THE EFFECT OF DIFFERENT MOISTURE CONTENT AND PACKAGING MATERIALS ON PADDY SEED VIABILITY STORED UNDER AMBIENT CONDITION

ALIYAH BT MOHD YAHAYA

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

CROP PRODUCTION PROGRAMME
FACULTY OF SUSTAINABLE AGRICULTURE
UNIVERSITY MALAYSIA SABAH
2017

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN TESIS

JUDUL: THE EFFECT OF DIFFERENT MOISTURE CONTENT AND PACKAGING MATERIALS ON PADDY SEED VIABILITY STORED UNDER AMBIENT CONDITION

IJAZAH: DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONORS

SAYA: ALIYAH BT MOHO YA HAYA **SESI PENGAJIAN:** 2013-2017.
(HURUF BESAR)

Mengaku membenarkan tesis *(LPSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (/)

[ ]	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di AKTA RAHSIA RASMI 1972)
[ ]	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
[/]	TIDAK TERHAD	

aliyah
(TANDATANGAN PENULIS)

Alamat Tetap: NO 10, JALAN NIRWANA 10, TAMAN NIRWANA, 68000 AMPANG, SELANGOR.

TARIKH: 13/01/2017

Disahkan oleh:
NURULAIN BINTI ISMAIL
PUSTAKAWAN KANAN
UNIVERSITI MALAYSIA SABAH
(TANDATANGAN PUSTAKAWAN)

DATUK HJ. MOHD. DANDAN @
AME BIN HJ. ALIDIN
PROFESSOR MADYA / FELO KANAN
FAKULTI PERTANIAN LESTARI
UNIVERSITI MALAYSIA SABAH,
(NAMA PENYELIA)

TARIKH: 9/1/2017

Catatan:
*Potong yang tidak berkenaan.
*Jika tesis ini SULIT dan TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.
*Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana Secara Penyelidikan atau disertai bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM).

DECLARATION

I hereby declare that this dissertation is based on my original work except on citation and questions which has been duly acknowledged. I also declare that no part of this dissertation has been previously or currently submitted for a degree at this year or any other university.

ALIYAH BT MOHD YAHAYA

BR13110004

29 NOVEMBER 2016

VERIFICATION

VERIFIED BY

1. Prof. Madya Datuk Haji Mohd Dandan @ Ame bin Haji Alidin
   SUPERVISOR

DATUK HJ. MOHD. DANDAN @
AME BIN HJ. ALIDIN
PROFESSOR MADYA / FELO KANAN
FAKULTI PERTANIAN LESTARI
UNIVERSITI MALAYSIA SABAH,
KAMPUS SANDAKAN

2. Prof. Dr. Abd. Rahman Milan
   CO-SUPERVISOR

PROF. DR. ABD RAHMAN MILAN
PENSYARAH
FAKULTI PERTANIAN LESTARI
UMS KAMPUS SANDAKAN

ACKNOWLEDGEMENT

Alhamdulillah all praise to Allah for the health, the wisdom and the perseverance that He had given to me throughout this study. It was not possible to complete this study without His blessing.

Foremost, I would like to express my sincere gratitude especially to my supervisor Prof. Madya Datuk Haji Mohd Dandan @ Ame bin Haji Alidin whose have invested his full effort in guiding me in achieving the goal and for the continuous support during this research, for his patience, motivation, enthusiasm and immense knowledge. Without his guidance and persistent help, this dissertation would not have been possible.

Not forgetting my co-supervisor, Prof Dr. Abd Rahman Milan and all supportive lecturers for priceless guidance in these four years of study. I really appreciate the guidance given by other supervisor as well as the panels especially in our project presentation that has improved our presentation skills, thanks to their comment and advice.

A special thanks to my parents, Mohd Yahaya bin Hj.Sheikh Ali and Arfah bt Abd Manan and all my family members for supporting me mentally and physically. I couldn't be able to overcome pressure and obstacle if not from them. Words cannot express how grateful I am for all of the sacrifices that you've made on my behalf. Your prayer for me was what sustained me this far.

I would like to thank my friends who have been my helping hand throughout this experiment. I would also want to thank all my fellow friends who supported me in writing and encourage me to strive towards my goal, for the stimulating discussions, for the sleepless nights we were working together before the deadlines and for all the fun we have had in last four years. Thanks for everything and success is meant for us all.

