THE EFFECTS OF DIFFERENT DRYING METHODS AND DIFFERENT PACKAGING MATERIALS ON SEED VIABILITY OF TR-9 VARIETY PADDY SEED

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ABSTRACT

An experiment was conducted at the laboratory in Faculty of Sustainable Agriculture, Campus UMS Sandakan which is situated at Mile 10, Jalan Sungai Batang, 9000, Sandakan, Sabah with latitude 50 55' N and longitude 1180 02'E. This experiment studies the effect of different drying methods and packaging materials as lining on TR-9 paddy seed viability stored under ambient condition. The objective of the research are to determine the effect of different packaging materials on the viability of paddy seed under ambient condition and to evaluate the effects of different drying methods on the viability of paddy seed under ambient condition. Two factors were used in this experiment which are different drying methods and different types of packaging material. The experiment design consist of 3 drying methods which are mat drying, pavement drying and mechanical drying and 3 packaging materials which are polypropylene, polypropylene lined with polyethylene, and polypropylene lined with cloth bag, with 3 replications for each treatment. The data was analysed using Statistical Analysis System (SAS) and Two way analysis of variance (ANOVA) has been carried out to determine the independent variables and mean value were calculated using Least Significant Difference (LSD) test. The results revealed that seeds packed in polypropylene bags (control) and with pavement drying recorded consistently higher germination rate (96%) under ambient condition. Parameters such as seed vigour index (1005.62), height of seedlings (12.21 cm) and root length (5.33cm) 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 and PL-Cloth bag proved to be less effective for maintaining seed viability and vigour under ambient storage condition. Seeds that were dried using pavement drying and mechanical drying and packed with permeable packages (PL-control) were less subjected to the fluctuations of moisture. However, seeds dried using mat drying 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 TR-9 should be dried using pavement drying and kept in porous packages (PL-control) in order to maintain their viability and vigour under ambient condition.

KESAN KAEDAH PENGERINGAN DAN PEMBUNGKUSAN YANG BERBEZA SEBAGAI LAPISAN TERHADAP KETAHANAN BENIH PADI YANG DISIMPAN DI DALAM KONDISI OPTIMUM

ABSTRAK

Eksperimen telah dilakukan di makmal Fakulti Pertanian Lestari, Kampus UMS Sandakan yang terletak di Batu 10, Jalan Sungai Batang, 9000, Sandakan, Sabah dengan latitud 50 55 'N dan longitud 1180 02'E. Eksperimen ini mengkaji kesan kaedah pengeringan yang berbeza dan bahan pembungkusan terhadap ketahanan benih padi yang disimpan di dalam kondisi ambien. Objektif penyelidikan ini adalah untuk menentukan kesan bahan pembungkusan yang berlainan terhadap daya maju benih padi di bawah keadaan ambien dan untuk menilai kesan kaedah pengeringan yang berlainan pada daya maju benih padi di bawah keadaan ambien. Dua faktor telah digunakan dalam eksperimen ini iaitu kaedah pengeringan yang berbeza dan pelbagai jenis bahan pembungkusan. Reka bentuk eksperimen ini terdiri daripada 3 kaedah pengeringan iaitu pengeringan beralaskan tikar, pengeringan turapan dan pengeringan mekanikal dan 3 bahan pembungkusan yang digunakan adalah polipropilena, polipropilena bersama polietilena, dan polipropilena bersama beg kain, dengan 3 ulangan untuk setiap rawatan. Data dianalisis dengan menggunakan Sistem Analisis Statistik (SAS) dan analisis dua arah varians (ANOVA) yang telah dijalankan untuk menentukan pembolehubah bebas manakala nilai min dikira dengan menggunakan ujian Perbezaan Least Significant (LSD). Keputusan menunjukkan bahawa benih yang dibungkus dalam beg polipropilena (kawalan) dan dengan pengeringan turapan mencatatkan kadar percambahan secara konsisten (96%) dalam keadaan ambien. Parameter seperti indeks vigor benih (1005.62), ketinggian benih (12.21 cm) dan panjang akar (5.33cm) juga lebih tinggi berbanding benih yang disimpan dalam beg pembungkusan lain. Oleh itu, kajian ini menunjukkan bahawa beg pembungkusan yang lain adalah PL-LDPE dan beg PL-Cloth terbukti kurang berkesan untuk mengekalkan daya maju dan semangat benih di bawah keadaan storan ambien. Benih-benih yang dikeringkan menggunakan pengeringan turapan dan pengeringan mekanikal dan dibungkus dengan pakej permeabel (PL-control) kurang tertakluk kepada turun naik kelembapan. Walaubagaimanapun, benih kering dengan menggunakan pengeringan tebal yang dibungkus dalam pakej yang tidak dapat dijaga akan menyebabkan biji-bijian mengurai dan merosot lebih cepat. Kandungan kelembapan yang rendah membantu meningkatkan kebolehan benih yang boleh dikaitkan dengan kadar pernafasan yang rendah, aktiviti metabolik serta jangkitan mikroorganisma yang lebih rendah. Sebagai kesimpulan, pelbagai benih padi TR-9 perlu dikeringkan menggunakan pengeringan turapan dan disimpan dalam pakej berliang (PL-control) untuk mengekalkan ketahanan dan ketegaran tumbuh mereka di bawah keadaan ambien.

