ASSESSING THE QUALITY OF *Jatropha curcas* L. SEEDS AS PLANTING MATERIAL IN SARAWAK

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Master of Science
2012
ASSESSING THE QUALITY OF *Jatropha curcas* L. SEEDS AS PLANTING MATERIAL IN SARAWAK

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A thesis submitted
In fulfillment of the requirements for the
Master of Science
(Botany)

FACULTY OF RESOURCE SCIENCE AND TECHNOLOGY
UNIVERSITI MALAYSIA SARAWAK

2012
DECLARATION

I hereby declare that no portion of the work referred to this thesis have been submitted in support of an application for another degree of qualification to this or any other university of institution of higher learning.

(Sivasangari A/P Jagatheeswaran)

Date:
I am grateful to the God for His grace, blessings, and the strength granted to me to complete this study. I would like to express my sincere appreciation and gratitude to my family and also to Prof Madya Dr Petrus Bulan, for his supervision, guidance, support, and tolerance throughout this study. His understanding and patience in this study were most comforting.

I would also like to acknowledge the contribution made by Dr. Siti Rubiah Zainudin for her meticulous and constructive comments on the dissertation.

Special thanks to all the staff at Faculty of Resource Science and Technology, UNIMAS, especially M. Nurfazillah and Fatimah Daud for their assistance. I also wish to extend my appreciation to Carbon Capitol Sdn Bhd, Sadong Jaya Kota Samarahan, Sarawak, for providing me with the seed materials and information for my study.

Thank you so much to all my friends for their help in one way or another also aided in the successful completion of this study.
ABSTRACT

A study was conducted to evaluate the quality of *Jatropha curcas* seeds collected from two different accessions in Sarawak. A significant seed source variation was observed in seed morphology (colour, size and weight), seed viability, germination, moisture content, seeds storability, priming treatments, accelerated ageing, seed oil percentage and early growth performance of seedling. The seeds from Bintulu, Samarahan and control were dehydrated in silica gel for 0, 24, 48, 72, 96 and 120 hours then stored in six different environments for the basic seed storage; ambient room (28–30 °C), air-conditioned room (22–24 °C), refrigerator (3–5 °C), incubator (35–40 °C), freezer (0–4 °C) and liquid nitrogen (-196 °C) for 4 months. Three types of priming treatment used were the hydroperving, osmopriming and thermopriming. The average fresh weights of 10 seeds were 8.02 g, 5.94 g, 7.55 g respectively, for Bintulu, Samarahan and Control seeds. Oil content was 36.75% in Bintulu, 30.37% in Samarahan and 35.49% in Control. Preliminary evaluation conducted indicated that moisture content was 18.92% for Bintulu, for 13.91% Samarahan and 17.07% for Control. Germination was 74.88, 50.10, and 70.5% for Bintulu, Samarahan and Control respectively. Viability for Bintulu, Samarahan and Control seeds were 80, 60 and 82% respectively. The dehydrated seeds at 48 hours were found successful after storing at all types of environment. The highest germination and viability percentage was obtained with seeds stored in liquid nitrogen. Seeds of *J. curcas* in liquid nitrogen can be stored for 163, 159, 177 days for Bintulu, Samarahan and control seeds respectively. The germination and viability percentages of *J. curcas* seeds from Bintulu were highest when the seeds were thermoprimed in water at 40 °C as compared to other priming treatments. At 24 hour ageing the germination percentage was the highest for both accessions. Photosynthesis rates (*A*), stomatal conductance (*g*ₜ), transpiration (*E*), and Chlorophyll content in Bintulu plant
higher than its water stress counterpart. The seeds from Bintulu responded better germination, viability, moisture content and also with greater seed weight and size as compared to the seeds from other accessions. Overall, the seeds from Bintulu are better in its seed quality, morphologically and physiologically as compared to other accessions. The positive effect has been very favorable in terms of its quality due to the plant’s potential to produce biofuel.

Keywords: *Jatropha curcas* L, storability, priming, accelerate ageing, germination, photosynthesis, moisture content.
MENILAI KUALITI BIJI BENIH JATROPHA CURCAS L SEBAGAI SUMBER PENANAMAN DI SARAWAK

ABSTRAK

Satu kajian telah dijalankan untuk mengkaji kesan penyimpanan, rawatan 'priming', penuaan buatan dan peratusan minyak terhadap kualiti biji benih Jatropha curcas Linnaeus, serta menilai ciri-ciri fizikal biji benih J. curcas. Biji benih dari Bintulu, Samarahan dan kawalan telah dehidrasi selama 0, 24, 48, 72, 96 dan 120 sebelah disimpan dalam enam persekitaran berbeza seperti suhu bilik (28-30°C), bilik berhawa dingin (22-24°C), peti sejuk (3-5°C), inkubator (35-40°C), penyelat beku (0-4°C) dan ceccair nitrogen (-196°C) selama 4 bulan. Tiga jenis rawatan 'priming' telah dijalankan iaitu 'hydropriming', 'osmopriming', dan 'thermopriming'. Berat bersih 10 biji benih adalah 8.02, 5.94, 7.55 g masing masingnya bagi biji benih dari Bintulu, Samarahan dan kawalan. Kandungan minyak dalam biji benih J. curcas adalah 36.75% di Bintulu, 30.37% di Samarahan dan 35.49% di Control. Kajian awal mendapati kandungan kelembapan biji benih adalah 18.92% bagi Bintulu, 13.91% bagi Samarahan dan 17.07% bagi kawalan. Percambahan adalah, 74.88, 50.10 dan 70.5% masing masingnya, untuk Bintulu, Samarahan dan kawalan. Keboleh-hidupan bagi biji benih Bintulu, Samarahan dan kawalan adalah 80, 60, and 82% masing masingnya. Biji benih J. curcas dapat disimpan dalam ceccair nitrogen selama 163, 159, 177 hari masing masingnya untuk sampel dari Bintulu, Samarahan dan kawalan. Percambahan dan keboleh-hidupan dalam 'thermoprimed' pada 40°C mencatat peratus tertinggi dibandingkan dengan rawatan 'priming' yang lain. Percambahan pada 24 jam penuaan buatan mencatat peratus yang tertinggi bagi semua kawasan. Kajian menunjukkan kadar fotosintesis (A), konduksi stomata (gs), transpirasi (E) dan kadar klorofil bagi biji benih dari Bintulu adalah tinggi...