ABSTRACT

An experiment was conducted to study the effect of different moisture content and packaging materials on paddy seed viability stored under ambient condition. The objective of the research was to determine the effect of different packaging materials on the viability of paddy seed under ambient condition. Two factors were used in the experiment which was different type of packaging materials and different initial seed moisture content. Seeds were packed in polypropylene (PL), polypropylene + polyethylene (PL-LDPE), polypropylene + high density polyethylene (PL-HDPE), polypropylene + metalized PET aluminium foil (PL-MPET) and polypropylene + nylon laminated plastic bags (PL-LN). The seed moisture contents used was 12%, 16% and 20%. There were 45 packages of TR-8 paddy seeds. Every two weeks seed samples were drawn from each package and they were tested for germinability. The parameters examined in this study were germination percentage (%), seedlings height (cm), root length (cm), number of normal and abnormal seedlings (%), moisture content (%), fresh and dry weight of shoot and root (g) and seed vigour index. Data were collected and analysed for different parameters by using 5x3 Factorial Completely Randomized Design (CRD) to determine the significant difference between treatments. The results revealed that seeds packed in PL bags (control) and stored with 12% moisture content recorded consistently higher germination rate (86.333%) under ambient condition. Parameters such as seed vigour index (9.7478), height of seedlings (11.2967cm) and root length (4.28cm) were also higher in comparison to those seeds stored in other packaging bags. Therefore the present study showed that others packaging bag which were PL-LDPE, PL-HDPE,PL-MPET and PL-LN proved to be less effective for maintaining seed viability and vigour under ambient storage condition. Seeds that initially stored with high MC (16% and 20%) and packed with permeable packages (PL-control) were less subjected to the fluctuations of moisture. However, seeds with high MC packed in impermeable packages will caused the seeds to respire and deteriorate faster. Lower moisture content helped to improve the storability of seeds attributable to the lower respiration rate, metabolic activity as well as lower infection of microorganisms. As a conclusion, paddy seeds variety TR8 should be kept in porous packages (PL-control) at low moisture content (12%) in order to maintain their viability and vigour under ambient condition.

KESAN KANDUNGAN KELEMBAPAN DAN PEMBUNGKUSAN YANG BERBEZA TERHADAP KETAHANAN BENIH PADI YANG DISIMPAN DI DALAM KONDISI OPTIMUM

ABSTRAK

Eksperimen telah dijalankan untuk mengkaji kesan kandungan kelembapan dan pembungkusan yang berbeza terhadap ketahanan benih padi yang disimpan di dalam kondisi optimum. Objektif kajian ini adalah untuk menyatakan kesan pembungkusan yang berbeza dan untuk mengenalpasti kesan kandungan kelembapan benih yang berbeza terhadap ketahanan benih padi yang disimpan dalam kondisi optimum. Terdapat dua faktor yang telah digunakan dalam kajian ini iaitu pembungkus dan juga kandungan kelembapan benih yang berbeza. Biji benih telah dimasukkan ke dalam pembungkus yang digunakan iaitu PL, PL-LDPE, PL-HDPE, PL-MPET dan PL-LN. Variasi kandungan kelembapan yang digunakan adalah 12%, 16% dan 20%. Terdapat 45 bungkusan padi dan setiap dua minggu, sampel biji benih telah diambil daripada pembungkus dan diuji percambahannya. Data telah dianalisa berdasarkan beberapa parameter iaitu peratus percambahan, panjang pucuk, bilangan anak benih normal dan tidak normal, kelembapan biji benih, berat basah dan kering pucuk dan akar, indeks kebernaasan benih. Keputusan menunjukkan padi 12% kandungan kelembapan yang disimpan di dalam bungkusan PL (kontrol) direkodkan dengan peratusan percambahan tertinggi (86.333%) di bawah kondisi optimum. Parameter seperti indeks kebernasan benih (9.7478), panjang pucuk (11.2967sm) dan panjang akar (4.28sm) juga tinggi bagi gabungan tersebut berbanding gabungan rawatan lain. Sehubungan itu, kajian ini telah membuktikan bahawa PL-LDPE, PL-HDPE, PL-MPET dan PL-LN, kurang efektif dalam mengekalkan kadar percambahan dan ketahan benih padi. Padi yang disimpan pada kandungan kelembapan yang tinggi (16% dan 20%) dan disimpan dalam PL dapat mengekalkan percambahan kerana kurang kadar turun naik kelembapan dan kadar pernafasan dan juga aktiviti metabolik jadi kadar kelembapan yang rendah membantu dalam mengekalkan ketahanan benih padi. Secara kesimpulan,padi perlu disimpan di dalam PL dengan gabungan kelembapan rendah 12% bagi percambahan yang baik.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, UNITS AND ABBREBIATIONS

