THE EFFECT OF DIFFERENT THICKNESSES OF POLYETHYLENE AS PACKAGING MATERIAL ON SEED VIABILITY OF PADDY VARIETY TQR-8 UNDER AMBIENT CONDITION

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ABSTRACT

This study was conducted at School of Sustainable Agriculture, Universiti Malaysia Sabah Sandakan from July 2013 to October 2013 to determine the effect of different thicknesses of polyethylene (PE) as packaging material on seed viability of paddy variety TQR-8 under ambient condition. The objectives of the study were to investigate the effect of different thicknesses of polyethylene as the packaging material on the seed viability of paddy seed variety TQR-8 under ambient condition and also to determine the most suitable thickness of polyethylene material for seed packaging of paddy under ambient condition. The paddy seeds were packed with polyethylene packaging material with the thicknesses of 0.03 mm (AP1), 0.035 mm (AP2), 0.04 mm (AP3) and 0.06 mm (AP4). The paddy seeds packed with PE packaging material were stored under ambient condition (30-35°C, RH 70-90%) while the paddy seeds packed with polypropylene (the packaging material used by Department of Agriculture) were stored in the cold room condition (5-10°C, RH 50-60%) as the control treatment. The experiment was designed in Completely Randomized Design (CRD) with three replicates for each treatment. For the period of two months, the germination test was carried out with two weeks interval. Parameters examined in this study were moisture content (%), percentage of germination (%), number of seedlings with radicle, number of seedlings with plumule, number of normal seedlings, number of abnormal seedlings, number of seedlings with leaf, height of seedlings (cm), length of root (cm) and number of dead seeds. The result obtained was analyzed into a one-way analysis of variance (ANOVA). At the end of 8^{th} week, the control treatment (85.67%) and AP1 (47.25%) are seen to have higher percentage of germination compared to AP2 (26.67%), AP3 (21.83%) and AP4 (11.50%). After two months of storage, PE with thickness 0.03 mm has recorded the highest percentage of germination (47.25%), highest percentage of seedlings with radicle (47.25%), plumule (43.83%), leaf (34.67%) and normal (32.83%) seedlings as compared to the other thicknesses of PE. It also produced the second tallest seedlings (5.40 cm) and longest root (5.68 cm) after the control treatment. From the findings of this study, none of the thickness of polyethylene packaging material is suitable for storing paddy seeds variety TQR-8 under ambient condition for two months period because the germination percentage was below 50%. However, the percentage of germination of paddy seed variety TQR-8 packed with PE with thickness of 0.03 mm was found to be good for shorter period of storage. On Week 2, paddy seeds packed with PE with thickness 0.03 mm recorded 71.67% of germination while on Week 4, it recorded 60.67% of germination. On Week 6, the percentage of germination decreased to a percentage lower than 50%. Therefore, the paddy seeds could be packed with PE with thickness of 0.03 mm when storing seeds under ambient condition for not more than one month of storage period. On the other hand, further study on a packaging material which can maintain low temperature inside the particular packaging material could be carried out.

KESAN KETEBALAN POLIETILENA YANG BERBEZA SEBAGAI BAHAN PEMBUNGKUS TERHADAP KUALITI BIJI BENIH PADI VARIETI TQR-8 PADA KEADAAN AMBIENT