Kata Kunci: Jatropha curcas L, penyimpanan, rawatan priming, penuaan buatan, fotosintesis, percambahan, kelembapan.
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<td>Photosynthesis rate</td>
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<td>AEOE</td>
<td>Aqueous enzymatic oil extraction</td>
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<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
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<td>AOSO</td>
<td>Association of official seed analysts</td>
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<td>ATP</td>
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<td>Carbon dioxide</td>
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<td>MANOVA</td>
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<td>Tetrazolium</td>
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CHAPTER 1

INTRODUCTION

1.1 Background

*Jatropha curcas* L. have the potential in bioenergy sources replace biodiesel can be used as diesel engines as pure fuel or in blends (Mathiyazhagan *et al*., 2008). *Jatropha curcas* L. belongs to family Euphorbiaceae. The botanist Carl Von Linne first classified the plant in 1753, and gave a name from the Greek word 'Jatros' means 'Doctor' and 'trophe' means 'Nutrition'. The common name for *J. curcas* is Physic Nut and in Malaysia is Jarak Pagar and the classification for this plant is under the division of Spermatophyta; sub division Angiospermae; class Dicotyledonae; order Euphorbiales; Family Euphorbiaceae; genes Jatropha; species *curcas* (Rama and Roy, 2006). It is a native of tropical America but now it is widely distributed in many tropical and sub-tropical regions especially in Asia and Africa (Keith, 2000; Jongschaap *et al*., 2007). *J. curcas* is a valuable hedge plant to Africa and Asia brought by the Portuguese traders (Heller, 1996).

*J. curcas* grows best on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content. It is found in the tropics and subtropics and likes heat, and it grows well even in lower temperatures of light frost. Physic nut is able to grow in areas with unsuitable soil and climate conditions, (Becker and Makkar, 2008; Jongschaap *et al*., 2007). Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves. The current distribution shows its introduction in the drier regions of the tropics with annual rainfall of 300-1000 mm (Achten *et al*., 2008; Kumar and Sharma, 2005).
This plant presents itself as a large shrub or small tree, growing up to 5m to five to seven meters in height. The life-span of *J. curcas* may be more than 50 years (Kumar and Sharma, 2005). It has unisexual flowers and is deciduous; shedding its big leaves in the rainy season. Flowering time takes place during the hotter seasons. The exocarp maintains moisture content until the three black ovoid oily seeds mature. At this point the fruit color changes from green to yellow (Sunder, 2006). Seeds contain several toxic substances, such as a lectin named curcin, phorbol esters and trypsin inhibitor. Secondary metabolites variety seems to depend on genetics or the environment (Makkar *et al.*, 1997).

Plate 1: Seeds of *Jatropha curcas* Linn.

1.2 Biofuel Production

1.2.1 Biofuel Worldwide

High oil prices in Asian countries have resulted in searching for alternative biodiesel plants that were economical and sustainable. As an alternative, *J. curcas* seeds had been identified as a very potential source of biodiesel. Jongschaap *et al.* (2007) analyzed that the seed of *J. curcas* contains viscous oil, highly suitable for production of biodiesel. Unlike petroleum, biofuels are a renewable energy source and its feedstock is inexhaustible if
produced sustainably. Domestic production of biofuels helps reducing countries' dependence on foreign fossil oil supply and protects their economies from the fluctuating oil prices (Sims, 2002).

*J. curcas* has its own economic values, because it produces seeds with an oil content of approximately 37% which is used for making biofuel. Plantation of *J. curcas* primarily focuses on producing green bio-diesel as an alternate source of fuel that can propel engines, generators and transportation as well as power generation in the future to replace existing fuel sources (Ramesh and Sampatharajan, 2008). Several projects have concentrated on the production of *J. curcas* oil as a diesel substitute for engines and as a kerosene substitute for cooking and lighting. In many developing countries, diesel is taxed less than petrol and kerosene, sometimes it is subsidized. Thus, as a general rule, the present day costs of diesel and kerosene do not make it attractive to produce plant oil as a substitute for these petroleum based fuels (Oppenshaw, 2000).

Oil crisis of the 1970's and recognition of world oil resources, vegetable oil has received special attention (Heller 1996; Hening 2000a). Special interest has been shown in the cultivation of the physic nut *J. curcas* for oil extraction, especially since it is drought resistant and can be cultivated on marginal land. United States is also producing corn for biodiesel, there will be shortage of food for animal and mankind. However, because Jatropha is inedible, it will not cause food shortage (Heller, 1996; Rintos, 2007a).

### 1.2.2 Biofuel in Malaysia

In the present scenario, Malaysia is seriously making an effort on cultivation of *J. curcas* on a large scale to produce biofuel. In 2007, BIONAS Agropolitan Technology Corridor Development (BATC Development Bhd) as non-governmental organization (NGOs) has prompted into this cultivation programme. In December 2008, Bionas Group executive