ANOVA	Analysis of Variance
°C	Degree of Celcius
cm	Centimetre
CRD	Completely randomized design
DAS	Days of Sowing
FAO	Food and Agriculture Organization
FSA	Faculty of Sustainable Agriculture
g	Gram
HDPE	High density polyethylene
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
kg	Kilogram
LDPE	Low Density Polyethylene
LN	Laminated Nylon Bag
LSD	Least Significant Difference
M1	12% Moisture Content
M2	16% Moisture Content
M3	20% Moisture Content
MC	Moisture Content
MPET	Metalized PET (Aluminium foil)
P1	Polypropylene
P2	Polypropylene + Low Density Polyethylene
P3	Polypropylene + High density polyethylene
P4	Polypropylene + Metalized PET (Aluminium foil)
P5	Polypropylene + Nylon laminated plastic bags
PL	Polypropylene
R	Replicate
RH	Relative humidity
SAS	Statistical Analysis System
T	Treatment
TR8	Tuaran Rice 8
UMS	University Malaysia Sabah
%	Percentage

LIST OF FORMULAE

3.1 Germination percentage

$$\%\text{Germination} = \frac{\text{Number of germinated seedlings}}{\text{100 seeds}} \times 100$$

3.2 Number of normal seedlings

$$\%\text{Normal seedlings} = \frac{\text{Number of normal seedlings}}{\text{100 seeds}} \times 100$$

3.3 Number of abnormal seedlings

$$\%\text{Abnormal seedlings} = \frac{\text{Number of normal seedlings}}{\text{100 seeds}} \times 100$$

3.4 Seed vigor index

$$\text{Seed Vigor Index} = \frac{\text{Seedlings height x Germination percentage}}{100}$$

CHAPTER 1

INTRODUCTION

1.1 Background

Rice is one of the most important cereal crops in the world and in Malaysia, rice is the main food. During the last few years, rice farmers in low-country wet zone increasingly complained about rapid loss of seed viability in storage (Slumith, 2009). In order to maintain the quality of seed for a longer period of time, there are two factors that affect the seed condition which are the packaging material and also seed moisture content.

Generally, seeds are required to be kept in safe storage since they are harvested in the preceding season and used for sowing in the next season often after a gap of six to nine months (Tiwari and Kuntal Dass, 2014). It is now being observed that some Malaysian farmers tend to store their seed for the next planting season in an ambient condition which will exposed the seed to many constraints that might deteriorate them. Some of the farmers stored their seed for more than 4 months in a paddy house which each of the pole of the house is wrapped with zinc sheet and cause the quality to reduce in time. Good quality of paddy seeds is the key to high production of rice. According to Alam *et al.* (2009), the quality of seed can increase the yield of a plant up to 15-20%. When effective storage method is not available especially in rural areas, traditional storage method often unable to ensure that seed were kept under proper storage condition and thus lead to losses during storage (Copeland and McDonald, 1995). It is a common practice in paddy industry to store them at 14% for periods of time but it is very critical to store dried paddy in an ambient environment to the lowest reasonable rate of deterioration.

Seed deterioration may be due to physiological changes during the seed storage process. Nagaveni (2005) reported that seed deterioration during storage was due to damage of the membrane, enzyme activity, proteins and nucleic acid. According to Onyekwelua and Fayose (2007) several factors such as temperature, seed moisture content and relative humidity would influence the seed longevity during storage. When the seeds were in dry state, it is necessary to keep them under the best possible conditions to ensure that the maximum potential germination and other seed quality traits are maintained.

