THE EFFECT OF DIFFERENT STORAGE CONDITIONS AND PACKAGING MATERIALS ON THE VIABILITY OF PADDY SEED VARIETY TQR-8

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DECLARATION

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

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ABSTRACT

This study was conducted at School of Sustainable Agriculture, Universiti Malaysia Sabah Sandakan from May 2012 to October 2012 to determine the effect of storage conditions and packaging materials on the viability of paddy seed variety TQR- 8. The paddy seeds were stored under three different conditions, ambient room condition (30-35 °C, RH 70-90%), split unit air-conditioned room (20-24 °C, RH 60-70%) and SSA laboratory cold room (5-10 °C, RH 50-60%) for seed storage. The paddy seeds were packed in five different packaging materials which were Polypropylene (PL), Polyethylene (PE), Polypropylene lined with low density polyethylene (PL- LDPE), Polypropylene lined with high density polyethylene (PL- HDPE) and Polypropylene lined with thin aluminum foil (PL-TAL). The experiment was designed in 3 x 5 Factorial in Complete Randomized Design (CRD) consisting of two factors: storage conditions and packaging materials. The germination test was carried out every two weeks interval for the period of five months. Parameters investigated in this study were moisture content (%), percentage of germination (%), number of seedlings with plumule, number of seedlings with radicle ,number of seedlings with leaf , length of root (cm), height of seedlings (cm), number of normal seedlings , number of abnormal seedlings and number of dead seedlings. The result was analyzed using two ways ANOVA repeated measures. At the end of 20th weeks, cold room (65.27%) and split unit air-conditioned room (65%) maintain the higher germination percentage than ambient room (18.60%). Both storage conditions also has record the highest percentage seedlings with plumule, radicle, leaf, and normal seedlings. It produced the tallest seedlings and longest root. It achieved low percentage of abnormal seedlings. On the other hand, the control used in this study was ambient room with PL. The germination percentage of paddy seed which stored under this condition was 31.67%. Seeds packed in PL (31.67%) and PE (29.67%), had statistically different compared to PL-LDPE (13%), PL- LDPE (10.33%) and PL- TAL (8.33%). In conclusion, paddy seed variety TQR- 8 can be stored safely under ambient condition for two months and should be packed with PE when storing in ambient condition. Besides, paddy seed should be stored at air-conditioned room and cold room when packed with PL- LDPE, PL- HDPE and PL- TAF for more than three months period onwards. The viability of paddy seeds variety TQR-8 can be maintained. Storability can be extended by storing under air-conditioned and cold room with PL and PE for small and large scale farmers for more than five months onwards.

Pengaruh Keadaan Penyimpanan dan Bahan Pembungkusan terhadap Kualiti Biji Benih Padi Varietas TQR-8

