



UNIVERSITI PUTRA MALAYSIA

***CLASSIFICATION AND ASSESSMENT OF EFFECTIVE DORMANCY
BREAKING METHODS FOR OIL PALM (*Elaeis guineensis* Jacq.) SEEDS***

MOHD NORSAZWAN BIN GHAZALI

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METHODS FOR OIL PALM (*Elaeis guineensis* Jacq.) SEEDS**

By

MOHD NORSAZWAN BIN GHAZALI



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

August 2016

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement of the degree of Master of Science

CLASSIFICATION AND ASSESSMENT OF EFFECTIVE DORMANCY BREAKING METHODS FOR OIL PALM (*Elaeis guineensis* Jacq.) SEEDS

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August 2016

Chairman: Associate Professor Adam bin Puteh, PhD

Faculty : Agriculture

Oil palm seeds require more than six months to germinate under natural condition. Commercial seed producers have adopted heat treatment to break oil palm seed dormancy. However, no particular studies have been conducted to systematically determine and classify oil palm seed dormancy type.

In the first experiment, different method to evaluate dormancy type were conducted on T × T (*tenera* × *tenera*) and D × P (*dura* × *pisifera*) seeds. This includes physical, morphological and physiological dormancy tests. Physical dormancy tests included imbibition of intact (control), chemical (soaking with 98% sulphuric acid for two minutes) and mechanically scarified (fibre plug removal and puncturing testa layer by using steel probe), as well as heat treated (40°C treatment for 50 days) seeds to determine percentage of mass increase over time. Morphological dormancy characteristics were evaluated by storing the seeds at room temperature for 32 weeks to monitor embryo growth (length and width) as well as the resulting germination percentage. The effects of heat treatments were also studied by incorporating 30 days heat treatment, 50 days heat treatment or control (no heat treatment) before measuring the embryo growth and germination percentage. Physiological dormancy was evaluated by pre-soaking the seeds in 150 mg L⁻¹ GA₃ (gibberellic acid) and monitoring germination at room temperature or 30°C condition. Results indicated that the seeds were unable to imbibe water, regardless of scarification treatments. This suggests that oil palm seeds exhibit physical dormancy characteristics. Morphological tests on seeds at room temperature indicated that an embryo length of 3.64 or 3.03 mm was required to initiate germination in T × T and D × P seeds, respectively. The applications of heat treatments (40°C) were able to accelerate embryo growth, regardless of treatment duration. On the other hand, application of exogenous GA₃ did not significantly increase germination during physiological dormancy test. The results indicate that oil palm seed exhibits combination of physical, morphological and physiological dormancy type.

In the second experiment, alternative methods to break oil palm seed dormancy of T × T, D × P EBOR and D × P ELMINA were evaluated based on dormancy type

determined from the first experiment. This include adoption of higher temperature treatment (50°C), alternating temperature regimes of high (40°C) and low (7°C) for different duration; as well as combining alternating temperature regimes of high (40°C) and low (7°C) temperatures with growth hormone GA₃ during germination period. The seeds were then allowed to germinate for 60 days. Parameters evaluated include percentage of normal pre-germinated seeds, percentage abnormalities, percentage of diseased seeds and Coefficient Velocity of Germination. The results indicated that adoption of alternating temperature along with exogenous GA₃ application during germination were able to result in similar percentage of normal pre-germinated seeds as the commercially practiced method, with acceptable percentage abnormalities and diseases occurrence level. . It was found also that the germination temperature should be less than 50°C due to higher abnormalities of germinated seeds as seen in the developing radicle and plumule. Cycles of alternating temperature was found to accelerate embryo growth prior to germination as it potentially alters the overall hormonal balance particularly leading to reduction of ABA (abscisic acid) and higher production of GA hormone during germination. This study suggests that there are alternative methods that can be adopted to break oil palm seed dormancy based on prior understanding of the exact dormancy type underlying the seeds.

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENGELASAN DAN PENILAIAN KAEDAH EFEKTIF PEMECAHAN DORMANSI BAGI
BIJI BENIH KELAPA SAWIT (*Elaeis guineensis* Jacq.)**

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Biji benih kelapa sawit memerlukan lebih dari enam bulan untuk bercambah dalam keadaan semulajadi. Produser biji benih komersil telah menggunakan kaedah rawatan haba bagi tujuan memecahkan dormansi biji benih kelapa sawit. Walaubagaimanapun, tiada kajian tertentu telah dilakukan sebelum ini untuk menentukan dan mengelaskan jenis dormansi bagi biji benih kelapa sawit.

