD

Fakulti : Pertanian

Suatu kajian dari aspek ekologi benah perang (BPH) *Nilaparvata lugens* (Stal) (Hemiptera: Homoptera) dan benah putih (WBPH) *Sogatella furcifera* (Horvath) (Hemiptera: Homoptera) telah dijalankan di Myanmar. BPH merupakan salah satu perosak utama tanaman padi dan tindakan menghisap pokok mengakibatkan kesan terbakar pada pokok. Oleh itu, teknik kawalan alternatif yang segera adalah perlu untuk diaplikasikan selain penggunaan racun serangga kimia. Kajian ini telah dijalankan dengan objektif untuk menghasilkan jadual hayat biologi BPH dan WBPH, menyelidik perilaku pemakanan serta pergerakan dan mengkaji perhubungan di antara turun naik populasi, tumbuhan perumah, taburan hujan dan kelembapan di sawah padi. Kajian ini telah dijalankan di sawah padi yang tidak disembur di Hmawbe Kawasan Penyelidikan, Myanmar dari Julai 2007 sehingga Mei 2008. Kebolehan hidup umur-spesifik berdasarkan usia dan tahap kesuburan BPH dan WBPH diukur dalam persekitaran makmal dan lapangan. jadual hidup dihasilkan dengan menggunakan kaedah satu seks. Parameter populasi BPH menunjukkan pertumbuhan semulajadi kadar intrisik (r_m) BPH adalah 0.0677 /betina/hari. Tahap

dan pertambahan kadar finate (λ) adalah 1.07 betina /hari, dengan purata tempoh generasi (T) adalah 34.64 hari. Kadar penghasilan bersih (R_0) populasi adalah 10.02. waktu penggandaan populasi (DT) adalah 10.42 hari. Parameter populasi WBPH menunjukkan bahawa pertambahan semulajadi kadar intrisik (r_m) WBPH adalah (0.0699) betina/hari. Tahap dan pertambahan kadar finate (λ) adalah 1.0255 betina/ hari, dan min tempoh generasi (T) adalah 34.97. Kadar penghasilan bersih (R_0) populasi ialah 9.2732. Waktu penggandaan populasi (DT) adalah 10.88 hari. Kajian perilaku pemakanan menunjukkan bahawa dalam kedua dua kajian dengan pilihan dan tanpa pilihan, pola makan antara BPH dan WBPH adalah hampir sama. Kesan pemakanan an yang lebih tinggi didapati pada tanaman berumur 30 hari. Kesan pemakan an yang lebih banyak dijumpai pada kelopak daun dibandingkan dengan helai daun bagi kedua-dua jenis benah. Dalam kajian pergerakan, didapati benah perang dewasa adalah lebih aktif dibandingkan dengan nimfa dan instar. Bagi padi dewasa, pergerakan tertinggi (4.7 sm/ dua jam) direkodkan pada tanaman berusia 60 hari dan pergerakan terendah (2.7 sm/ dua jam) pada tanaman berusia 30 hari. Peningkatan dalam pergerakan direkodkan pada jam 13:00. Kajian turun naik populasi mendedahkan bahawa populasi BPH adalah tinggi pada hari ke 64 dan 74 selepas penanaman (pada pertengahan September 2007). Ini adalah berhubungan dengan taburan hujan tinggi, suhu tinggi dan kelembapan yang tinggi. Populasi adalah terendah di 138 HSM (di minggu pertengahan Oktober 2007) mungkin disebabkan oleh taburan hujan yang kurang dan kelembapan rendah dan ini setidaknya bertanggungjawab atas penurunan populasi BPH. Semasa musim kering, populasi adalah rendah pada 8 HSM (minggu awal Januari 2008) dan kemudian meningkat kepada 31 HSM (minggu pertama bulan Februari 2008). Walaubagaimanapun, populasi menurun pada 56 HSM dan meningkat ke 86

HSM. Cara perkembangan populasi WBPH hampir serupa dengan yang diamati pada BPH. Pada musim kering, populasi WBPH adalah tertinggi pada 90 HSM dan terendah pada 33 HSM. Sewaktu tanaman pertama pada musim hujan, turun naik benah populasi adalah berkorelasi dengan suhu dan taburan hujan. Sewaktu tanaman kedua yang sama dengan musim kemarau, tidak ada hujan dan populasi benah didapati berkorelasi dengan suhu dan kelembapan relatif. Oleh kerana itu, suhu, taburan hujan dan kelembapan relative didapati mempengaruhi populasi benah pada dua musim penanaman.