ABSTRAK

Kajian ini telah dijalankan di Sekolah Pertanian Lestari, Universiti Malaysia Sabah Sandakan dari Mei 2012 hingga Oktober 2012 untuk menentukan pengaruh keadaan penyimpanan dan bahan pembungkusan terhadap kualiti biji benih padi varieti TQR-8. Benih telah disimpan di bawah tiga keadaan yang berbeza, keadaan bilik persekitaran ambient (30-35 ° C, RH 70-90%), keadaan bilik berhawa dingin (20-24 ° C, RH 60-70%) dan bilik sejuk (5-10 ° C, RH 50-60%) untuk penyimpanan benih. Benih padi disimpan dalam lima jenis bahan pembungkusan yang berbeza iaitu Polipropilena (PL), Polietilena (PE), Polietilena berketumpatan rendah dialas dengan polipropilena (PL-LDPE), Polietilena berketumpatan tinggi dialas dengan polipropilena (PL-HDPE) dan Aluminium nipis dialas dengan polipropilena (PL-TAL). Rekabentuk eksperimen adalah 3 x 5 Faktorial dengan menggunakan susunan Complete Randomized Design (CRD) yang terdiri daripada dua faktor: keadaan penyimpanan dan bahan pembungkusan. Ujian percambahan dijalankan setiap dua minggu sepanjang tempoh lima bulan. Parameter yang dinilai dalam kajian ini ialah peratusan percambahan biji benih padi (%), anak benih dengan plumule, anak benih dengan radikel, anak benih dengan daun, kepanjangan akar (sm), ketinggian anak benih (sm), peratusan percambahan anak benih normal, anak benih abnormal dan anak benih mati. Keputusan dianalisis dengan menggunakan dua cara ANAVA Dua Hala (repeated measures). Pada akhir minggu ke 20, bilik sejuk (65.27%) dan keadaan bilik berhawa dingin (65%) mengekalkan peratusan percambahan yang lebih tinggi daripada keadaan bilik persekitaran ambient (18.60%). Kedua-dua keadaan penyimpanan juga mencatakan peratusan yang lebih tinggi dari segi anak benih dengan plumule, radikel, daun dan anak benih normal. Biji benih yang disimpan dalam keadaan ini menghasilkan benih yang tinggi dan mempunyai akar yang panjang serta peratusan percambahan anak benih abnormal yang rendah. Selain itu, kawalan yang digunakan dalam kajian ini ialah bilik persekitaran ambient dengan PL. Peratusan percambahan biji benih padi yang disimpan di bawah keadaan ini adalah 31.67%. Biji benih yang dibungkus dalam PL (31.67%) dan PE (29.67%), secara statistik berbeza secara nyata berbanding PL-LDPE (13%), PL-LDPE (10.33%) dan PL-TAF (8.33%). Kesimpulannya, biji benih padi variety TQR-8 boleh disimpan di bawah keadaan persekitaran ambient selama dua bulan dengan selamat dan perlu dibungkus dengan PE apabila menyimpan dalam keadaan persekitaran ambient. Selain itu, benih padi harus disimpan di bilik berhawa dingin dan bilik sejuk apabila dibungkus dengan PL-LDPE, PL-HDPE dan PL-TAF untuk tempoh penyimpanan melebihi daripada tiga bulan. Daya tumbuh biji benih dapat dikekalkan. Tempoh penyimpanan biji benih padi varieti TQR-8 dapat diperpanjangkan lebih daripada lima bulan ke atas dengan disimpan di bilik berhawa dingin dan bilik sejuk serta dibugkus dengan PL dan PE untuk kegunaan petani berskala kecil atau besar.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CO_2	Carbon Dioxide
°C	Celsius
cm	Centimeter
cm^2	Centimeter Square
CRD	Complete Randomized Design
DAS	Days After Sowing
DLS	Diffuse Light Storage
DMRT	Duncan's Multiple Ranged Test
FAO	Food and Agriculture Organization
ga	Gauge
g	Gram
ha	Hectare
HDPE	High Density Polyethylene
IRRI	International Rice Research Institute
ISTA	International Seed Testing Association
kg	Kilogram
LLDPE	Linear Low Density Polyethylene
LDPE	Low Density Polyethylene
MPET	Metallized Polyethylene Terephthalate
μm	Micron
mm	Milimeter
MC	Moisture content
O_2	Oxygen
%	Percentage
PA	Polyamide
PE	Polyethylene
PL	Polypropylene
PL-HDPE	Polypropylene Lined With High Density Polyethylene
PL-LDPE	Polypropylene Lined With Low Density Polyethylene
PL-TAF	Polypropylene Lined With Thin Aluminium Foil
PVC	Polyvinyl Chloride
QC	Quality Control
RH	Relative Humidity
RM	Ringgit Malaysia
SCA	Seed Certification Agency
SPSS	Statistical Package for Social Science
SSA	School of Sustainable Agriculture
TAF	Thin Aluminium Foil
t	Tonnes
$t\ h^{-1}$	Tonne per hectare
TLS	Truthfully Labelled Seed
TQR-8	Tuaran Quality Rice 8
UMS	Universiti Malaysia Sabah
WP	Woven Polysack

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Paddy (*Oryza sativa* L.) is one of the most important staple foods for the world population and Malaysia has been ranked 25th paddy producer in the world (Akinbile *et al.*, 2011). It is the main field crop grown in Malaysia and an important source for employment and income of the rural population (Tao *et al.*, 2008). In year 2011, the world population has reached seven billion while global production land for paddy is only eight billion hectares (United Nation, Department of Economic and Social Affairs, 2011). Hence there is a need to maximize paddy production in the world and in the same time, to minimize yield lost due to disease during cultivation and post-harvest lost due to improper storage conditions and packaging materials for paddy grain and seed. It is estimated that about 25% of annual value of paddy seeds are lost due to poor seed quality.