Dalam eksperimen pertama, kaedah pemecahan dormansi berbeza telah dilakukan ke atas biji benih $T \times T$ (*tenera \times tenera*) dan $D \times P$ (*dura \times pisifera*). Ini termasuk ujian dormansi fizikal, morfologikal dan fisiologikal. Ujian dormansi fizikal merangkumi rendaman air ke atas biji benih yang masih sempurna (kawalan), kimia (rendaman dengan asid sulfurik 98% selama dua minit) dan dicalarkan secara mekanikal (membuang fibre plug dan membocorkan lapisan testa dengan menggunakan jarum besi), di samping rawatan haba (40°C selama 50 hari) terhadap biji benih untuk menentukan peratusan kenaikan berat terhadap masa. Ujian morfologikal dormansi telah dinilai dengan menyimpan biji benih pada suhu bilik selama 32 minggu untuk memerhatikan pertumbuhan embrio (panjang dan lebar) dan juga peratusan percambahan yang terhasil. Kesan rawatan haba turut dikaji dengan merangkumi rawatan selama 30 hari, 50 hari dan juga tanpa sebarang rawatan sebelum mengukur pertumbuhan embrio dan juga peratusan percambahan. Dormansi fisiologikal telah dinilai dengan merendam biji benih di dalam 150 mg L⁻¹ GA₃ (asid gibberelik) dan memerhatikan percambahan pada suhu bilik atau 30°C. Keputusan menunjukkan bahawa biji benih tidak boleh menyerap air, walaupun telah dicalarkan. Ini menunjukkan bahawa biji benih kelapa sawit mempunyai karakteristik dormansi fizikal. Ujian morfologikal ke atas biji benih pada suhu bilik menunjukkan bahawa panjang embrio 3.64 dan 3.03 mm adalah diperlukan untuk memulakan percambahan bagi biji benih $T \times T$ dan $D \times P$. Penggunaan rawatan haba (40°C) mampu mempercepatkan pertumbuhan embrio, tanpa mengira durasi rawatan tersebut. Akan tetapi, penggunaan GA₃ tidak berjaya untuk meningkatkan peratusan percambahan semasa ujian dormansi fisiologikal. Keputusan menunjukkan bahawa biji benih kelapa sawit mempunyai kombinasi jenis dormansi fizikal, morfologikal dan juga fisiologikal.

Dalam eksperimen kedua, kaedah alternatif untuk memecahkan dormansi bagi biji benih kelapa sawit telah dinilai berdasarkan jenis dormansi yang telah ditentukan dalam eksperimen pertama. Ini merangkumi penggunaan suhu yang lebih tinggi (50°C), suhu berbeza iaitu suhu tinggi (40°C) dan rendah (7°C) berdurasi berbeza; dan juga menggabungkan suhu tinggi (40°C) dan rendah (7°C) bersama penggunaan hormon penggalak (asid giberelik), semasa tempoh percambahan. Biji benih kemudiannya dibiarkan bercambah selama 60 hari. Parameter yang dinilai termasuk peratusan percambahan normal, peratusan tidak normal, peratusan biji benih berpenyakit, dan Coefficient Velocity of Germination. Keputusan menunjukkan bahawa penggunaan suhu berbeza bersama GA₃ semasa percambahan mampu menghasilkan peratusan percambahan normal yang sama seperti kaedah yang digunakan secara komersil, dengan peratusan tidak normal dan penyakit di tahap yang masih terkawal. Selain itu, suhu percambahan mesti kurang dari 50°C oleh kerana peratusan tidak normal yang tinggi semasa percambahan seperti yang boleh dilihat pada radikel dan plumul yang berkembang. Kitaran suhu berbeza digunakan mampu mempercepatkan perkembangan embrio sebelum percambahan kerana ia berkemungkinan mengubah kseseimbangan hormone keseluruhan terutamanya yang menjurus kearah pengurangan ABA (asid absisik) dan penghasilan GA yang lebih tinggi semasa percambahan. Kajian ini jelas menunjukkan bahawa terdapat kaedah alternatif yang boleh digunakan bagi tujuan pemecahan dormansi untuk biji benih kelapa sawit berdasarkan pengetahuan terdahulu mengenai jenis dormansi biji benih yang tepat.

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I certify that a Thesis Examination Committee has met on 30th August 2016 to conduct the final examination of Mohd Norsazwan bin Ghazali on his thesis entitled "Classification and assessment of effective dormancy breaking methods for oil palm (*Elaeis guineensis* Jacq.) seeds" in accordance with the 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 Master of Science.