ACKNOWLEDGEMENTS

The author would like to express her heart-felt thanks and appreciation to Professor Dr. Rita Muhamad Awang, Chairman of the Supervisory Committee for her encouragement, available support, invaluable advice and intellectual guidance throughout the studies and in preparation for the research proposal, the conduct of the experiments, and writing up of this thesis. I am also greatly indebted to my supervisory committee members, Associate Professor Dr. Zainal Abidin Mior Ahmad, and Dr. Nur Azura Adam for their enlightening comments, advice and help throughout my study and encouragement in the completion of this thesis.

I would like to extend my gratitude to my Supervisory Committee member Professor Dr. Myint Thaung, Rector of Yezin Agricultural University, Yezin- Nay Pyi Taw, Myanmar for his precious suggestions and guidance throughout the studies and in the preparation for the thesis. Special thanks are due to Prof. Dr Aung Kyi, Prorector of Yezin Agriculture University for his valuable advice and suggestion in preparation of this thesis especially with planthoppers life table studies and statistical analysis. Sincere thanks to Mr. Aye Tun, Head of Plant Protection Division, Myanmar and Dr. Tun Win, Director of Myanmar Rice Research Center for their kind permission to accommodate this research and encouragement throughout my studies.

My gratitude is also due to the authorities of Ministry of Agriculture and Irrigation of Union of Myanmar for the official permission to pursue a Ph.D study at Universiti Putra Malaysia (UPM), Malaysia.



I express my special thanks and gratitude to Third World Organization on Women in Science (TWOWS) for awarding the scholarship for this study at UPM.

My deeply heart felt love and gratitude go to my loving parents Dr Mya Thwin and Daw Khin Khin Swe for their kind understanding. My great thanks are also goes to Ma Myint Thuzar for she had done all in my study life at Universiti Putra Malaysia.

Finally, I wish to express my deepest appreciation to my husband U Kyaw Htin Oo and my daughter Myintzu Khin for their patience, understanding, support and inspiration given to me during the period of my study in Malaysia.

I certify that a Thesis Examination Committee has met on 10 June 2010 to conduct the final examination of San San Win on her thesis entitled “The ecology of rice brown planthopper *Nilaparvata lugens* (Stal) and white backed planthopper *Sogatella furcifera* (Horvath) on rice ‘in accordance with 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 degree of Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Kamaruzaman Sijam, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Dzolkhifli Omar, PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Faizah Abood Haris, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Abu Hasan Ahmad, PhD

Professor
Faculty of Science
Universiti Science Malaysia
Pulau Pinang
(External Examiner)

BUJANG KIM HUAT, PhD

Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 9 July 2010



This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Rita Muhamad Awang , PhD

Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairperson)

Zainal Abidin Mior Ahmad, PhD

Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Nur Azura Adam, PhD

Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

HASANAH MOHD GHAZALI, PhD

Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 12 August 2010

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or any other institutions.

San San Win

Date: 9 July 2010

TABLE OF CONTENTS

	Page
ABSTRACT	iv
ABSTRAK	vii
ACKNOWLEDGEMENTS	x
APPROVAL	xii
DECLARATION	xiv
LIST OF TABLES	xviii
LIST OF FIGURES	xx
LIST OF APPENDICES	xxii
LIST OF ABBREVIATIONS	xxiv
CHAPTER	
I GENERAL INTRODUCTION	
1.1 Background	1
II LITERATURE REVIEW	
2.1 Brown planthopper (BPH)	7
2.1.1 Distribution and biology	7
2.1.2 Life history of BPH	8
2.1.3 Host range and preference	12
2.1.4 Seasonal occurrence and abundance	12
2.1.5 Symptoms of damage	13
2.1.6 Cause of BPH Outbreak	14
2.2 White backed planthopper (WBPH)	15
2.2.1 Distribution and biology	15
2.2.2 Life history of WBPH	17
2.2.3 Host range and preference	19
2.2.4 Seasonal occurrence and abundance	19
2.2.5 Symptoms of damage	21
2.3 Integrated Pest Management of BPH and WBPH	21
2.3.1 Cultural Control	22
2.3.2 Biological control	22
2.3.3 Chemical Control	23
2.4 Ecology and population	25
2.4.1 Biotic factors	25
2.4.2 A-Biotic factors	30
2.4.3 Natural Enemies of BPH and WBPH	36
2.4.4 Alternated host weeds of BPH and WBPH	37
2.5 Host plants of BPH and WBPH	38
III LIFE TABLES AND DEMOGRAPHIC PARAMETERS OF BPH and WBPH on RICE	
3.1 Introduction	39
3.2 Materials and Methods	41
3.2.1 Life table conduction	41

