

UNIVERSITI TEKNOLOGI MARA

**THE EFFECTIVENESS OF ETYHL
FORMATE TO CONTROL BEETLES
OF STORED MILLED RICE AND
RELATIONSHIP TO EATING
QUALITIES OF RICE**

NUR'AMIRA BINTI HAMID

Thesis submitted in fulfillment
of the requirements for the degree of
Master of Science


Faculty of Plantation and Agrotechnology

September 2016

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulation of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulation for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Nur'Amira Binti Hamid
Student I.D No	:	2011785233
Programme	:	Master of Science (Entomology)-AT 780
Faculty	:	Plantation and Agrotechnology
Thesis Tittle	:	The Effectiveness of Ethyl Formate to Control Beetles of Stored Milled Rice and Relationship to Eating Qualities of Rice.
Signature of Student	:	
Date	:	September 2016

ABSTRACT

Ethyl formate was tested both in laboratory and in polyvinyl chloride tent fumigation for disinfesting milled rice to control *Sitophilus oryzae*, *Tribolium casteneum*, *Oryzaephilus surinemensis* and *Rhyzopertha dominica*. The laboratory experiments were to verify the effective gas exposure time and the lethal concentration to kill 99% of the population (LC_{99}). Milled rice fumigation in 1-tonne polyethylene bags with test insects was to assess procedure for field application for bagged rice during storage, the effective concentration, exposure time, and effect on eating quality of the cooked rice. The LC_{99} and the calculated Ct product from laboratory studies conducted in desiccators for *Tribolium casteneum* was respectively 50.72 mgL^{-1} , 239.00 mghL^{-1} ; *Oryzaephilus surinemensis* 26.22 mgL^{-1} , 158.5 mghL^{-1} ; *Sitophilus oryzae* 50.22 mgL^{-1} , 239 mghL^{-1} ; and *Rhyzopertha dominica* 26.83 mgL^{-1} , 83.94 mghL^{-1} . Based on least susceptible *Tribolium casteneum*, milled rice fumigation requires 291.9 gm^{-3} to achieve LC_{99} and Ct product 162.5 ghm^{-1} after 24 hour; 227.6 gm^{-3} and 562.0 ghm^{-3} for 48 hour. It is recommended $230\text{-}300 \text{ gm}^{-3}$ concentration range and 48 hour exposure period be adopted to ensure effectiveness against all species and insect stages in milled rice fumigation. The eating quality of cooked rice in terms of the aroma, stickiness, taste, colour and overall acceptability was not affected from the multiple exposure (3 times) to the ethyl formate. Findings from this study indicated ethyl formate is a potential replacement for methyl bromide and phosphine but it is recommended that the compressed fumigant with carbon dioxide can be used for commercial application to improve evaporation and gas penetration within fumigated space of the liquid formulation used in this study.

TABLE OF CONTENT

	Page
CONFIRMATION BY PANEL OF EXAMINER	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENT	vi
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF PLATES	xiii
LIST OF SYMBOLS	xiv
LIST OF ABBREVIATIONS	xv
CHAPTER ONE: INTRODUCTION	
1.1 Background of Study	1
1.2 Problem Statement	4
1.3 Significant of Study	4
1.4 Research Objectives	5
1.5 Hypothesis	5
CHAPTER TWO: LITERATURE REVIEW	
2.1 Grain Storage	6
2.1.1 Grain Storage in Malaysia	8
2.1.1.1 Silo Storage Practice in Malaysia	9
2.1.1.2 Imported Grain (Bulk) Storage	10
2.1.1.3 Local (Paddy) Bulk Storage	10
2.1.1.4 Local (Paddy) Bag storage	11
2.2 Insect Pests of Stored Grain	12
2.3 Insect Pests Management Grain Storage	18
2.4 Pest Control in Grain Storage in Malaysia	20
2.4.1 Mechanical and Physical Insect Control Methods in Grain	22

Storage.	
2.4.2 Cultural Control in Stored Grain Pests	23
2.4.3 Biological Control in Stored Grain Pests	23
2.4.4 Chemical Control in Stored Grain Pests	23
2.4.5 Integrated Pest Management (IPM)	25
2.5 Problems of Pest Management in Grain Storage.	27
2.6 Fumigation as Pest Control Technique	28
2.6.1 Fumigant	28
2.6.2 Standard Procedure for Fumigation (Assessment and Annex, 2013)	36
2.6.3 Fumigation Technique for Common Grain Storage Type	38
2.6.3.1 Silo	38
2.6.3.2 Bulk Loose Grain in Store	39
2.6.3.3 Bag Stack Grain	39
2.6.4 Criteria and successful fumigation	39
2.6.4.1 Gas-tightness	39
2.6.4.2 Gas Circulation	40
2.6.4.3 Achieving Concentration X Times (Ct Product)	40
2.6.4.4 Temperature	41
2.6.5 Limitations with fumigation	42
2.6.5.1 Insect Resistance	43
2.6.5.2 Environmental Safety	44
2.6.6 Ethyl Formate Characteristics	44
2.6.6.1 Ethyl Formate Fumigation	44
2.6.6.2 Ethyl Formate Residue	48

CHAPTER THREE: MATERIALS AND METHOD

3.1 Experimental Approach	51
3.2 Insect Culture	52
3.3 Ethyl Formate	53
3.4 Effectiveness of Ethyl Formate Under Laboratory Conditions	53
3.4.1 Pre-Fumigation Preparation	53
3.3.2 Fumigation Technique	53
3.4.3 Experimental Design and Treatments	54
3.4.4 Statistical Analysis	55