ABSTRAK

Kajian ini telah dijalankan di Sekolah Pertanian Lestari, Universiti Malaysia Sabah dari Julai 2013 sehingga Oktober 2013 untuk menentukan kesan ketebalan polietilena yang berbeza sebagai bahan pembungkus terhadap kualiti biji benih padi varieti TQR-8 pada keadaan ambient. Objektif bagi kajian ini adalah untuk menyelidik kesan ketebalan polietilena yang berbeza terhadap kualiti biji benih padi variety TQR-8 dalam keadaan ambient dan juga untuk menentukan ketebalan polietilena yang paling sesuai untuk pembungkusan biji benih padi dalam keadaan ambient. Biji benih padi dibungkus dengan polietilena (PE) dengan ketebalan 0.03 mm (AP1), 0.035 mm (AP2), 0.04 mm (AP3) dan 0.06 mm (AP4). Biji benih padi yang dibungkus dengan bahan pembungkus polietilena (PE) disimpan dalam keadaan ambient (30-35°C, RH 70-90%) manakala biji benih padi yang dibungkus dengan polipropilena (bahan pembungkus yang digunakan oleh Jabatan Pertanian) disimpan dalam keadaan bilik sejuk (5-10°C, RH 50-60%) sebagai rawatan kawalan. Eksperimen direkabentuk dengan menggunakan Completely Randomized Design (CRD) dengan tiga replikasi bagi setiap rawatan. Untuk tempoh selama dua bulan, ujian percambahan dijalankan setiap dua minggu. Parameter yang dinilai dalam kajian ini adalah kandungan lembapan (%), peratusan percambahan biji benih padi(%), bilangan anak benih dengan radikel, bilangan anak benih dengan plumule, bilangan anak benih normal, bilangan anak benih abnormal, bilangan anak benih dengan akar sekunder, bilangan anak benih dengan daun, ketinggian anak benih (sm), kepanjangan akar (sm) and bilangan biji benih mati. Keputusan yang diperoleh dianalisis dengan menggunakan ANOVA satu hala. Pada akhir minggu ke-8, rawatan kawalan (85.67%) dan AP1 (47.25%) dilihat mempunyai peratusan percambahan biji benih yang lebih tinggi berbanding AP2 (26.67%), AP3 (21.83) dan AP4 (11.50%). Selepas penyimpanan selama dua bulan, PE dengan ketebalan 0.03 mm telah merekodkan peratusan percambahan (47.25%), peratusan anak benih dengan radikel (47.25%), plumule (43.83%) dan daun (34.67%) serta anak benih normal (32.83%) tertinggi berbanding dengan ketebalan PE yang lain. PE dengan ketebalan 0.03 mm juga telah menghasilkan ketinggian anak benih kedua tertinggi (5.40 sm) dan kepanjangan akar kedua terpanjang (5.68 sm) selepas rawatan kawalan. Dari keputusan kajian ini, tidak ada ketebalan bahan pembungkus polietilena yang sesuai untuk menyimpan biji benih padi variety TQR-8 dalam keadaan ambient selama dua bulan kerana peratusan percambahan adalah di bawah 50%. Walaubagaimanapun, peratusan percambahan biji benih padi variety TQR-8 yang dibungkus dengan PE yang berketebalan 0.03 mm didapati baik untuk penyimpanan yang lebih singkat. Pada Minggu ke-2, biji benih padi yang dibungkus dengan PE berketebalan 0.03 mm mencatatkan peratusan percambahan sebanyak 71.67% manakala pada Minggu ke-4 sebanyak 60.67% percambahan direkodkan. Pada Minggu ke-6, peratusan percambahan menurun pada peratusan di bawah 50%. Oleh itu, biji benih padi boleh dibungkus dengan PE berketebalan 0.03 mm semasa menyimpan biji benih dalam keadaan ambient untuk tempoh penyimpanan tidak lebih dari satu bulan. Di samping itu, kajian lanjut mengenai bahan pembungkus yang boleh mengekalkan suhu rendah dalam bahan pembungkus berkenaan boleh dijalankan.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

ANOVA	Analysis of variance
AP1	Polyethylene with thickness of 0.03 mm under ambient condition
AP2	Polyethylene with thickness of 0.035 mm under ambient condition
AP3	Polyethylene with thickness of 0.04 mm under ambient condition
AP4	Polyethylene with thickness of 0.06 mm under ambient condition
°C	Degree Celsius
C	Control treatment under cold room condition
cm	Centimeter
CRD	Complete Randomized Design
DAS	Day After Sowing
FAO	Food and Agriculture Organization
g	Gram
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
kg	Kilogram
MC	Moisture content
mm	Millimeter
%	Percentage
PE	Polyethylene
RH	Relative humidity
RM	Ringgit Malaysia
SPSS	Statistical Package for Social Science
SSA	School of Sustainable Agriculture
TQR-8	Tuaran Quality Rice 8
UMS	Universiti Malaysia Sabah

