

UNIVERSITI TEKNOLOGI MARA

**EFFECTS OF NITROGEN AND
POTASSIUM COMBINATION
TREATMENTS ON GROWTH,
NUTRIENT ECONOMY, YIELD
POTENTIAL AND ZERUMBONE
CONTENT OF *Zingiber zerumbet* (L.)
Smith**

SITI NURUL ATIKAH BINTI ABU SAMAH

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

Faculty of Plantation and Agrotechnology

June 2020

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations 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 Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student : Siti Nurul Atikah binti Abu Samah
Student I.D. No. : 2015634908
Programme : Master of Science (by Research) – AT750
Faculty : Plantation and Agrotechnology
Thesis Title : The Effect of Nitrogen and Potassium Combination
Treatments on Growth, Nutrient Economy, Yield
Potential and Zerumbone Content of *Zingiber
zerumbet* (L.) Smith

Signature of Student : 

Date : June 2020

ABSTRACT

Zingiber zerumbet (L.) Smith or also is known as pine cone ginger has been extensively studied because of its tremendous medicinal benefits. However, little knowledge is available on the cultivation science of this species grown under humid tropical environment which lead to varying rhizome and zerumbone yield depending on practices. Growth and Yield are generally limited by fertilization formulation and amount in particular nitrogen (N) and potassium (K). The objective of this study was to quantify the overall growth, biomass production, phenological development, nutrient uptake and rhizome yield expressed as fresh weight or zerumbone content as affected by N and K fertilization levels. A field study was carried out at the Botanical Garden Shah Alam, Selangor, Malaysia from February 2016 to January 2017. The experiments were designed as a factorial experiment consisting of two N levels and four K levels, with a total of eight treatment combinations. The N levels were normal – 60 and high – 120 kg N ha⁻¹ and the K levels were 0, 60, 120 and 180 kg ha⁻¹ for each N level, while phosphorus (P) level was kept constant at 70 kg ha⁻¹. A total of 1120 plants were planted in Randomized Complete Block Design (RCBD) with four replications. The sampling plants consisted of 256 plants with the rest of the other plants (864) were used as guard rows. Seven principal growth stages namely bud and leaf development, formation of stem or tillering, peduncle elongation, inflorescence emergence, flowering and inflorescence senescence were distinctively defined. A growing degree day (GDD) of 373 - 390°C-d and 474 - 510°C-d were required for the formation of the first leaf and tiller while a GDD of 2246 - 2332°C-d for flower blooming. In general, the results showed that both N and K were important for the overall growth, however, their effects differed with growth parameters and stages. The high K rates (120 and 180 kg ha⁻¹) had significantly increased the plant height, primary root number, leaf dry mass (LfDM), stem dry mass (StDM), total root dry mass (TotRtDM), primary root dry mass (PriRtDM), leaf area (L_A), leaf mass ratio (LfMR), stem mass ratio (StMR), total root mass ratio (TotRtMR), rhizome mass ratio (RhMR), root to shoot ratio (R/S), leaf area ratio (LAR) and specific leaf area (SLA) at mainly active tillering stage (186 DAT). The high K rates also significantly increased the new rhizome P, leaf and stem K concentrations and leaf and stem K content at mainly maturity stage (290 days after transplanting (DAT)). Conversely, the K effect was significant in zerumbone content across harvest and total zerumbone yield at the rhizome expansion stage (237 DAT) under zero K rate (0 kg ha⁻¹). The amount of nutrient taken up was the highest in N followed by K and P for both rhizome expansion and maturity stages. In general, as the N and K level increased, the biomass production, partitioning and nutrient concentrations and contents and zerumbone content were increasing. These results are important for better cultivation practices of *Z. zerumbet*.

ACKNOWLEDGEMENT

Alhamdulillah and praise to Allah the Almighty, by whose Grace and Permission that I was able to complete this thesis. I wish to express my sincere gratitude and appreciation to my supervisor, Dr. Mohd Yusoff Abdullah for his supervision, guidance, critiques, advices, encouragement and endless patience throughout the course of my study. My gratitude also goes to my co-supervisor, Dr. Nor Azma Yusuf for her supervision and guidance.

I would like to express my sincere gratitude to En. Asriya from The Herbal Unit, Department of Agriculture Pontian, Johor for providing information and planting materials and The Botanical Garden Shah Alam for providing experimental field plot for the study. Also, to Prof. Dr. NorZulaani Khalid, Dr Zuwairi Saiman, Nurul Huda Alwakil and Gayatri from Plant Biotechnology Research Lab, University of Malaya for their assistance and guidance throughout my stay in their lab. I would like to thank En Shahfie Md Latep and all laboratory staff from the Faculty of Plantation and Agrotechnology Campus Puncak Alam and Jasin, Universiti Teknologi MARA (UiTM) for their help, cooperation and guidance in conducting the experiments. My deepest appreciation goes to Faculty of Plantation and Agrotechnology, UiTM for the research facilities.

I dedicated this thesis to my beloved family, Abu Samah Mobarak and Marpungah Mohd Sidek for financial support, guidance and endless prayers and motivation, and to my beloved siblings, Siti Nor Balkis, Mohd Suhaimi Ismail, Mohd Khairulna'im, Nor Eamy Fadila Masani, Mohd Nor Ghani, Siti Nor Muslihah and Siti Nor Asmah for their willingness and involvement in the field and laboratory works.

Last but not least, to all my dear friends; Khairunnisa Abd Ghani, Nurul Hidayah Khairlani, Mohd Faiz Ibrahim, Nur Yasmin Mohd Fauzi, Syahira Mansor, Noor Shafifiyaz Yazid, Noraniza Kadir, Nur Hazreena Muhammad Ali, Hafizuddin Md Hashim and Nik Harith Nik Abd Halim for their continuous support and encouragement.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	II
AUTHOR'S DECLARATION	III
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	xii
LIST OF FIGURES	xiv
LIST OF PLATES	xv
LIST OF SYMBOLS	xvii
LIST OF ABBREVIATIONS	xviii
LIST OF NOMENCLATURE	xx
CHAPTER ONE: INTRODUCTION	1
1.1 Background of study	1
1.1.1 The herbal industry in Malaysia	1
1.1.2 Research on Zingiberaceae in Malaysia	3
1.1.3 <i>Zingiber zerumbet</i> (L.) Smith	3
1.1.4 Nitrogen and potassium in relation to yield and bioactive compound production	4
1.1.5 Phenological development and thermal time requirement	4
1.1.6 Bioactive compounds in <i>Zingiber zerumbet</i> (L.) Smith	5
1.2 Problem statement	5
1.3 Research objectives	6
1.4 Research questions	6
1.5 Hypotheses	7
1.6 Scope of study	7
1.7 Limitation of study	8
1.8 Significance of research	8