Moreover during seed storage, seed viability is known to be preserved under low moisture conditions. According to Ito (1975) also reported the necessity of low moisture in seed in long term storage of rice. It is found by Nishiyama (1977) that the rice seeds of 10-14% moisture content can be stored in a good condition at 18°C for more than two years. Paddy seeds may deteriorate faster during storage if they are exposed to adverse environments or improper packaging material was used. According to Miller (2006) seeds are hygroscopic and tend to absorb moisture during storage. Paddy seeds are categorized as orthodox seeds and it can withstand drying. At low moisture level, these seeds can be kept for quite a long time in ambient condition.

In addition to seed moisture, the choice of packaging material is also important. Possibly the most important property of packaging material is its ability to either maintain a certain level of humidity and moisture or to allow some transmission of moisture and gas. Types of packaging material for storing seeds will influence percentage of germination, moisture contents and seedling growth. After drying seeds to the correct moisture content, it can be placed in a sealed moisture proof containers such as polyethylene bag and aluminium foil. Thus this will avoids extensive usage of dehumidification requirements.

1.2 Justification

Farmers tend to store their seed in ambient temperature as they did not have any cold room for storage and moisture content is the major factor that influences the quality of seed. Without proper storage conditions, seeds tend to lose viability

rapidly before planting season. Based on previous studies, the ambient temperature and relative humidity of ambient condition are higher in the afternoon and evening compared to the morning reading with the average of temperature 29.5°C and the relative humidity of 80.5% will affect the germination percentage of seed to be low after five months storage.

Sometimes, the harvested seed do not properly dried up to the safe moisture content for storage purposes thus it leads to low yield production for that particular farmers. Environment factors in influencing the life span of seeds are relative humidity, temperature and initial seed moisture content. Seeds stored at higher moisture content of 12% using jute bag showed deterioration with an increase in conductivity throughout the storage period. Under ambient air, seeds will be more susceptible to deterioration in germination and vigor those nearer the center of the stack, where temperature is higher and more easily maintained. Thus, safe seed moisture content should be maintained by using proper packaging material in storing seeds.

In the other hand, Department of Agriculture only used polypropylene as seed packaging materials in low temperature ($5 - 10°C$) with the relative humidity less than 60% and under this condition, seed vigor can last for approximately 2 years. Thus, the seed storage for extended longevity of paddy seed comes out with the combination of packaging materials and improvement of polypropylene lined with all the treatment studied hopefully can improve the seed viability and vigor in a longer period especially in an ambient condition. This study will be carried out in order to identify if any of the packaging has the potential to maintain the seed viability under ambient storage condition.

Basically, this research will give some information of different packaging material that can be used with safe seed moisture content for paddy seed as reference of future research regarding to the efficiency of paddy seed storage. Apart from that, the data collected from this research can be used to determine availability of possible useful packaging material for better paddy seed storage. Even though the production of paddy seems to be potentially increase and sufficient for food

supply, but farmers need to consider the number of population that keep increase by time. Thus, it is very important for the farmers to keep the productivity of paddy maintained in order to fulfill the demand of food.

1.3 Objectives

i. To determine the effect of different packaging materials on the viability of paddy seed under ambient condition

ii. To evaluate the effects of different seed moisture content on the viability of paddy seed under ambient condition

1.4 Hypothesis

H_o: There was no significant difference in different packaging materials on the viability of paddy seed under ambient condition

H_a: There was a significant difference in different packaging materials on the viability of paddy seed under ambient condition

H_o: There was no significant difference in different seed moisture content on the viability of paddy seed under ambient condition

H_a: There was a significant difference in different seed moisture content on the viability of paddy seed under ambient condition

CHAPTER 2

LITERATURE REVIEW

2.1 Taxonomy and Classification of *Oryza Sativa*

Rice (*Oryza sativa* L.) is a staple food for more than half of the world's population. It is also the most important human food crop in the world (Itani *et al.*, 2002). *O. sativa* is indigenous to Asia (Chang *et al.*, 1965). The taxonomy of *O. sativa* according to Department of Health and Ageing Office of the Gene Technology Regulator is shown below in table 2.1.

Table 2.1 The taxonomy of *Oryza sativa* L.

Kingdom	**Plantae**
Phylum	Magnoliophyta
Class	Liliopsida
Order	Poales
Family	Graminae
Genus	Oryza
Species	Sativa

Source: Department of Health and Ageing Office of the Gene Technology Regulator, 2005

2.2 Paddy variety TR-8

The rice consists of many varieties botanically and more than 4000 varieties have been identified. The variety studied in this project is variety TR8. This new paddy strain TR8 or Seri Aman is a high yield variety which was developed by the Agricultural Department.

