GROWTH RESPONSE OF DIFFERENT OIL PALM SEEDLING PARENTAGE TOWARDS CHEMICAL FERTILIZER TREATMENT

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DEDICATION

Dedicated to my beloved parents; Mahidah binti Md Tap and Abbas bin Mohd Said; my supervisor, Dr Fazilah Abd Manan and Associate Prof Dr Chong Chun Shiong; my family, friends, and all the lecturers and teachers, all of whom helped me reach where I am today.

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ABSTRACT

Oil palm (*Elaeis guineensis*) requires a sufficient amount of chemical fertilizer to sustain their growth and development. To date, many oil palm varieties are available commercially. These varieties may experience insufficient or excessive fertilization as their specific nitrogen and potassium requirements are not fully elucidated. This research aimed to determine the effects of different nitrogen-potassium (NK) fertilizer levels on oil palm morphological characteristics, foliar nutrient content (FNC) and nitrate reductase (NR) activity of six oil palm seedlings of different parentage. Oil palm progenies designated as A-F was planted at the test plots and supplied with three NK fertilizer levels designated as T0 (0 kg Ammonium Sulphate (AS) and 0 kg Muriate of Potash (MoP) per palm), T1 (2.7 kg AS and 1.75 kg MoP per palm) and T2 (5.4 kg AS and 3.5 kg MoP per palm). Our findings indicated minimal impact of fertilizer application on oil palm growth rate. A significant ($p<0.05$) increase was observed in foliar nitrogen and potassium content from T1 fertilization with an average of 28% and 32%. Whereas, T2 caused only a small overall increase of 5% and 7%, respectively. Similar NR activity was recorded in most of the seedlings showing a reduced activity at the average of 18% when treated with T1 while drastically elevated when treated with T2 with a 41% overall increase. The similarity in parentage of each oil palm seedling plays a significant role in the overall reaction of seedlings towards fertilization. Although fertilization may not have a significant observable impact towards growth and foliar nutrient content, a significant response can be seen in the nitrate reductase reaction of the seedlings. Overall, the study indicates a slight favour towards T1 treatment based on the overall response of the seedlings.

ABSTRAK

Kelapa sawit (*Elaeis guineensis*) memerlukan baja kimia yang mencukupi untuk mengekalkan tumbesaran dan perkembangannya. Kini, terdapat pelbagai jenis varieti kelapa sawit dalam pasaran. Jenis-jenis varieti kelapa sawit ini mungkin mengalami pembajaan yang tidak mencukupi atau pembajaan berlebihan memandangkan keperluan nutrien masing-masing tidak diketahui sepenuhnya. Kajian ini bertujuan mengenalpasti kesan tahap berbeza baja nitrogen-kalium ke atas ciri-ciri morfologi, kandungan nutrien daun dan aktiviti enzim nitrat reduktase (NR) enam anak pokok kelapa sawit yang berbeza bakanya. Progeni kelapa sawit yang dilabel A-F telah ditanam pada petak kajian dan diberikan tiga tahap baja NK yang ditetapkan sebagai T0 (0 kg Amonium Sulfat (AS) and 0 kg Kalium Klorida (MoP) sepokok), T1 (2.7 kg AS and 1.75 kg MoP sepokok) dan T2 (5.4 kg AS and 3.5 kg MoP sepokok). Dapatan kajian menunjukan pemberian baja telah memberikan impak yang minimum terhadap perkembangan kelapa sawit. Peningkatan yang mendadak telah didapati pada kandungan nitrogen dan kalium pada daun selepas pembajaan T1, masing-masing dengan purata sebanyak 28% dan 32. Bagaimanapun, pembajaan T2 membawa peningkatan yang sedikit, masing-masing pada 5% dan 7 %. Enzim NR menunjukkan tahap aktiviti yang serupa di kalangan anak pokok yang diuji dengan pengurangan purata yang ketara sebanyak 18% apabila dibaja dengan T1 tetapi peningkatan mendadak dengan purata sebanyak 41% apabila dibaja dengan T2. Keturunan anak pokok memainkan peranan besar dalam persamaan kepada tindak balas anak pokok terhadap pembajaan. Walaupun tidak terdapat tindak balas ketara terhadap tumbesaran dan kandungan nutrien, terdapat tindak balas ketara pada reaksi aktiviti enzim nitrat reduktase anak pokok. Secara keseluruhan, kajian ini menunjukkan sedikit keserasian kepada pembajaan T1 berdasarkan reaksi keseluruhan bahan penanaman.