CHAPTER 1

INTRODUCTION

1.1 Introduction

Being the crop that feeds more than 60% of the world population, paddy is the most important food crop in the world. More than 90% of the world's rice is grown and consumed in the Asian region where 60% of the earth's people live. The country with the largest paddy area production in the world is India which comes second in the production after China. The global land of production for paddy reached eight billion hectares yet it is still not enough to feed seven billion people (United Nation, Department of Economic and Social Affairs, 2011). Therefore, agronomists around the world are combining theirs forces to increase the world's rice production and eventually minimize the loss of yield in paddy. These losses are mainly caused by the poor quality possessed by paddy seeds. According to McDonald and Nelson (1986), in 1984, the seed sales in United States are amounted over $2 billion and 25% of the value (approximately $500 million) was lost due to poor seed quality. The quality of paddy seeds deteriorate due to many external conditions and one of them is unsuitable packaging material. Paddy seeds with improper packaging material have the high tendency to lose their viability and vigor quickly. Shenoy *et al.* (1988) stated that 20% of the yield losses are due to the deterioration of seed vigor in rice crop.

Quality seed is the master key for a successful cultivation of any plant. There are three major aspects of seed quality which are a) genetic and physical purity, b) high germination percentage and vigour, and c) free from seed-borne diseases and insects (Seshu and Dadlani, 1989). According to Alam *et al.* (2009a), a quality seed can increase 15 to 20% of the yield. Progressive farmers realize that their farming investment and chances for a profit depend upon the planted seed thus they become increasingly seed-conscious. With high demand of quality seed, Seed Certification Schemes are established to guarantee the quality of the seed bought by farmers meets the standard. Seed quality could only be maintained but it could not be improved. Even after the post-harvest treatments, maintaining the seed quality however is a challenging task. Factors such as storage period, storage conditions and seed quality, significantly affect the germination rate and the period of which seed can remain viable without germinating (FAO, 2001). Therefore, it is important that the seed retains its viability and vigor during the period of storage.

The oldest practice used by the farmers to store their seeds is storing the seeds under ambient conditions on-farm. Storing the paddy seeds in improper storage conditions in the on-farm had been identified as an obvious factor that reduces the quality in paddy seeds. Compared to temperate countries, in Malaysia, which has the tropical climate with high humidity, storing seed under ambient condition has more difficulties. Due to the high relative humidity and humid temperatures, the farmers need to give extra attention to the seed during storage. As seeds have the nature of being hygroscopic, they have the capability to absorb and release moisture to the surrounding areas. When the seed absorbs the moisture from its surrounding, the moisture content in the seed increases, thus activating all the metabolic reactions thus contributing to the seed deterioration before the seeds could be planted. Due to this reason, farmers have the tendency to use higher seed rate that the actual requirement in sowing to compensate the ungerminated seeds and causes seed wastage (Hossain *et al.*, 2002).

The rapid loss of viability of the paddy seeds deteriorates gradually thus brings out the great complaints from the farmers. One of the factors that caused the problem is the unsuitability of packaging material used for seed storage. As the technologies enhanced daily, polythene and polysack bags slowly replaced the common jute bags. The past few years had shown the interest of researchers on finding different packaging materials for paddy seed storage. Hohenheim (2005) and Alam *et al.* (2009b) had respectively done their researches on the effect of different packaging materials on the viability of paddy seed. Both studies had used polyethylene as one of the packaging materials. With 31% of production in polymer manufacturing, polyethylene is the most manufactured plastic compared to the closely-related compound, Polypropylene. The largest use for these polymers is in packaging materials including in the packaging of crop seeds.