The quality of seed is most important in the mean of crop production as it is essential for good crop yields and minimizes the incident of crop failure. Seed vigour is recognized as an important seed quality parameter distinct from germinability. According to Seshu and Dadlani (1989), there are three major aspects of seed quality, namely genetic and physical purity, and high germination percentage and vigour, and most importantly free from seed-borne diseases and insects. Genetic purity means trueness-to-type of the seed lot and is important to assure the genetic identity. Seed vigor is to ensure the rapid, uniform emergence of seeds under a wide range of conditions. Seed carries fungi, bacteria, and viruses on the seed coat or within the seed cause plant diseases while insects can damage seed in storage therefore seed may need to be protected from them until it can be planted. It is proven that good quality seed can increase yield by 15-20% (Fakir, 2004; Alam *et al.*, 2009a). Therefore, Seed Certification Schemes is established to protect farmers and their customers by ensuring the seed they buy meets certain quality standards. The management of rice grain after harvesting has been reported to play an essential role in posterior maintenance of rice yield and quality. The post-harvest treatments often considered include methods and temperature of drying, storage moisture content (MC), storage conditions and duration (Daniels *et al.*, 1998; Pearce *et al.*, 2001). The period and condition of storage together with the quality of seeds greatly affect the germination rate and the period of which seed can remain viable without germinating (FAO, 2001). Longer storage period can cause loss of seed viability and vigourousity, and result in seed deterioration. This has been one of the major problems faced by seed producer agencies and farmers. Thus attention should be focused to retain viability in paddy seed during storage.

Storing paddy grain seeds under ambient condition is the most common practice use by farmers. However, storing paddy seed at ambient condition of a tropical country like Malaysia is quite challenging due to relatively high humidity and daily temperature. Seeds are hygroscopic in nature and capable to absorb and retain moisture from surrounding areas. High RH increases the seed MC, leads to biochemical events which is the increased of hydrolytic enzyme activity, respiration and free fatty acids. Another drawback storing seeds in high humidity environment is the growth of microflora fungi such as *Aspergillus* sp. and *Penicillium* sp. which require minimum usage of water to continue survive and reproduction (Nithya *et al.*, 2011). High temperature also enhances rates of occurrence of enzymatic and metabolic reactions. Due to seed deterioration during the storage stage, farmers tend to use higher quantity of seed than the actual requirement in sowing to compensate the ungerminated seeds and causes the seed wastage (Hossain *et al.*, 2002).

As normally practiced after harvesting paddy grains, farmers will store their paddy seeds that need to be sown for next growing season, and sell the excess immediately due to the poor storage. Rice farmers complain the rapid loss of seed viability during storage and will take the grains out and re-dry several times during storage period. This is mainly attributed to the packaging materials that utilize in storage paddy seed. The jute bags have been gradually replaced by polythene and polysacks bags, and more rarely, sealed in containers for paddy seed storage (IRRI, 2005). Several studies have been carried out at Chiang Mai (Hohenheim, 2005) and Bangladesh (Alam *et al.*, 2009b) to investigate the effect of packaging material and different storage periods on the viability and vigourousity of paddy seeds. However, very few studies have been carried out locally to examine the similar type of research work.

1.2 Justification

The optimum conditions and packaging materials for paddy grains storages is vital to avoid seed deterioration. Most local farmers keep paddy seeds that needed to be sown on for next growing season under ambient condition. This situation is normally practiced by farmers especially in developing countries. Most of the local traditional varieties are cultivated for only one season in a year as the maturation period are longer than 5 months. Hence, the harvested paddy seeds are stored for more than half a year in paddy granaries or warehouses. Usually, the seeds are stored in the traditional storage, which is known as a paddy granary at ambient tropical condition for a few months before sowing. Moreover, they bought seeds in bulk to reduce the price and thus to reduce the cost. They also need to maintain number of minimum stocks to prevent sudden drastic changes. In addition, farmers normally do not have cold room as it is very expensive to maintain. The electricity fee for a normal cold room which is running days and nights with the size of 10 width x 14 length x 10 feet height is RM 1500 per month (Mohd. Dandan, 2012). Amongst many constraints, quality seeds, post-harvest drying and storage facilities are considered as the major uptake barriers of improved rice production technologies available at Research Institutes in Bangladesh (Alam *et al.*, 2009b).