This variety comes out from the hard work of Tuaran Agriculture Research Center that has been very keen to produce a high quality paddy variety. This variety is resistant to the Rice Tungro Bacillium Virus (RTBV). It can produce up to five to seven tones of paddy per hectare per season. This variety is known for its high quality grain and also potential to be commercialized. Through this new agricultural technology farmers in Sabah can produce more than 10 tones paddy per hectare per season. The new strain will help to boost rice self-sufficiency that is currently at 30% to 42% target by the end of the 9th Malaysia Plan, (Liusin, 2009). The detail and characteristics of paddy seed variety TR8 can be found in Table 3 in Appendix A.

2.3 Paddy seed

2.3.1 Paddy Seed Structure and Morphology

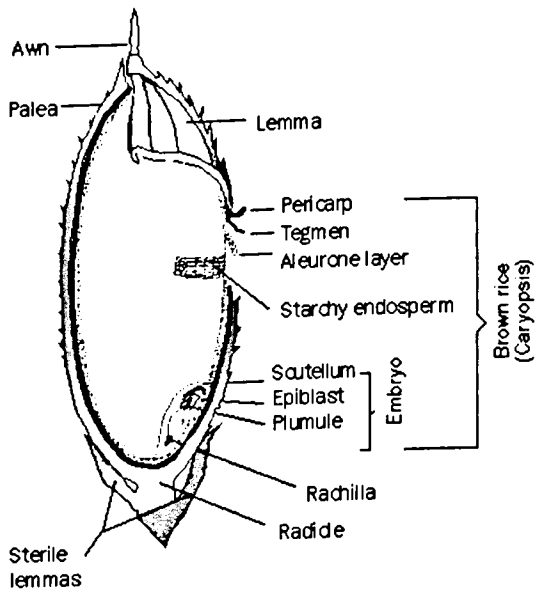

Figure 2.1 The structure of rice grain
Source: IRRI, 2009

Seed is known as fertilized ovule consisting of intact embryo, stored food and seed coat which is viable and has got a capacity to germinate (Panda, 2010). It is the combination of mature male and female gametes coming from the stamen and pistil of the flower, respectively in a process known as fertilization, or *syngamy* (Desai, 2004). A rice grain or a paddy seed consists of a husk as the outer part and the

edible rice grain on the inside part. The husk consists of palea, lemmas, and rachilla as shown in figure 2.1. The brown rice consists of pericarp, tegmen, aleurone layer, endosperm and embryo. For the rice seed to be used to grow a new rice crops, the husk is retained and the whole seed is planted. Rice plants develop clusters of small wind-pollinated 'flowers' at the top of the plant called panicles. Once they are pollinated, the flowers develop rice grains. Although they are perennial in which continue to grow from one season to the next, rice plants are treated as annuals, new seeds are usually planted each season for better yields.

2.3.2 Paddy Seedlings Morphology

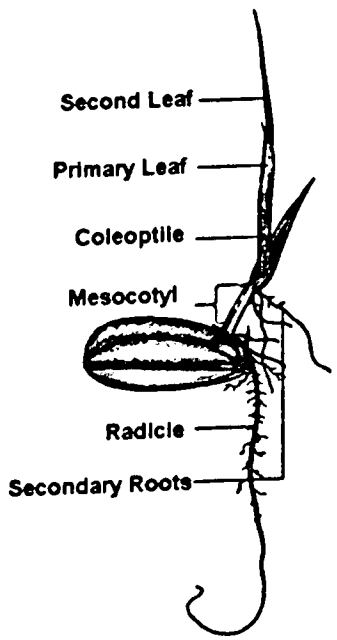

Figure 2.2 Parts of a germinating seedling

Source Hardke, 2013

According to ISTA (2007), after an embryo has gone through the process of germination and the seed coat has break, it is called as a seedling which will be consisting of three different parts which are:

1. A root system which grows down into the soil

The main function of the root system is to grow down into the soil where it will helps in anchoring the plant into the soil, absorbs water and dissolved nutrients from the soil which will be conducted to the cotyledon and the terminal bud. At