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LIST OF ABBREVIATIONS

AAR	-	Advanced Agriecological Resources
$AlCl_3$	-	Aluminium chloride
$AlCl_3.6H_2O$	-	Aluminium chloride hexahydrate
AMT	-	Ammonia transporters
ANOVA	-	Analysis of variance
AS	-	Ammonium sulphate
AVROS	-	Algemeene Vereniging van Rubber Planterster Oostkustvan Sumatra
B	-	Boron
BPRO	-	Breeding populations of restricted origin
BRP	-	Bayovar Rock Phosphate
C	-	Carbon
CO_2	-	Carbon dioxide
COVID 19	-	Coronavirus disease
DAP	-	Diammonium phosphate
DNA	-	Deoxyribonucleic acid
DOA	-	Department of Agriculture
D×P	-	Tenera oil palm hybrid
et al	-	And others
Fertibor	-	Boron fertilizer
Fe	-	Iron
GCA	-	General combining ability
H_20	-	Water
H_20_2	-	Hydrogen peroxide
H_2SO_4	-	Sulphuric acid
HCl	-	Hydrochloric acid
HNO_3	-	Nitric acid
K	-	Potassium
KNO_3	-	Potassium nitrate
KNO_2	-	Potassium nitrite

KS	-	Kieserite
LAI	-	Leaf area index
Mg	-	Magnesium
Mo	-	Molybdenum
MoP	-	Muriate of potash
N	-	Nitrogen
NADH	-	Nicotinamide adenine dinucleotide
Na_2CO_3	-	Sodium carbonate
$NaNO_2$	-	Sodium nitrite
NaOH	-	Sodium hydroxide
NEDD	-	N-(1-naphthyl)ethylenediamine dihydrochloride
NH_3	-	Ammonia
NH_4	-	Ammonium
NH_4^+	-	Ammonium ions
$(NH_4)_2SO_4$	-	Ammonium sulphate
NK	-	Nitrogen-Potassium
NO	-	Nitrogen oxide
NO_3^-	-	Nitrate
NO^{-2}	-	Nitrite
NOS	-	NO synthase
NR	-	Nitrate reductase
NRT	-	Nitrate transporters
O_2	-	Oxygen
P	-	Phosphorus
RAPD	-	Random amplified polymorphic DNA
RM	-	Ringgit Malaysia
SIRIM	-	Standard and Industrial Research Institute of Malaysia
SPSS	-	Statistical Package for the Social Sciences
S	-	Sulphur
T0	-	Treatment 0 (Control)
T1	-	Treatment 1
T2	-	Treatment 2
USD	-	United States Dollar

UV	-	Ultraviolet

LIST OF SYMBOLS

=	-	Equal
+	-	Plus
±	-	Plus minus
%	-	Percent
×	-	Times
-	-	Minus
°C	-	Degrees Celsius
µg/mL	-	Microgram per millilitre
g	-	Gram
Kg/palm	-	Kilogram per palm
min	-	Minute
mL	-	Millilitre
mm	-	Millimetre
nm	-	Nanometre
pH	-	Potential hydrogen

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Oil palm (*Elaeis guineensis*) is an important commercial crop in Malaysia and has shaped the national economic landscape for nearly a century. Suitable climate conditions and soil composition enabled the first commercial oil palm estate to be opened here in 1917 (Jagoe, 1952). Since then, even with the economic challenges brought by the coronavirus disease (COVID-19) Malaysia still remains an important player in the global vegetable oil industry, remaining the 4th largest producer of oils and fats in 2020 accounting for 8.1% of total global production. Oil palm economic importance to Malaysia is still significant, reaching 26.59 million tonnes of oil palm product exports and amounting to RM 73.25 billion in export earnings in 2020 (Parveez *et al.*, 2021).

