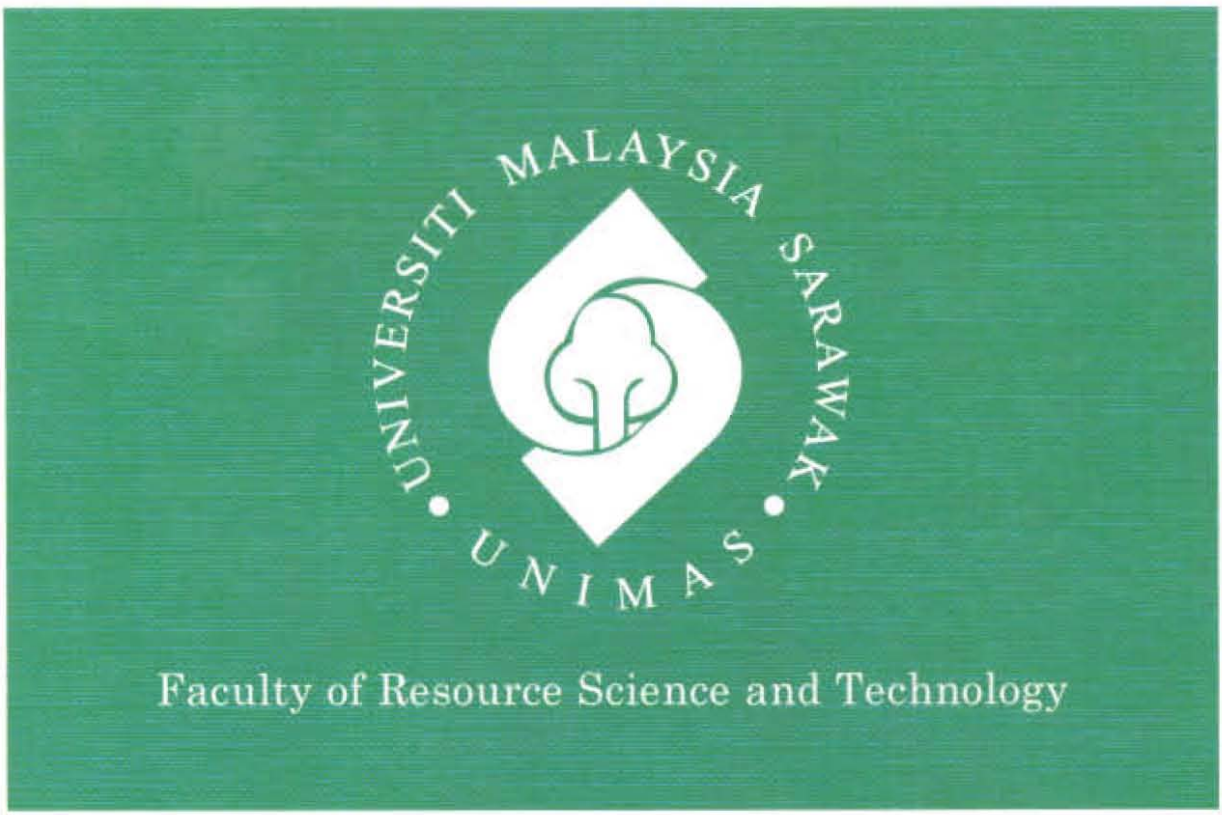

GERMINATION OF *CAPSICUM ANNUUM* L. SEEDS FOLLOWING STORAGE IN DIFFERENT ENVIRONMENTS

Chong Seow Chen

Bachelor of Science with Honours
(Plant Resource Science and Management)
2013

UNIVERSITI MALAYSIA SARAWAK

Grade: _____

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Final Year Project Report ☑

Masters ☐

PhD ☐

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GERMINATION OF *CAPSICUM ANNUUM* L. SEEDS FOLLOWING STORAGE IN DIFFERENT ENVIRONMENTS

CHONG SEOW CHEN

This report is submitted in partial fulfillment of the requirement for the Degree of Bachelor of Science with Honours in Plant Resource Science and Management

Faculty of Resource Science and Technology

UNIVERSITI MALAYSIA SARAWAK

2013

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DECLARATION

I hereby declare that no portion of this project work has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.