1.2 Justification

Seed viability is one of the biggest concerns of farmers. Farmers are investing a huge amount of money to buy seeds to be planted with hope that the seeds planted would give them the yield they wanted. However, without proper storage condition, seeds tend to lose viability rapidly before the planting season. This will cause unnecessary loss of cost to the farmers.

Under ambient condition, it is hard to retain the viability of the paddy seeds in Malaysia, which is a humid tropical country. Even with such climate, most of the paddy farmers still keep the paddy seeds for the next planting season under ambient condition. This will result in seed deterioration and when the seeds are sown into the soil, they will fail to germinate. Addressing the issue, cold room storage was introduced into the seed industry and instantly became the most reliable initiative to store seeds. The temperature and relative humidity of a controlled cold room is maintained at low level (5-10°C, relative humidity 55-60%) which enable the cold room to store seed for a long term without the seeds losing their viability. Under cold room condition, the viability of paddy seeds could be kept for more than three years. Even though cold room storage has significantly solved the rate of seed deterioration issue, when it is considered from another perspective, the practice demands expensive cost. A proper cold room utilizes air conditioners and dehumidifiers to keep the relative humidity and the temperature at the safe level for seed storage. With the machines being used continuously, the bill of electricity will not be cheap. As a real example, Pusat Pengeluaran Bahan Tanaman Kontan Tenom in Keningau is paying approximately RM 25,000 for its cold room with the capacity of 1000 metric tons of planting materials every month (Mohd. Dandan, 2013). Generally, paddy farmers do not have proper seed storage under tropic condition where both the temperature and relative humidity are high. Most of the farmers could not afford the costly storage such as cold room therefore they prefer the traditional storage practice that is under ambient conditions storage which cost them less in the maintenance aspect. Thus, it is the selection of packaging material used by the farmers under ambient condition that will maintain the viability of paddy seeds until the next growing season.

By using the polyethylene as the packaging material, the moisture content of the seeds could be retained at low level thus maintaining the seed viability. Abeysiriwardena (1985) stated that the germination percentage of paddy seeds with moisture content of 12% packed with polyethylene material is the highest (33%) compared to other packaging materials after 33 weeks of storage. In similar study, Huong (2011) found out that the best packaging material that gives the highest percentage of paddy seeds germination is polyethylene bags (54.67%) after being stored for 22 weeks. This is due to the characters of polyethylene which are airtight and moisture-proof. Adding to its advantages, polyethylene is economically affordable by the farmers. The farmers only need to spend around RM 8 to RM 10 for a kilogram of polyethylene material.

The ability of the polyethylene to retain the seed viability may or may not be different with different thicknesses under ambient condition. Therefore, the study will be conducted to study the effect of different thicknesses of polyethylene as the packaging material on the seed viability of paddy TQR-8 variety under ambient condition. This study is expected to emphasize the utilization of polyethylene material in storing paddy seeds with regards to the farmer's economic conditions. The most suitable thickness of polyethylene material for ambient condition storage can be found out from this study. The result from this study can be suggested to the farmers prior to short-term high quality seed storage under ambient condition. If farmers are able to keep their own seeds of paddy in good packaging material, it will significantly solve the problem faced by Department of Agriculture to fulfill 100% requirement of paddy seed farmers nowadays. It will eventually help the farmers to produce and keep their own seed as being programmed by Department of Agriculture by planting the same seed per three consecutive planting seasons. It will not only contribute to minimization of losses due to poor quality seeds, but also ensure the food security of the nation.

1.3 Objectives

1. To investigate the effect of different thicknesses of polyethylene as the packaging material on the seed viability of paddy seed under ambient condition

2. To determine the most suitable thickness of polyethylene material for seed packaging of paddy under ambient condition

1.4 Hypothesis

H_0: There is no significant effect of different thickness of polyethylene as the packaging material on the seed viability of paddy variety TQR-8 under ambient condition.

