

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

ABSTRACT

Ethyl formate was tested both in laboratory and in polyvinyl chloride tent fumigation for disinfecting milled rice to control *Sitophilus oryzae*, *Tribolium casteneum*, *Oryzaephilus surinensis* and *Rhyzopertha dominica*. The laboratory experiments were to verify the effective gas exposure time and the lethal concentration to kill 99% of the population (L_{c99}). 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 L_{c99} 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 surinensis* 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 L_{c99} 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.

ACKNOWLEDGEMENT

In the name Allah, the most Gracious and the Most Merciful who has given me the determination and strength to complete this work. First and foremost, I would like to express my deepest gratitude to my supervisor Dr Ab. Rahim bin Muda for his guidance, patience and support towards the completion of this thesis. I also would like to thank the staff of MARDI especially Haji Mohd Rasali bin Musa for his assistance throughout the laboratory and fieldwork, and the Director General of MARDI for providing facilities, materials and information on pest control and fumigation .

My thanks also go to Universiti Teknologi MARA and Kementerian Pendidikan Tinggi for the financial support during my study. My infinite thanks also goes to my colleagues and friends for helping me with this project.

Special thanks to my husband Muhamad Faizal Awi and children Muhamad Adam Fitri and Muhamad Adi Fawwaz for their unfailing encouragement in pushing me to complete my study.

Finally to my late father Hamid bin Awang, my mother
and my little brothers for emotional support and confidence. Amin.

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 |

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Fumigation is a pest control method that utilizes gas to disinfest any pests within a confined, sealed space. All form of pests are expected to be affected by a fumigant (e.g., invertebrate including arthropod, microorganisms, vertebrate, etc) thus in global commercial trade this control method is widely used to ascertain zero live organism presence in an export commodity from one country to another. In pest control industry fumigation is employed mainly as soil disinfectant where other control measures are less effective compared to high vapour active gas such as methyl bromide which can penetrates deep into every inter-granular space within an enclosed area. The United States of America (U.S) is the country that relies heavily on fumigation to disinfest all soil borne pathogen prior planting of certain type of short-term fruits. Another sector that employ fumigation technique is in the “urban” pest control such as for phytosanitary (quarantine) treatment of export commodities, disinfesting structural (building) and stored (dried) agricultural commodities, mainly cereal grains. A fumigant is formulated for application either in the form of solid (pellet/tablet/sachets as the case of phosphine gas), or liquefied gas (methyl bromide) or as liquid as in other less known chemicals with fumigative characteristics. In fumigation procedure the gas is dispensed into an enclosure that is sealed to an adequate standard; the fumigant then is left inside for a specific duration to ensure sufficient time for complete volatization, gas dispersement, and gas reaching all of targeted organisms within the treated space. The gas exposure period is followed by safe airing of the residual gas from the enclosure which signals completion of fumigation. With prevailing increased public concern over the adverse effects of pesticide chemicals on human health and the environment, fumigation can be considered the only chemical pest control method that is residue-free upon completion of the treatment procedure.

In Malaysia most fumigation is being use for phytosanitary treatment, followed by structural and food commodity disinfestations, particularly milled rice.