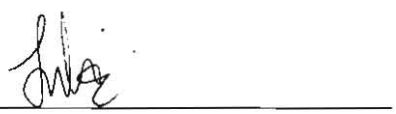

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ABA	Abscisic acid
AOSA	Association of Official Seed Analysts
GA	Gibberellic acid
ISTA	International Seed Testing Association
KH_2PO_4	Potassium dihydrogen phosphate
KNO_3	Potassium nitrate
K_3PO_4	Tripotassium phosphate
$MgSO_4$	Magnesium sulphate
NaCl	Sodium chloride
PEG	Polyethylene glycol
RH	Relative humidity

LIST OF FIGURES

LIST OF TABLES

Germination of *Capsicum annuum* L. Seeds Following Storage in Different Environments

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ABSTRACT

A study was conducted to evaluate the effects of storage environment on the germination of *Capsicum annuum* L. seeds following priming treatments. The initial moisture content and germination of the seeds were 8.36% and 80% respectively. In hydration treatments, seeds were soaked in water at ambient temperature for six hour-periods, and were evaluated for moisture content and germination. In moisturization treatment, *C. annuum* seeds were placed on moist filter paper for six hour-periods and determined for moisture content and germination. Results indicated that seeds primed using hydration treatment gave better germination than moisturization treatment, with the highest germination percentage of 87% at 4 hours of hydration.Untreated seeds and seeds primed using hydration and moisturization were stored in four different environments: ambient room (28- 30 °C), air-conditioned room (22-23 °C), refrigerator (3-5 °C) and incubator (35 °C) for 15 days. Untreated seeds can be stored better than primed seeds. Regression analysis showed that untreated seeds after stored in air-conditioned room can be stored longer up to 268 days.

Keywords: *Capsicum annuum* L., hydration, moisturization, storage, germination.

ABSTRAK

Satu kajian telah dijalankan untuk menilai kesan persekitaran penyimpanan pada percambahan biji benih Capsicum annuum L.berikutan rawatan suntikan. Kandungan kelembapan awal dan percambahan benih kawalan adalah 8.36% dan 80% masing-masing. Dalam rawatan penghidratan, benih telah direndam di dalam air pada suhu bilik selama enam jam tempoh yang berlainan dan telah dinilai bagi kandungan kelembapan dan peratus percambahan. Dalam rawatan pelembapan, biji benih telah diletakkan di atas kertas penapis lembap selama enam jam tempoh yang berlainan dan ditentukan bagi kandungan kelembapan dan peratus percambahan. Keputusan menunjukkan bahawa benih menggunakan rawatan penghidratan memberikan percambahan yang lebih baik daripada rawatan pelembapan, dengan percambahan peratusan tertinggi sebanyak 87% pada 4 jam penghidratan. Benih tanpa rawatan dan benih menggunakan rawatan penghidratan dan rawatan pelembapan telah disimpan dalam empat persekitaran yang berbeza: Bilik ambien (28 - 30° C), bilik berhawa dingin (22-23° C) petisejuk (3-5° C) dan inkubator (35° C) selama 15 hari. Benih yang tidak dirawat boleh disimpan lebih baik daripada benih yang dirawat. Analisis regresi menunjukkan bahawa benih tanpa rawatan boleh disimpan untuk jangka masa panjang sehingga 268 hari selepas disimpan di dalam bilik berhawa dingin.