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LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

ANOVA	Analysis of Variance
cm	Centimetre
CRD	Completely Randomized Design
DAS	Days After Sowing
FSA	Faculty of Sustainable Agriculture
g	Gram
ISTA	International Seed Testing Association
LSD	Least Significant Difference
D1	Mat Drying
D3	Mechanical Drying
D2	Pavement Drying
PE	Polyethylene
PP	Polypropylene
P1	Polypropylene
P2	Polypropylene + LDPE
P3	Polypropylene + Cloth bag
RH	Relative Humidity
R	Replicate
SAS	Statistical Analysis System
T	Treatment
TR-9	Tuaran Rice 9
UMS	Universiti Malaysia Sabah

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

1.1 Background

Rice (*Oryza sativa* L.) is a staple food for people in Malaysia and is a contributor to the advancement of the national economy by earning revenue of 1.5 million tons in 2008. Total per capita rice is adopted by 82 kg and the net amount applied is 2.3 million tons per year in Malaysia (Raziah *et al.*, 2010). However, according to Slumith (2009), during the last few years, rice farmers in low-country wet zone increasingly complained about rapid loss of seed viability in storage due to the packaging materials in common use today. The use of quality seeds is one of the main conditions in the cultivation of rice (Wan Darman *et al.,* 2008). In order to maintain the quality of seed for a longer period of time, there are two factors that affect the seed viablility and quality, which are the drying method and the seed packaging material.

Drying is the phase of the post-harvest system where the seeds are rapidly dried until it reaches the "safe-moisture" level. The aim of this desiccation is to lower the moisture content in order to guarantee conditions favorable for storage or for further processing of the product (FAO, 1994). In some parts of Sabah, there are farmers who still uses traditional method of drying such as sun drying which is where the grains are spread out outside in the sun. Then, the sun heats up the grains and also the surrounding air. This causes the water to evaporate from the grains, which makes the grain dry (IRRI, 2007). There are several types of sun drying methods such as mat drying, pavement drying, panicle drying and field drying. On the other hand, mechanical drying is a mechanical way to remove the water from wet grains by blowing heated air through the grain. This drying is done until the grain has the desired moisture content. However, farmers do not own this mechanization which leads to the use of sun drying.

Moreover, drying is very important in seed production, as it brings about consistent, homogeneous post-harvest seed maturation (Berti *et al.*, 2005). According to International Rice Research Institute (2007), drying is an important stage in seed production as the quality of grains depends on it.