H_A: There is a significant effect of different thicknesses of polyethylene as the packaging material on the seed viability of paddy variety TQR-8 under ambient condition.

CHAPTER 2

LITERATURE REVIEW

2.1 Paddy

A self-pollinated crop, paddy or its scientific name, *Oryza sativa* L., botanically belongs to the Poaceae family. There are two most important cultivated species of paddy in the world namely *Oryza sativa* and *Oryza glaberrima*. There are around 22 wild species of paddy grown in the continents of Asia, Africa and America. While *Oryza sativa* is grown in most parts of the Asian and American continents, *Oryza glaberrima* is grown only in Africa. Besides of the mostly grown *Oryza sativa* in the tropics, there are three subspecies of paddy in the world which are *Oryza indica*, *Oryza japonica* and *Oryza javanica*. *Indica* rice or the long grain is grown in warm climate zone of Indo-China, India, Pakistan, Thailand, Brazil and Southern America. The round grain, *Japonica*, is mostly grown in cold climate zone of Northern China, Korea, Japan and California. *Javanica* or the medium grain is only grown in the land of Indonesia.

2.1.1 Paddy Variety TQR-8

Paddy variety TQR-8 is also known as Seri Aman paddy and is one of the paddy varieties produced by the Department of Agriculture Sabah which was launched and introduced to the public in 2009 by the Chief Minister of Sabah, Datuk Seri Musa Aman. It has high resistant towards diseases attack such as Rice Tungro Virus (Penyakit Merah) and is able to produce high yield up to 7 tons per hectare. The details characteristics about paddy seed variety TQR-8 can be found in Appendix A.

2.1.2 Morphology of Paddy Seed

The paddy seed, or also called as rice grain, consists of the brown rice or caryopsis. Enclosing the caryopsis is a hard hull (husk) that functions to protect the kernel. A complete hull is made up of a lemma, a palea, an awn, a rachilla and two sterile lemmas. The hull only needs light forces of grinding to be broken apart from the inner caryopsis. The caryopsis has three fibrous bran tissues. They are namely pericarp or fruit coat, tegmen or seed coat, aleurone, endosperm or hard dough and embryo (Justin and Bass, 1979).

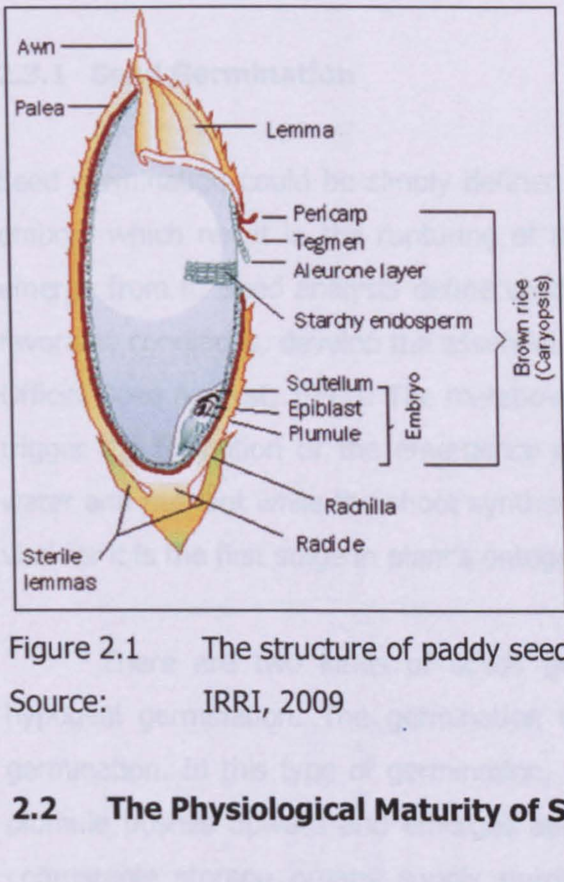

Figure 2.1 The structure of paddy seed/ rice grain

Source: IRRI, 2009

2.2 The Physiological Maturity of Seeds

A seed is said to have reached its physiological maturity when the maximum dry weight is attained during the development (Kameswara and Jackson, 1995). During physiological maturity, the viability and the vigor of the developing seeds are the greatest (Harrington, 1973). The viability and vigor gradually decline as the seeds age. On the other hand, when the seed reaches its physiological maturity, it is not suitable to be stored due to the high moisture of the seed. For safe storage, the seeds must be harvested at their harvest maturity as the moisture content is still low.