3.3	Results and Discussion	44
3.3.1.	Age- specific survival life table for BPH	44
3.3.2.	Age-specific fertility life table for BPH	50
3.3.3.	Age-specific survival life table for WBPH	53
3.3.4.	Age-specific fertility life table for WBPH	59
3.4	Conclusion	64
IV	FEEDING AND MOVEMENT BEHAVIOUR OF BPH and WBPH on RICE	
4.1	Feeding behaviour of BPH and WBPH on rice	
4.1.1	Introduction	64
4.1.2	Materials and methods	64
4.1.3	Results and Discussion	66
4.2	Movement of BPH and WBPH on rice	81
4.2.1.	Introduction	81
4.2.2.	Materials and Methods	82
4.2.3.	Result and Discussion	83
4.3	Conclusion	95
V	POPULATION FLUCTUATION OF BPH and WBPH	
5.1	Introduction	96
5.2	Materials and methods	98
5.3	Results and Discussion	99
5.4	Conclusion	100
VI	GENERAL DISCUSSION AND CONCLUSION	115
	REFERENCES	130
	APPENDICES	152
	BIODATA OF STUDENT	161
	LIST OF PUBLICATIONS	162

LIST OF TABLES

Table		Page
2.1	Biology of BPH	11
2.2	Biology of WBPH.	19
2.3	List of host plants to BPH and WBPH.	38
3.1	Life table of BPH fed on rice (cohort 1, 2 July 2006).	46
3.2	Life table of BPH fed on rice (cohort 2, 12 July 2006).	47
3.3	Life table of BPH fed on rice (cohort 3, 22 July 2006).	48
3.4	Pool life table of BPH on rice.	49
3.5	Life and age-specific fecundity table of BPH fed of rice.	51
3.6	Population and reproductive parameters of BPH fed on rice.	52
3.7	Life table of WBPH fed on rice (cohort 1, 7 July 2006).	56
3.8	Life table of WBPH fed on rice (cohort 2, 20 July 2006).	57
3.9	Life table of WBPH fed on rice (cohort 3, 25 July 2006).	58
3.10	Pool life table of WBPH on rice.	59
3.11	Life and age-specific fecundity table of WBPH fed of rice.	61
3.12	Population and reproductive parameters of WBPH fed on rice.	62
4.1a	Mean diameter of feeding lesion on different ages of rice plants caused by different stages of BPH in feeding preference (non-choice experiment).	69
4.1b	Mean diameter of feeding lesion on different ages of rice plants caused by different stages of WBPH in feeding preference (non-choice experiment).	71
4.2	Mean number of feeding lesion on different age of rice plant caused by BPH and WBPH in (non-choice experiment).	75
4.3	Mean total number of feeding lesions on different age of rice plants caused by BPH and WBPH in non-choice experiment.	76

4.4	Mean diameter of feeding lesions on different age of rice plants caused by BPH and WBPH in choice experiment.	78
4.5	Mean number of feeding lesion on different age of rice plants caused by BPH and WBPH in choice experiment.	79
4.6	Mean number of feeding lesions on different age of rice plants caused by BPH and WBPH in choice experiment.	80
4.2.1	Mean movement (cm) of BPH stages on different age of rice plants.	83
4.2.2	Mean movement (cm) of WBPH stages on different age of rice plants.	85
5.1	Coefficient correlation(r) between BPH and WBPH population and environmental factors during rainy (2007) and dry (2008) seasons.	104
5.2	Coefficient correlation(r) between number of tillers with environmental factors during rainy (2007) and dry (2008) seasons.	105
5.3	Stepwise regression for planthoppers against environmental factors during rainy (2007) and dry (2008) seasons.	107
5.4	Stepwise regression for tillers against environmental factors during rainy (2007) and dry (2008) seasons.	110

LIST OF FIGURES

Figure		Page
3.1	Patterns of survivorship curve (l_x) of BPH for three (A, B and C) different cohorts	45
3.2	Daily age-specific survival (l_x) and fecundity (m_x) of female BPH fed on rice plants	50
3.3	Patterns of survivorship curve (l_x) of WBPH for three (A, B and C) different cohorts	55
3.4	Daily age-specific survival (l_x) and fecundity (m_x) of female WBPH fed on rice plants	60
4.2.1	Daily pattern of movement of different stages of BPH on 30 (A), 45 (B) and 60 (C) days old rice plants.	89
4.2.2	Water temperature recorded according to time.	90
4.2.3	Daily pattern of movement of different stages of WBPH on 30 (A), 45 (B) and 60 (C) days old rice plants.	92
5.1	Population abundance of BPH and WBPH on rice plant in relation to numbers of tillers per hill, rainfall, temperature and relative humidity at Hmawbe rice field between July 2007-April 2008.	100