Kata Kunci: Capsicum annuum L, *hidrasi, Kelembapan, penyimpanan, percambahan.*

1.0 INTRODUCTION

1.1 Background

Capsicum annuum L. is commonly known as chili, chili pepper or hot pepper which belongs to Solanaceae family. It is native to Central and South America and is grown in the tropical and subtropical regions of the world. *C. annuum* grow in both tropical and subtropical regions from sea level to 2000m altitude. A rainfall of 600-1250mm is suitable for *C. annuum* seedlings growth. Rajput and Parulekar, as cited in Salunkhe and Kadam (1998) mentioned that a minimum temperature of 10 °C is optimum for successful cultivation. Root development of *C. annuum* may be retarded when the soil temperature is above 30 °C. High temperature is the main factor for abscission of flowers and fruits (Huberman, 1997). Besides that, the colour of fruits and pungency of some cultivars are affected by temperature. The growth of *C. annuum* is preferably on sandy and clay loam, slightly acidic with aluminium depth of 30cm and pH range of 6.0-7.0. Highly acidic and alkaline soils are not suitable for *C. annuum* growth.

C. annuum is one of the economically important spices and condiments (Greenleaf, 1986; MARDI, 1994). Both green and ripe chilies are used to add a spicy taste to cuisine as they are mild and pungent. Chili pungency is a desirable attribute in many foods. This pungent spice is due to the presence of an alkaloid compound called capsaicin which can only be found in the *Capsicum* genus. Capsaicin contains antibacterial and antioxidant properties.

Chili is a good source of vitamin A, B, C, calcium, phosphorus and iron. It is used to impart a bright red colour and enhance the flavor of many processed foods. It can be eaten fresh, dried or processed as spice in powder form. It is a very popular fruit vegetable among the Malaysians. Chili is mainly used as flavouring in most cuisine. *C. annuum* medicinal properties and vitamin contents resulted the demand of it has increased all over the world. The *C. annuum* are extensively cultivated throughout tropical Asia for their edible pungent fruits. Extracts can be produced from chili pepper fruits that acts as spicy flavoring when added to ginger beer or vodka.

1.2 Problem statement

C. annuum have a steady prices and demand due to its uses as condiment, spices and vegetables. They are relatively short lived and may not remain viable for a long period in storage. There is no guarantee of sufficient viable seed available for commercial cultivation. Low viability and germination of seeds can be resulted when the seeds are being exposed to prolong-opened environment. High quality seeds are one of the most important factors for successful crop production to achieve high productivity. To maintain and preserve the seeds quality, suitable storage environment is needed to store the seeds. Hence, this study was carried out to address these problems with the following main objectives.

1.3 Objectives

The main objectives of this study were:

i) To assess quality of *C. anuuum* seeds used in the study.

ii) To evaluate the effects of priming treatments using hydration and moisturization seed performance.

iii) To determine the most suitable environment conditions for long term storage of *C. annuum* seeds following suitable priming treatments.

2.0 LITERATURE REVIEW

2.1 Botanical Description

C. annuum is an erect perennial herb but usually grown annually. The leaves are simple, alternate, elliptic, exstipulate, globrous, lanceolate, and subtrete. The colours of leaves are light to dark green and paler green beneath. The lamina is broadly lanceolate to ovate, the margin entire, the base is acute and the tip acuminate. The petiole is 0.5 to 2.5cm long with light green colour. There is no present of stipules. The stem is erect, 45 to 100cm, often becoming woody at base, sparsely to densely tomentose, rarely globrous, green to brown-green, often purplish spots near nodes and irregulary angular to substrete. The stem is much branched, the main shoot is radial with cincinnate lateral branches. The pedicels are erect or pendent and slender or thickness up to 1.5cm (Weiss, 2002).

Flowers are bracteolate, pedicellate and bisexual. They are normally solitary but may occur in clusters for some cultivars. The corolla is usually yellowish white with 5 – 7 lobes. The 5 stamens are alternate with the corolla, white to purple with anthers of 2.5 – 4.0 × 1.0.– 2.0. The ovary is superior and it is conical in shape. Cultivar characteristics of *C. annuum* depend on the existence numbers of flowers. The flower will fall down once the fruit begins to set.