2.3 Seed Quality

Seed quality could be determined from the purity of the seeds and also the germination (FAO, 2001). Quality of seed is determined by performing seed germination test or Tetrazolium test on the seed. A good quality seed should have 80% or more germination percentage. The purity of the seed must be 98% and are free from seed borne disease, inert materials and seeds of noxious seeds (Awangku Damit, 2010). High quality seeds will also produce high percentage of normal seedlings compared to abnormal seedlings. The illustrations of normal and abnormal seedlings of paddy can be seen in Appendix C.

2.3.1 Seed Germination

Seed germination could be simply defined as the resumption of active growth of the embryo which result in the rupturing of the seed coat and a functional young plant emerge from it. Seed analysts define seed germination as the seeds which are under favorable conditions, develop the essential structures for further growth (Association of Official Seed Analyst, 1991). The metabolic reactions that take inside the seeds would trigger the formation or the emergence of shoot and root. The root would take up water and nutrient while the shoot synthesizes food from photosynthesis. This stage is vital for it is the first stage in plant's ontogenesis (Amarjit, 2006).

There are two kinds of seeds germination: a) epigeal germination and b) hypogeal germination. The germination that possessed by paddy seed is hypogeal germination. In this type of germination, the cotyledon stays under the soil while the plumule pushes upward and emerges above the ground. Cotyledons that act as the comparable storage organs supply nutrition to the growing points throughout the germination. On the other hand, seed germination will not taken place without its requirements being fulfilled. The requirements include seed maturity, water, oxygen, temperature and light.

a) Seed maturity

Most species of seeds have the capabilities to germinate before they reach the physiological maturity (Thoroddur and Holmgeir, 1994). Maximum seed germination rate could be reached when the seeds are allowed to dry slowly as they mature (Harrington, 1972).

b) Water

It is the basic requirement for germination to occur (Baskin and Baskin, 2001). It is important for the embryo to absorb adequate amount of water so that all the metabolic reactions inside the seeds could be activated. Once the metabolic reactions take place, it will develop radical which allows the seed to imbibe water. The next growth is the plumule which will grow a shoot that enables the light absorption of seed (Bedell, 1998).

c) Oxygen

Adequate supply of oxygen is essential for the germination of seed as the respiration increases sharply during seed germination. Absence of sufficient oxygen supply will retard the seed germination. However, according to Copeland and McDonald (1995), rice seeds can still germinate even in a complete absence of oxygen. Despite being able to germinate, the seedlings of the paddy will be weak and abnormal.

d) Temperature

Most seeds germinated well at the temperature of 15 to 30°C (Copeland and McDonald, 1995). High quality seeds are able to germinate in wide range of temperatures as compared to low quality seeds.

e) Light

In their study, Hiroaki and Kazuyuki (2001) found out that the paddy seeds that were collected from abandoned paddy field in a temperate region of Japan germinated well under the temperature of 10 to 25°C with 14 hours of photoperiod.