REFERENCES

Abdul-Baki, A. A. and Anderson, J.D. 1973. Physiological and Biochemical Deterioration of Seed. In Kozlowski, T. T. (Eds.). *Seed Biology*. Academic Press: New York, London

Abeysiriwardena, D. S. 1985. Effect of Packaging Material and Moisture Content on the Viability of Paddy Seeds . *Tropical Agriculturist* **141:** 37-54

Alam, M., Ahmed, M., Hasanuzzaman, M. and Islam, M. O. 2009. *S*eed Quality of Aman Rice as Affected by Some Alternate Storage Devices, *Journal of Agronomy* **2(3):** 130-137

Alam, M., Islam, M. O. and Mirza, H. 2009. Performance of Alternate Storage Devices on Seed Quality of Boro Rice. *Middle-East Journal of Scientific Research* **4(2):**78-83

Amarjit, S. B. 2006. *Handbook of Seed Science and Technology*. Food Prodcuts Press Inc

Babasaheb B. Desai. 2004. Processing and Storage Books in Soils, Plants and The Environment. *Seeds Handbook*.

Barreto, F. A. 2009. Artificial Seed Cooling. *International Seed Magazine*

Basavegowda, S. G. and Hosamani, A. 2013. Effect of Commercial Cold Storage Conditions and Packaging Materials on Seed Quality of Chickpea (*Cicer Arietinum.L*). *Global Journals Inc. (USA)*, **13:** 23-28

Bharat, K. P. and Hemant, K. B. 2012. Effect of Storage Conditions and Storage Periods on Seed Germination in Eleven Populations of *Swertia chirayita*. *Scientific World*, **12(8):** 105-115

Balasevic-Tubic, S. Doredevic, V. Miladinovic, J., Dukic, V. and Tatic, M. 2011. Stability of Soybean Seed Composition, *Genetika* **42(2):** 217-227

Cemal, M., Orkun, O. and Mehmet, Y. 2008. Examination of The Possibility of Recycling and Utilizing Recycled Polyethylene and Polypropylene. *Materials and Design* **29:**701-705

Chang, T. T. 1965. The Morphology and Varietal Characteristics of Rice Plant, *Rice Plant* 3

Clarkson, D. T., Hopper, M. J. and Jones, H. P. 2006. The Effect of Root Temperature on the Uptake of Nitrogen and The Relative Size of The Root System in Lolium Perenne. I. Solutions Containing Both NH_4^+ and NO_3^- . *Plant, Cell and Environment* **9(7):** 535-545

Cuthbertson, E. G. 1970. Chondrilla Juncea in Australia. Seed Maturity and other Factors Affecting Germination and Establishment. *Australian Journal of Experimental Agriculture and Animal Husbandry* **10(42):**62-66

Copeland, L. O. and McDonald, M. B. 2001. Principles of Seed Science and Technology. 4th edition. Massachusetts. *Kluwer Academic Publishers*

Dharmasena, C. M. D and Abeysiriwardena D. S. D. Z. 2003. Effect of Variety, Grain Moisture and Packaging Material on Weight and Storage Pests of Rough Rice During Storage. *Preecedings of the Annual Symposium of the Department of Agriculture*

Donahaye, J. E., Navarro, S., Andales, S., Mundo, A. M. D., Caliboso, F., Sabio, G., Felix, A., Rinder, M., Azrieli, A. and Dias, R. 2000. Quality Preservation of Moist Paddy under Hermetic Conditions. In: *Preceedings of International Conference Controlled Atmosphere and Fumigation in Stored Products.* 29 Oct 2000 - 3 Nov 2000 Frensco, CA