LIST OF APPENDICES

Table		Page
APPENDIX 1		
1	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of rice plants caused by different stages of BPH in feeding preference with (non-choice experiment).	152
2	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 30 days old rice plants caused by different stages of BPH in feeding preference with (non-choice experiment).	152
3	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 45 days old rice plants caused by different stages of BPH in feeding preference with (non-choice experiment)	152
4	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 60 days old rice plants caused by different stages of BPH in feeding preference with (non-choice experiment)	153
APPENDIX 2		
1	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of rice plants caused by different stages of WBPH in feeding preference (no-choice experiment)	154
2	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 30 days old rice plants caused by different stages of WBPH in feeding preference (no-choice experiment)	154
3	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 45 days old rice plants caused by different stages of WBPH in feeding preference (no-choice experiment)	154
4	Analysis of variance for mean diameter of feeding lesions (mm) on different ages of 60 days old rice plants caused by different stages of WBPH in feeding preference (no-choice experiment)	155

experiment)

APPENDIX 3

- | | | |
|---|--|-----|
| 1 | Analysis of variance for total number of feeding lesion on different age of plant caused by different stages of BPH in feeding preference with non- choice experiment | 156 |
| 2 | Analysis of variance for total number of feeding lesion on different age of plant caused by different stages of WBPH in feeding preference with non- choice experiment | 156 |

APPENDIX 4

- | | | |
|---|---|-----|
| 1 | Analysis of variance for diameter of feeding lesion on different age of plant caused by BPH in feeding preference with choice experiment | 157 |
| 2 | Analysis of variance for diameter of feeding lesion on different age of plant caused by WBPH in feeding preference with choice experiment | 157 |

APPENDIX 5

- | | | |
|---|--|-----|
| 1 | Analysis of variance for total number of feeding lesion on different age of plant (30, 45 and 60) leaf sheath and leaf blade caused by BPH in feeding preference with choice experiment | 158 |
| 2 | Analysis of variance for total number of feeding lesion on different age of plant (30, 45 and 60) leaf sheath and leaf blade caused by WBPH in feeding preference with choice experiment | 158 |

APPENDIX 6

1	Analysis of variance for Mean movement (cm) of BPH stages at different ages of 30 day old rice plants.	159
2	Analysis of variance for Mean movement (cm) of BPH stages at different ages of 45 day old rice plants.	159
3	Analysis of variance for Mean movement (cm) of BPH stages at different ages of 60 day old rice plants.	159

APPENDIX 7

1	Analysis of variance for Mean movement (cm) of WBPH stages at different ages of 30 day old rice plants.	160
2	Analysis of variance for Mean movement (cm) of WBPH stages at different ages of 45 day old rice plants.	160
3	Analysis of variance for Mean movement (cm) of WBPH stages at different ages of 60 day old rice plants.	160

LIST OF ABBREVIATIONS

%	Percent
°C	Degree Celcius
ANOVA	Analysis of Variance
cm	Centimeter
cm ²	Centimeter Square
cohort	an initial number or unit of individual insects used in the study on life table in which its development is recorded from birth until the last member is dead
distribution	the position, arrangement, or frequency of occurrence (as of the members of a group) over an area or through a space or unit of time
DAT	days after transplanting
DT	doubling time
efficiency	effectiveness of the predator in affecting coexistence of the prey
ETL	Economic Threshold Level
fecundity	a measure of the total egg production by a female (Southwood, 1979)
fertility	the number of viable eggs laid by a female (Southwood, 1978)
functional response	the form of an increasing number of prey eaten per predator as prey density increases, at least up to some limiting value representing maximum prey consumption within a prescribed time.
life cycle	total number of days of immature stadia, egg, larva and pupa (for MS) or nymphal instar (for AG)
life table	tabulation presenting complete data on the mortality and fecundity schedule of a cohort

G	Gram
h	Hour
ha	Hectare
HSM	Hari Selepas Menyemai/Menanam
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
Kg/ha	Kilogram per Hectare
LSD	Least Significant Difference
m	Meter
mm	Millimeter
ns	Not Significant
RH	Relative Humidity
SAS	Statistical Analysis System
sp.	Species
TN-1	Taichung Native 1
UPM	Univeristi Putra Malaysia
WAT	Week After Transplanting