Plantations and businesses in the palm oil industry use a variety of methods to keep up with increasing demand. One of the most important focuses for crop productivity is variation in seedlings such as planting different oil palm varieties and using different rates of fertilizer treatments. These are done to identify the most suitable seedling variety and fertilizer applications that cater to specific regional climate and soil conditions which enables better growth and development of oil palm crops.

Some research to elucidate the interactions of these parameters and its effects have been done with varying results. When subjected to different rates of fertilizer application, different performance in terms of fresh fruit bunch weight has been observed on multiple studies (Kushairi *et al.*, 2001; Rao, 2009; Sanputawong *et al.*, 2017). Different seedling variety also provide different nutrient input to the plant and directly affect the yield and vegetative parameters (Law *et al.*, 2014). Thus, the

utilization of seedling varieties and fertilizers leads to significant improvement in the overall performance of oil palm crops but studies with regards to how it impacts both on growth and foliar properties when these parameters are manipulated remains not investigated. This study broadly aims to understand the relationship between different oil palm seedling varieties and chemical fertilizer application primarily in terms of growth and foliar responses as well as identify the most suitable fertilizer for each seedling.

1.2 Problem Statement

Seedling variety and fertilizers play an important role in maximizing the productivity of commercial crops with emphasis towards oil palm. In adapting to different soil and environmental conditions, plantations use different oil palm varieties and ratios of fertilizer application to increase productivity of oil palm plantations. These seedling varieties may have different nutritional requirements and require a distinct level of fertilization to ensure optimal growth. Seedlings may undergo insufficient fertilization that can impair plant growth or excessive fertilization that may cause toxicity as their specific nutrient requirement is widely unknown. This research aimed to elucidate the effects of different fertilizer concentrations on the growth and foliar properties of different oil palm seedling varieties to provide data in identifying the most suitable fertilizer level with regards to individual seedling variety.

1.3 Research Objectives

The objectives of this research: -

(1) To determine the impact of different fertilizer treatments on the growth of oil palm varieties.

(2) To determine the foliar nutrient content of oil palm varieties treated with different fertilizer applications.

(3) To determine the effect of different fertilizer treatments on nitrate reductase activity in leaves of oil palm varieties.

(4) To describe the interaction and relationship between foliar nutrient content and nitrate reductase activity when subjected to different fertilizer concentrations.

1.4 Scope of Research

While extensive research on oil palm cultivation has been performed to address various aspects of the industry, focus on newly cultivated oil palm seedlings and how its responses to different level of fertilization has remain widely unknown. The study aims to shed some light into the interactions of both oil palm seedlings and levels of fertilization with emphasis towards morphological growth and foliar properties.

The study involves utilising 6 types of oil palm seedlings that were planted in a test plot owned by collaborators, Applied Agricecological Resources (AAR) Sdn. Bhd located in Telok Sengat, Johor. Morphological data including height, girth, number of green fronds, frond length and number of pinnae was taken on site and leaf samples were stored and brought to a laboratory in Universiti Teknologi Malaysia (UTM) in Skudai, Johor for analysis. Each oil palm plant was physically measured to evaluate growth while leaf samples were collected and analysed in the laboratory to determine its foliar nutrient content and nitrate reductase activity.

1.5 Significance of Research

The findings of this research helped provide new insight and improve current understanding of how growth, foliar nutrient content and nitrate reductase activity are affected in oil palm seedlings that have been subjected to different fertilizer treatments. This will help tailor individual oil palm plants to better fertilization regime to increase its productivity and health.

It also highlighted the importance of proper amount of fertilizer as improved fertilizer management will reduce adverse effects and wastage. This will help important oil palm industry players from large plantations to small shareholders to save on economical usage of fertilizer and better enact sustainable agricultural practises.

Lastly, this study will aid in future work involving new varieties of oil palm seedlings as well as understanding how fertilization may impact the inner biochemical reactions of oil palm plants. This will help further increase our understanding of one of the primary sources of edible oil in facing increasing demands and possible climate change in the future.

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