FAO. 2013. Rice Market Monitor . **16(3):** 1-36

Fonesca, J. F. 1980. Conservation of Bean Seed under Three Method of Storage . ravista Brasiliera de sementes **2:** 19-27
Forestry Department. 1987. A Guide to Forest Seed Handling. Retrieved at 21 June 2016
Ghazali, N. A. 2013. Effect of Storage Conditions and Packaging Materials on Viability and Vigour of *Zea Mays* Seed
Goneli, A. L. D., Correa, P. C., Oliveira, G. H. H., Afonso., G. H. H. 2013. Water Sorption Properties of Coffee Fruits, Pulped and Green Coffee. *Food Science And Technology,* **50:** 386-391
Gupta, N., Patel, S., Yadu, Y. K., and Bakane, P. H. 2005. Influence of Storage Structure on Seed Properties During Storage . *Kamataka Journal of Agriculture Science.* **19(3):** 628-634
Hardke, D. J. 2013. *Arkansas Rice Production Handbook.* University of Arkansas Division of Agriculture
Harrington, J. F. 1960. Seed Storage and Longevity. *Seed Biology* **3:** 145-240
Highland, H. A. and Wilson, R. 1981. Resistance of Polymer Films to Penetration by Lesser Grain Borrer and Description of A Device for Measuring Resistance. Journal Economy Entomology **74**: 67-70
ILSI. 2002. Packaging Materials: Polypropylene As a Packaging Material For Foods And Beverages . *International Life Sciences* . Belgium
IRRI. 2005. Rice Storage Systems. Joe, R. and Martin, G. International Rice Research Institute. Philippines
IRRI. 2013. Seed Quality. Postharvest Unit CESD. Philippines
ISTA. 1997. Seed Science and Technologies. International Rules for Seed Testing. 288
ISTA. 2001. International Rules for Seed Testing Rules Amendments. *Seed Science and Technology* **29(2):** 1-127
ISTA. 2007. International Seed Testing Association. *ISTA Handbook On Moisture Determination.* Switzerland
Itani, T. M, Tamaki, E. Arai and T. Horino. 2002. Distribution Of Amylose, Nitrogen And Minerals In Rice Kernels With Various Characters. *J. Agric. Food Chem.* 5326-5332
Ito, H. 1975. Long Term Storage Of Crop Seeds and Its Use For Breeding. 849-852
Justice, O. L. and Bass, L. N. 1979. *Principles of Practices of Seed Storage.* Agricultural Handbook. Washigton DC.
Lawrence, O. C. and Miller B. M. 2001. *Principles Of Seed Science And Technology* . Kluwer Academic Publishers. United States of America
Liusin, K. 2009. New Paddy Strain Yields More Than 10 Tonnes per Hectare. New Sabah Times. Retrieved at May 10 2016.
Marcio, D. P., Denise, C., and Eduardo, E. Physiological Quality of Physic Nut (*Jatropha Curcas L.*) Seeds During Storage. *Journal of Seed Science.* **35(1):** 205-217
Mashooda, B., Lokesh, S., Ravishankar, R. V., Shailaja, M. D. Kumar, T. V. and Shetty, H. S. 2005. Evaluation of Certain Storage Conditions for Okra (*Abelmoschus esculentus (L.) Moench*) Seeds Against Potential Fungal Pathogens. International Journal of Agriculture and Biology **7(4):** 550-554
Makhal, S. Tanweer, A. and Sharma, D. H. 2003. Requirement And Recent Development Of Weaning Foods. Beverage and Food World **45:**15-22
Magdalena, R. 2016. *Enzyme Degradation In Seed.* Retrieved at April 20 2016
McDonald, M. B. 2005. Seed Germination. *Physiology of Seed Germination*, 4-8

Mettanada, K. A. Weerasena, S. L. and Liyanage, Y. 2001. Effect of Storage Environment, Packaging Materials and Seed Moisture Content on Storability of Maize (*Zea Mays L.*) Seeds. Annals of the Sri Lanka Department of Agriculture **7:** 183-189

Mersal, I. F., A. A. M. El-Emam and Amal H. S. 2006. Effect of Storage Period, Seed Moisture Content and Insecticides Treatment on Wheat Seed Quality. Annals of Agric.Sci,Moshtohor. **44 (1)**: 111:124

Michael, F., Karwan, E. Kim, E. and Thomas , C. 2000. The Purpose of Packaging Materials. Retrieved at 25 September 2016

Miller, B. M. 2006. Seed Moisture and the Equilibrium Seed Moisture Content Curve . *Seed Technology*, **29(1):**7

Moreano, T. B., Braccini A. L., and Krzyzanowski F. C. 2011. Changes In The Effects Of Weathering and Mechanical Damage On Soybean Seed During Storage. *Seed Science And Technology,* **39:** 604-611

Muhammad, A. and Muhammad. A. 2002. Evaluation Of Physical Quality Of Onion Seed Stored In Different Periods. *International Journal Of Agriculture And Biology,* **4(3):** 365-369