Huong (2011) stated that the highest storability of paddy seeds is those kept at freezer condition, which is 5-10 °C, RH 12-40% is 94.33% irrespective of the packaging materials used after 22 weeks. This is followed by air-conditioned room condition, which is which is 25-27 °C, RH 68-81% is 88.42% and ambient room condition, which is 28-33 °C, RH 70-85% is 40.67%. Therefore, the cold room is being added as another new storage condition. The cold room has lower temperature and relative humidity (RH) (5-10 °C, RH 50-60%) compared with freezer condition (10-20 °C, RH 55-60%). Normally, paddy seed can keep their viability for more than three years under cold room condition.

For the packaging materials, the best storage method which gives the highest percentage of germination of paddy seeds is stored in polyethylene (PE) bags (54.67%). Jute bags showed the germination percentage of 30.67%, polypropylene (PL) bags (36.67%) and continued by used flour bags (31.67%) after 22 weeks. This is because PE is air-tight and moisture-proof materials and can preserve seeds in short term storage. Therefore, the treatment of PL lined with different thickness of PE and thin aluminum foil (TAF) is chosen in this study. PE with different thickness is cheap and only about RM 8 to 10 per kg. PL lined with different thickness of PE can preserve seeds in short term storage because it is air-tight and moisture proof. In addition, TAF is cheap and being use as seed and food packaging material. Most importantly, it is affordable by farmers because for the size of a normal PL bag (80 cm x 55 cm), it costs RM50 for one hundred pieces. Most of the commercial seed being packed under this condition since it is reflective and air-tight. For example, the imported seeds from China and Taiwan, which can lasts for four years. Light cannot penetrate the aluminum and can prolong the longevity of paddy seeds in bigger packaging amount.

According to Karunakaran *et al.* (2001), the deterioration rate of rice is determined by measuring the germination capacity, respiration rates and microorganisms. Kawamura (2004) stated that the decreasing to about 50% of germination rate of rice subjected to room temperature indicating that the rice seeds had lost their viability during ambient room temperature storage. The declining of seed quality affects the paddy field performance, resulting in low germination rate, low growth rate, low pest and disease resistance, low competitive ability and lowered the yield.

The following experiments were therefore conducted to study the effect of different packing materials which are commonly used to preserve seed vigorousity and viability on different conditions. This study therefore expected to highlight an effective storage method for seed paddy under farmer's conditions. The result of this study can be proposed to farmers and this promotes the new storage conditions and packaging materials to them. This has wide practical importance to the local farmers and others who need to keep seed paddy viable for a longer period of time. This can contribute to the country food safety and securities since it can increase the storage capacity and minimize the farmers' losses.

1.3 Objectives

I. To determine the effect of different storage conditions on the viability of paddy seed variety TQR-8.

II. To determine the effect of different packaging materials on the viability of paddy seed quality TQR-8.

1.4 Hypothesis

H0: There are no significant differences of storage conditions and packaging materials seed viability over a period of time on paddy variety TQR-8

Ha: There are significant differences of storage conditions and packaging materials seed viability over a period of time on paddy variety TQR-8

CHAPTER 2

LITERATURE REVIEW

2.1 Paddy (*Oryza sativa* L.)

Rice is the major calorie source for a large proportion of the world's population. Two species of rice are considered important as food source for humans. They are *Oryza sativa* which is grown worldwide and *O. glaberrima* in parts of West Africa. Three most common sub-series of *O. sativa* are *Japonica, Javanica* and *Indica*. Rice is also the staple food of people in Sabah. It is grown both as wet and hill (dry) rice by local people (Hanafi *et al.,* 2009).

2.1.1 Paddy variety TQR-8

Paddy variety TQR-8 is released by Agriculture Research Centre, Tuaran. This is a new variety after research and studies were done by the Department of Agriculture which is a reliable variety because of the good eating quality and high yield potential of 7 t ha^{-1}. The detail characteristics of paddy variety TQR-8 more stated in Appendix A.

2.2 Paddy Seed Storage

The storage of seed stocks for planting the following season remains the most important reason for storing seeds. Farmers and seeds men found out that it is advantageous to carry seeds for two or more years. Damage from improper storage causes seeds receive internal fractures from impaction, moisture or heat stress without corresponding damage to the surface (Oren and Louis, 1978).

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