2.3.2 Seed Viability

Basra (1995) defined seed viability is defined as the degree to which a seed is alive, metabolically active and possessed enzymes that capable if catalyzing metabolic

REFERENCES

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

Agrawal, P. K. 2012. *Principles of Seed Technology.* New Delhi: Directorate of Information and Publications of Agriculture

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

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

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

Baskin, C. C. and Baskin, J. M. 2001. *Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination.* USA: Academic Press

Basra, A. S. 1995. *Handbook of Seed Science and Technology.* New York: Food Products Press

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

Bedell, P. E. 1998. *Seed Science and Technology of Indian Forestry Species*. New Delhi: Allied Publishers Limited

Boxall, R. A. 1987. Storing Grain on the Farm. *Approp. Technology* **14(2)**:14-16

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

Chandrasekaran, B., Annadurai, K. and Kavimani, R. 2007. *A Text Book of Rice Science.* India: Scientific Publishers

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

Copeland, L. O. and McDonald, M. B. 1995. *Principles of Seed Science and Technology.* 3rd edition. United States of America: Thomson Publishing

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

Delouche, J. C. and Caldwell. W. P. 1960. Seed Vigor and Vigor Tests. *Proceedings of the Association of Official Seed Analysts* **50**:124-129

Delouche, J. C. 1973. Precepts of seed storage. *Proceeding of the Mississippi State Seed Processors Shortcourse* 1973:93-122

Dharmasena, C. M. D. and Abeysiriwardena D. S. D. Z. 2003. Effect of Variety, Grain Moisture and Packing Material on Weight and Storage Pests of Rough Rice during Storage. *Proceedings of the annual symposium of the department of agriculture*, Edited by Kotagama, H.B. Wijesekara, G.A.W. and Wijesundara, D.S.A. Sri Lanka: Department of Agriculture

EMIL DEISS KG. 2013. Types of Polyethylene. http://www.deiss.de/en.php/mehr/polyethylen.html Verified on 19 March 2013

FAO. 2001. FAO Production Year Book. Food and Agricultural Organization. Rome, Italy **55**:64

Girish, G. K., Arora, K. K. and Jain, S. K. 1990. Post Harvest Technology of Food Grains in India. *Bull. Grain Technology* **28**:66-88

Gupta, N., Patel, S., Yadu, Y. K. and Bakane, P. H. 2005. Influence of Storage Structures on Seed Properties Paddy during Storage. *Kamataka Journal of Agriculture Science* **19(3)**:628-634

Harrington, J. F. 1972. Seed Storage and Longevity. *Seed Biology* **3**:145-240

Harrington, J. F. 1973. Biochemical Basis of Seed Longevity. *Seed Science and Technology* **1**:145-240

Hiroaki, I. and Kazuyuki, I. 2008. Germination and Water Dispersal of Seeds from a Threatened Plant Species *Penthorum chinense. Journal of Agriculture Science.* **16(1):** 99-106

Hohenheim, S. 2005. Influence of Packaging Materials and Storage Time on Seed Viability and Chemical Component of Rice Seed. *Conference on International Agricultural Research for Development.* 11-13 October 2005. Chiang Mai, Thailand

Hossain, M., Janaiah A., Husain, A. M. M. and Naher, F. 2002. Rice Seed Delivery System and Seed Policy. The role of seed delivery system in Bangladesh. 8 January 2002. Dhaka.

Huong, T. T. 2011. *The Effect of Packaging Materials on Paddy Seed Quality Variety TQR-2 under Different Storage conditions.* Bachelor of Agriculture Science with Honours. Universiti Malaysia Sabah

Inter-American Institute of Cooperation on Agriculture (IICA). 2010. Conversion of the thickness of a polymer film in inches, gauges, mils and micrometres. http://www.iica.int/Eng/regiones/caribe/guyana/IICA%20Office%20Documents/tfo_packaging_workshop/Guyana%20TFO%20Pkg%20W'shp%20Session%204%20-%20Plastic%20Film.pdf Verified on 23 March 2013

International Rice Research Institute (IRRI). 2009. Grain Storage Systems. http://www.knowledgebank.irri.org/rkb/grain-storage-systems.html Verified on 19 March 2013

International Seed Testing Association (ISTA). 1985. International Rules for Seed Testing. *Seed Science and Technology* **13(2)**: 307-520