Nagaveni, P. 2005. Effect of Storage Compositions, Packaging Materials Seed Treatment on Viability and Vigour of Onion Seeds. Department of Seed Science and Technology College of Agriculture, Dharward University of Agricultural Sciences:7-70

Nishiyama, I. 1997. Decrease In Germination Activity of Rice Seeds Due to Excessive Dessication In Storage . *Japan Journal Crop Science,* **46(1):** 111-118

Onyekwelua J. C. and Fayose, O. J. 2007. Effect Storage Methods on Germination and Proximate Composition of *Treculia Africana* Seeds

Panda, S. C. 2010. Crop Management and Integrated Farming. *Rice Crop Science.* India

P.Srimathi, K. 2006. Seed Physiological Maturity. Retrieved at 26 October 2016

Paulo, C. C., Maycon, F. T. R., Gabriel, H. H., Ana, P . L., Fernando M. B., 2015. Moisture Desorption Isotherms Of Cucumber Seeds: Modeling And Thermodynamic Properties . *Journal Of Seed Sciences.* 218-225

Pradhan, B. K. and Badola, H. K. 2011. Effect Of Storage Conditions And Storage Periods On Seed Germination In Eleven Populations Of Swertia Chirayita. *A Critically Endangered Medicinal Herb In Malaya* . 21-35

Rahman, N. F. 2014. The Effect Of Different Packaging Materials And Two Different Storage Conditions On The Viability Of Paddy Seed Variety TR8. 99-102

Rattanaporn, M. 2005. Influence Of Packaging Materials And Storage Times On Fungal Growth And Deed Quality Of Rice Seed. Master of Science. Postharvest Technology Institute, Chiang Mai University

Roberts, E. H. 1961. The Viability of Rice Seeds in Relation to Temperature, Moisture Content and Environment . *Annals of Botany* **25:** 381-390

Roberts, E. H. 1972. Viability of Seeds. Chapman and Hall Co. Ltd, London

Schawass, R. H. and Allo, A. V. 1973. Seed Quality and Its Control. Tokyo: Food and Fertilizer Technology Center

Silvana, 2013. Conservation Of *Campomanesia Adamantium (Camb.) O.Berg* Seeds In Different Packaging and at Varied Temperatures . 262-269

Singh, R. M., and Singh, I. D. 1981. Effect Of Methods And Duration Of Storage On Seed Germination And Seedling Vigor In Papaya. *Seed Reseacrh.* **9(1):** 67-72

Slumith, D. and Abeysiriwardena Z. 2009. Effect of Packaging Material and Moisture Content on The Viability of Paddy Seed

Tatipata, A. 2009. Effect Of Seed Moisture Content, Packaging And Storage Period On Mitochondria Inner Membrane Of Soybean Seed. *Journal Of Agricultural Technology.* **5(1):**51-64

Tiwari R. K. S., And Kuntal D. 2014. Impact Of Differential Storage Conditions On Seed Germination And Viability Of Some Medicinal Plants. *African Journal Of Agricultural Research.* **9:** 1-8

Uma, S. S. 2008. Seed Technology and Seed Technology. Anmol Publications Pvt.Ltd

Wani A. A. Joshi J. Titov A. Tomar D. S. 2014. Effect of Seed Treatments and Packaging Materials on Seed Quality of Maize (Zea mays L.) during Storage **4(4):**102-108

Warrier, R. R. Gurudev, S. R. Anandalakshmi, R., Sivakumar, V., Kumar, A. M. and Hedge, M. T. 2009. Standardization of Storage Conditions to Prolong Viability of Seeds of Artocarpus heteropyhllus Lam- A Tropical Fruit Tree. *Journal of Agriculture and Biological Science* **4(2)**

Weeson, G., and Wareing, P. F. 1967. The Role Of Light In The Germination Naturally Occuring Population Of Buried Weed Seed. Botany Department, University College of Wales: 402-413

White, N.D. G. and Jayas, D. S. 1991. Factors Affecting the Deterioration of Stored Flaxseed Including the Potential of Insect Infestation. Canadian Journal Plant Science **71:** 325-335

Zhang, S. J., Wang L. H., and Xin, C. S. 2008. Effects Of Packaging Materials On Vigor Of Different Types Of Cotton Seeds During Storage.