Micro-organisms, particularly fungi, can attack if the moisture content of the seed is high due to poor drying or high relative humidity (Tom Osborn, 2004). Drying is an important method in storing seed as it decrease the risk of fungi contamination. Tom Osborn (2014) stated that dry seeds are less affected to fungi. However, very dry seeds are prone to mechanical damage and injuries. Such damage may result in physical damage or fracturing of essential seed parts; broken seed coats permit early entry and easy access for microflora, make the seed vulnerable to fungal attack and reduce storage potential (Shelar, 2008). 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 in long term in appropriate environment.

Seed has been kept in storage after being harvested since humans domesticated plants from one growing season to the next usually after a gap of three to nine months (Tiwari and Dass, 2014). Some farmers in Indonesia keep their seeds in traditional seed storage which can be seen in Appendix C, Figure 2. Some Malaysian farmers tend to keep their seeds in a paddy house with each pole wrapped with zinc sheet. This will affect the quality of the seeds as it is kept for more than 5 months due to planting seasons of rice. A good quality seed is one of the key factors in maintaining high productivity of paddy. The quality of seed can increase the yield of a plant up to 15-20% (Alam *et al.*, 2009). The viability and the quality of the seed can only be maintained if it gets suitable condition for storage until the next planting season.

Several environmental factors contribute to seed deterioration and these conditions makes it very difficult to maintain viability during storage (Jyoti and CP Malik, 2013). Seed deterioration may be due to physiological changes during storage. According to Jyoti and CP Malik (2013), seed deterioration is associated with various cellular, metabolic and chemical alterations which includes peroxidation of lipid, disruption of membrane, DNA damage, impairment of RNA and protein synthesis which in turn cause several detrimental effects on seed. Furthermore, Nagaveni (2005) reported that seed deterioration during storage was due to damage of the membrane, enzyme activity, proteins and nucleic acid. These degradation changes resulted in complete disorganization of membranes and cell organelles, thus causing death of the seeds. Several factors such as temperature, seed moisture content and relative humidity would influence the seed longevity during storage (Onyekwelua and Fayose, 2007). Paddy seed can be stored up to 10 years in a cold room maintained at 4°C and 50% relative humidity with the expected result of low loss of viability.

In addition, seed packaging material is also important. Types of packaging material for storing seeds will influence percentage of germination, moisture contents and seedling growth. Moreover, 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. After drying seeds by using drying methods, it can be placed in a sealed moisture proof containers such as polyethylene bag. This can prevent the use of dehumidification.

1.2 Justification

When paddy reaches its physiological maturity, it is considered to be at its prime state in every aspect of its quality. Generally, paddy seed is stored at 12% moisture content for up to 5 years. However, it is very critical to store dried paddy in an ambient environment to the lowest reasonable rate of deterioration. In accordance to Copeland and McDonald (2001), traditional storage method is incompetent to dry and store grain properly which can lead to increase losses during storage when effective storage technology is unavailable particularly in rural area. This research will give some information on the methods of drying that can be used for the farmers to prevent more losses of paddy seeds during storage.

Generally, farmers keep their harvested seed in ambient condition. Therefore, they need to improve the effectiveness of storing their paddy seed to maintain and reduce quality deterioration. They usually buy seeds in a bulk volume as it reduce cost but in terms of storage, they do not have proper way in storing them. Most of the farmers could not afford to buy the costly storage such as cold room thus, they choose to store seed under ambient condition with less cost needed. Sometimes, the harvested seed do not properly dried up to the safe moisture content for storage purposes which leads to low yield production for that particular farmers. This is supported by Sugunya

Wongpornchai *et al.* (2003) which states that the management of rice grain after harvesting plays an important part in rice yield and quality.

This research will give some information of different packaging material that can be used as a lining with safe seed moisture content for paddy seed as reference of future research regarding to the efficiency of paddy seed storage. Moreover, the method for drying on seed is determined which is the most compatible with the type of packaging material used. 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. In order to fulfill the food demand, farmers needs to know the best way to store their seeds to maintain or increase the productivity of paddy.