The fruit is a berry with short thick peduncle with varies of colours, shape and degree of pungency. Generally, the size of fruit is in the range of 1 – 19 × 0.5 – 4.5cm diameter. It is indehiscent and borne singly at nodes. Immature fruit is light green, then turns yellow orange and finally becoming red when ripens. It takes about 30 – 35 days from fruit set to

complete development into green stage, while the fruit start to ripe on the 80 – days after fruit set. This is due to the caratenoid content has increases during full ripeness compare to the green stage (Shukla and Naik, 1993). The seeds are numerous with orbicular shape and pale yellow colour. The embryo is white, curved and embedded in copious grey endosperm. Bees, ants and thrips are the pollinator of *C. annuum*.

2.2 Seed Priming

Seed priming is a pre-sowing strategy for influencing seedling development by modulating pre-germination metabolic activity prior to emergence of radical and generally improves germination rate. Germination rate of seeds can be accelerated through the process of priming where this treatment improves the seed vigour as it produce uniform seedling with higher germination rate (Walters, 1998). Previous study showed the advantage of seed priming in enhancing the germination period besides improving the emergence uniformity established under laboratory conditions (Arif, 2005).

Five basic priming treatments which are hydro-priming, chemo-priming, thermo-priming, matrix-priming and osmo-priming have been developed. Hydro-priming is a hydration technique that initiates seed germination when seeds are hydrated to a sufficient level of moisture percentage. This is a very simple and environmental friendly type of seed priming in which seeds are soaked in water for certain time and dried before sowing (Thornton and Powell, 1992).

Chemo-priming is a scarification technique that involves soaking of seeds in low water potential osmotic solution such as sodium chloride (NaCl), magnesium sulphate ($MgSO_4$),

potassium nitrate (KNO_3), potassium dihydrogen sulphate (KH_2PO_4), tripotassium sulphate (K_3PO_4), glycerol and mannitol (Copeland and McDonald, 1995). These compounds are beneficial in supplying seeds with nitrogen and other nutrients essential for protein synthesis during germination.

Thermo-priming refers to condition of seeds treated in different range of temperature to increase seed performance. Dry heat, fire or hot water treatments are thermo-priming treatments. Thermo-priming by hot water has been used to improve seed germination where the seeds are soaked in water at high temperature, especially for seeds with hard seed coat.

Matrix-priming is a technique which involves the scratching or cracking of hard testa seed to help it germinate. When the seed coat is altered physically, water and gases are allowed to penetrate into the seed which aids in the germination. Thus, this technique is usually applied for seeds that have hard testa which are impervious to water and gases.

According to Doty *et al.* (1985), osmo-priming is the priming technique which allows seed to slowly absorb water from an aerated solution that contains osmotic agents such as salts, polyethylene glycol (PEG), potassium hydroxide (KOH), sucrose, mannitol and hydrated media. Soaking of seeds in osmotic solution results in increased germination rate as simple sugar is synthesized immediately upon germination.

2.3 Seed Hydration

Seed hydration is a priming technique that helps to improve seed performance by increasing germination with more range of environment conditions. It is a process to maintain the moisture content in seeds prior to sowing whereby seeds are supplied with water using various protocols. Hydration is one component of priming which can increase germination even in critical range of environment conditions (Copeland and McDonald, 1995). The technology of pre-soaking acts as an established tool to improve germination and emergence in many crops (Chippendale cited in Jafar, 2006).

Copeland and McDonald (1995) stated that soaking seeds in water prior to planting enhances germination and seedling growth by controlling the imbibition conditions and reducing the impacts of adverse weather and soil condition. Jafar (2006) reported both the germination and emergence percentage were drastically reduced when water logging exceeds 48 hours. Prolonged soaking has also been found to cause injury to seeds of many species.

According to Copeland and McDonald (1995), primed seeds can be stored successfully for short period without losing the benefits gained from the treatment. This is due to metabolic and physiological activities within the seed are recovered through hydration process which then could improve the vigour and storage potential.