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%	Percentage
°C	degree Celsius
µl	micro liter
ABA	abscisic acid
ANOVA	Analysis of variance
cm	centimeter
df	degree of freedom
FELCRA	Federal Land Consolidation and Rehabilitation Authority
g	gram
GA ₃	gibberellic acid
LSD	Least Significant Differences
Min	minute
mL	milliliter
mm	millimeter
mm ³	cubic millimeter
MPOB	Malaysian Palm Oil Board
n.s	non-significant
per mL	per milliliter
P-value	probability value
SAS	Statistical Analysis Software
S.V	source of variation
UPM	Universiti Putra Malaysia

CHAPTER I

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is known as the highest yielding oilseed in the world. On average, 4.0 metric tonnes of oil is produced per hectare of land every year, far exceeding the yield of other sources of oilseed such as soybean, sunflower and also rapeseeds (Malaysian Palm Oil Council, 2013). In Malaysia, the oil palm industry was first commercialized in 1917 at Tennamaran Estate, Kuala Selangor. Through out these years, advancement has been made in terms of development of high yielding variety of *tenera* × *tenera* (T × T), produced by *dura* × *pisifera* (D × P) hybrid planting material. T × T seeds are also used as planting material for breeding purpose through straight crossing in order to produce segregating population 1:2:1 ratio of *dura*, *tenera* and *pisifera*, respectively (Mandal and Mathur, 2015). This is particularly important in *pisifera* palm production as P × P fruitlets are generally self-sterile. Records have shown that T × T fruitlets generally contain 20% average oil extraction rate from both mesocarp and the kernel (Corley and Tinker, 2003).

The supply of D × P pre-germinated seeds are continuously needed in the oil palm nurseries and estates. In recent years, oil palm replanting programs are extensively conducted, particularly for fields that have exceeded the economic period of planting oil palm; 25 years. Besides that, supply of D × P seedlings are also required to ensure a full stand of palm trees all year round, at approximately 148 palms per hectare. It was reported that the Malaysian D × P seed production had increased from 50 million in 1995, to 88 millions seed in 2008 in order to meet the increasing demand (Kushairi *et al.*, 2010).

Currently, the production of D × P pre-germinated seeds are based on a standard guideline as described in Malaysian Standard MS 157: 2005 Oil Palm Seeds for Commercial Planting- Specification (Department of Standards Malaysia, 2005). Based on this guidelines, all licensed seed producers are required to subject all D × P seeds to 40 – 60 days of 40 ± 2°C to break to seed dormancy, before allowing the seeds to germinate at 30 ± 2°C in the germination room. Overall, approximately 130 days is needed to achieve 75% successful germination of normal pre-germinated D × P seeds. However, the seeds indicated poor uniformity during germination. The remaining 25% are usually discarded, including seeds that are either abnormally developed (radicle or plumule), infested with disease such as pathogenic brown germs, or seeds that are not germinating at all. Seed Production Unit of FELCRA Plantation Services Berhad reported that the D × P seeds requires nearly 60 days to achieve 75% germination (Samsudin, personal communication, May 12, 2014) despite the heat treatment that was applied beforehand to break the seed dormancy. Theoretically, if the dormancy-breaking method was successful, uniform germination should be observed under wide range of physical condition including temperature and humidity. This suggests that the current heat treatment method is not efficient in breaking the oil palm seed dormancy completely.

Understanding the exact dormancy type in oil palm seeds is crucial to ensure adoption of an accurate method in breaking the seed dormancy. Generally, five types of seed dormancy has been reported previously; physical, morphological, physiological,

morpho-physiological and combinational dormancy. Each different dormancy type will require a specific dormancy-breaking method. For instance, Rodrigues-Junior et al. (2013) reported that tegument removal treatment in physically dormant macaw palm (*Acrocomia aculeate*) was able to increase germination percentage with faster germination speed. Similarly, alternating temperature regimes along with physical scarification treatments that were applied on *Diplopeltis huegelii* (Australian shrub) had successfully alleviate both physical and physiological dormancy characteristics (Turner et al., 2006). Currently, no specific research has been conducted to systematically evaluate and classify the oil palm seed dormancy.

Therefore, the objectives of this study are:

1. To established the type of dormancy present in oil palm seeds
2. To evaluate the influence of alternative dormancy breaking treatments on germination of oil palm seeds

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