International Seed Testing Association (ISTA). 1999. International Rules for Seed Testing. *Seed Science and Technology* **27**:340

International Seed Testing Association (ISTA). 2001. International Rules for Seed Testing Rules Amendments. *Seed Science and Technology* **29(2)**: 1-127

Joao Abba, E. and Lovato, A. 1999. Effect of Seed Storage Temperature and Relative Humidity on Maize (*Zea mays* L.) Seed Viability and Vigour. *Seed Science & Technology* **27**:101-114

Justin, O. L. and Bass, L. N. 1979. *Principles and Practices of Seed Storage.* Washington: Science and Education Administration's Federal Research

Kameswara, N. and Jackson, M. T. 1995. Seed Longevity of Rice Cultivars and Strategies for their Conservation in Genebanks. *Annals of Botany* **77**:251-260

Kamra, S. K. 1967. Studies on Storage of Mechanically Damaged Seed of Scots Pine (*Pinus silvestris* L.). *Studia Forestalia Suecica* **42**:1–19

Kawamura, S., Takekura, K. and Itoh, K. 2004. Rice Quality Preservation during On-Farm Storage Using Fresh Chilly Air. *Proceedings of the 2004 International Quality Grains Conference.* 19-22 July 2004. Indianapolis, USA. 1-17

Lauridsen, E. B., Olesen, K. and Scholer, E. 1992. Packaging materials for tropical tree fruits and seeds. Tech. Note 41. Humlebaek, Denmark: Danida Forest Seed Centre.

Lepoutre, P. n.d. The Manufacture of Polyethylene. http://nzic.org.nz/ChemProcesses/polymers/10J.pdf Verified on 19 March 2013

Lita, S. 2002. *Teknologi Benih.* Edisi Revisi. Jakarta: Rajawali Pers

McDonald, M. B. and Nelson, C. J. 1986. Physiology of Seed Deterioration. *Crop Science Society of America*, Madison, WI

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

Mettanada, K. A. 2005. Effects of Storage Environment and Packing Method on the Viability of Seed Paddy. *Annals of the Sri Lanka Department of Agriculture* **7**: 183-189

Mohd. Dandan. Former Deputy Director, Department of Agriculture Sabah. March 2013. Personal communication

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

Oren, L. J. and Louis, N. B. 1978. Principles and Practices of Seed Storage. Washington: Science and Education Administration

Polymer Science Learning Centre. 2005. The Molecule of Polyethylene Polymer. http://www.pslc.ws/macrog/pe.htm Verified on 20 February 2013.

Roberts, E. H. 1961. The viability of rice seed in relation to temperature, moisture content and gaseous environment. *Annals of Botany* **25**: 381-390

Roberts, E. H. 1973. Predicting the storage life of seeds. *Seed Science and Technology* **1**:499-514.

Seshu, D. V. and Dadlani, M. 1989. *Role of Woman in Seed Management with Special Reference to Rice.* IRTP Technical Buletin

Shenoy, S. N., Paris, T. R. and Duff, B. 1988. Farm level harvest and post-harvest seed management practices of farm women in an irrigated rice system: a case study. *Paper presented at "Women in Rice Farmin System Network Orientation and Planning Workshop"*, International Rice Research Institute, Los Banoz, Laguna, Phillipines, May 2-11, 1988

Thorroddur, S. and Holmgeir, B. 1994. The Effect of Seed Maturity, Drying Temperature and Storage Temperature on Germination and Viability in Icelandic *Poa pratensis* L. *Journal of ICEL. AGR. SCI* **8**:5-71

United Nation, Department of Economic and Social Affairs. 2011. Population Division. *World Population Prospects: The 2010 Revision, Highlights and Advance Tables*. Working Paper No. ESA/P/WP.220

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 heterophyllus* Lam – A Tropical Fruit Tree. *Journal of Agriculture and Biological Science* **4(2)**

Yoshida, S. 1981. *Fundamental of Rice Crop Science*. Manila: International Rice Research Institute