2.4 Seed Dormancy

Seed dormancy is the failure of an intact viable seed to germinate under favorable conditions. It is a state in which seeds are prevented from germinating even under environmental conditions normally favorable for germination (Copeland and McDonald, 1995). There are two types of dormancy which are exogenous (seed coat dormancy) and endogenous (embryo dormancy). Hard seed coat could prevent imbibitions of water and exchange of gases and cause the absence of suitable germination conditions. Endogenous dormancy is inherent in the embryo due to the absence of growth promoter such as gibberellic acid (GA) as well as the presence of inhibitors especially abscisic acid (ABA).

2.5 Seed Moisture Content

Moisture content can be defined as the amount of water present in the seed and usually being expressed in percentage. It is important to determine the moisture content as it is useful in providing information regarding the potential for harvesting, plant injury as well as the likelihood for successful long term storage (Sivasangari, 2009). Moisture content can be expressed on either a wet weight basis or dry weight basis.

Seeds should contain sufficient moisture content to meet the requirements for germination. However, the moisture must not be excessively high as this will cause loss of viability over time. High moisture content increases the biochemistry activity that will increase the rate of enzymatic activities and metabolism reaction that will cause rapid deterioration rate (Agrawal, 1993). Seeds will meet maximum viability, germination and storage at critical moisture content level.

A slight change in seed moisture content will cause large effects on the storage life of seeds. The two important factors in seed storage are moisture content and temperature. Moisture content is considered the more crucial factor compared to temperature (Schmidt, 2000). This is because the potential of seed storage is different according to species as each has different range of moisture content. The life of seed is doubled for every 1% decrease in moisture content and every 5°C lowering of storage temperature (Harrington, 1973).

2.6 Seed Viability

Seed Viability is the ability of the seed to germinate and produce a normal seedling (Copeland and McDonald, 1995). Viability indicates that the seed is alive, metabolically active and have enzymes capable to catalyze metabolic reaction needed for germination and seedling growth. Seed viability is highest when the seeds are at maturity and viability will gradually declined after reaching physiological maturity.

In this test, tetrazolium is utilized to recognize the viability of seeds. Tetrazolium is a biochemical compound (2, 3, 5 – triphenyl tetrazolium chloride) that functions in estimating the viability, assessing vigour and diagnosing physiological problems in particular seeds. This method distinguishes between viable and dead seeds on the basis of their relative respiration rate in the hydrated state.

Tetrazolium is a water soluble powder, white or light yellow in colour. The solution with concentration of 0.1, 0.5, and 1.0% on a weight/volume (w/v) basis is prepared with distilled water and must be stored in a cool dark place. The test relies on the action of tetrazolium chloride molecule to react hydrogen atoms that are released as a result of dehydrogenase enzyme activity in living organism (Zhang *et al.*, 2001). The colour of

seeds will turn red if they are viable. Duration and temperature for staining in the tetrazolium test can be varied depending on types of seed, tetrazolium concentration and method used.

2.7 Seed Germination

Germination can be defined as the emergence and development a normal plant from the seed embryo (ISTA, 1976). Germination test is conducted to estimate the maximum number of seeds that can be germinated in optimum condition. The process of germination begins with seed imbibition, which is the water uptake process by seeds and ends when radical of the embryonic axis starts to elongate (Sivasangari, 2009). Germination is expressed as the percentage of normal seedlings produced from pure seeds.

The germination of seed is influenced by factors such as moisture content, temperature and level of oxygen. Different seed need different temperature to germinate whereby some seeds can tolerate either high or low temperature. Occasionally, seeds will germinate at optimum temperature between 15-30 °C, less or more than that will cause the seeds slow or fail to germinate. High quality seeds are able to germinate under wider temperature ranges than low quality seeds (Copeland and McDonald, 1995).

Duration of time after harvest and seed quality can affect percentage of seed germination other than factors such as species, variety and growing region. According to Evans and Turnbull (2003), high quality seeds are germinating maximum when physiological maturity is achieved. Otherwise, factors such as ageing, effect of environmental conditions