1.3 Significance of Study

This research is conducted to improve the efficacy of drying methods of paddy on different seed packaging material. Malaysia is heavily reliant in the production of rice as it is the main food. It was for that reason, the way of drying and storing the seeds for good quality is required. Moreover, most farmers tend to store their seed in ambient temperature as they do not have cold room for storage of seed. This in turn will affect the quality of the seeds. Thus, the seeds will lose their viability and vigorousity. The germination rate of rice subjected to room temperature storage decrease to about 50% indicating that the rice seed has loss viability during ambient storage condition (Kawamura *et al.*, 2004). This study is conducted to determine the availability of possible useful packaging material with the right drying method for better seed storage on viability of seed. Furthermore, this research can benefit the farmers in terms of drying method availability and using the most suitable packaging material. This is because sun drying methods can be done without the help of any machines which saves cost in terms of money and time. Although the production of paddy is potentially increasing and sufficient for food supply, farmers need to consider the number of population that keeps increasing by time. Thus, it is very important for the farmers to keep the productivity of paddy maintained or improved in order to fulfill the demand of food.

1.4 Objectives

i. To determine the effect of different drying methods on the viability of paddy seed under ambient condition

ii. To evaluate the effect of different packaging materials on the viability of paddy seed under ambient condition

1.5 Hypothesis

H_o: There is no significant difference in different drying methods on the viability of paddy seed under ambient condition

H_a: There is a significant difference in different drying methods on the viability of paddy seed under ambient condition

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

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

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Rice

Rice (*O. 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). Rice is a green leafy plant that is in the kingdom Plantae and belongs to the order Poales that there are more than 18,000 species of flowering plants monocotyledons which are categorized by a single leafy seed in order Poales (Encylopaedia Britannica, 2015). It is derived from a plant belonging to the grass family Poales order for which there are seven families of Poaceae, Restionaceae, Centrolepidaceae, Anarthriaceae, Ecdeiocoleaceae, Flagellariaceae and Joinvilleaceae. According Bouchenak-Khelladi *et al.* (2014), Poales represents more than one-third of angiosperms monocotyledons and contains a microcosm.

2.1.1 Types of Rice

According to Vaughn (1994), there are 12 genera oryzae and rice in groups of at least 22 species of which 20 species are wild species, while two others are the kinds that have been cultivated *O. sativa* and *O.glaberrima* varieties. There are more than 40,000 varieties of cultivated rice (the grass species *Oryza sativa*) said to exist. But the exact figure is uncertain. Over 90,000 samples of cultivated rice and wild species are stored at the International Rice Gene Bank and these are used by researchers all over the world (Rice Association, 2017)

2.2 Paddy variety Seri Sabah (TR-9)

The variety studied in this project is paddy variety Seri Sabah. This paddy strain TR-9 or Seri Sabah was released by the Tuaran Agriculture Research Centre in a way to increase the production of rice in our country as a mean for self-sufficiency. It has a high disease resistance and at the same time it can produce high yield that can reach up to seven or eight tons per hectare.

Moreover, this paddy variety is expected to reach a harvested yield up to 10 tons in one hectare of land under proper utilization of agriculture technology. Thus, it can help in increasing the yield of paddy farmer in Sabah as the yield of harvested paddy is only 3.5 tons per hectare compared to previous yield that is only about one ton per hectare according to Utusan Sabah Online (2009). On the other hand, this can aid Sabah government to reach self-suffiency in the production of rice in the future as the self-sufficiency in Sabah is currently below 30 percent (Borneo Post Online, 2016). Table 2.1 shows the agronomy of the paddy variety Seri Sabah (TR-9).

Table 2.1: The characteristics of TR-9 paddy seeds

Characteristics	**Description**
Breed	IR 4215--301-2-2-6//BG 90-12/IR 19661-131-1-2
Progeny code	IR 32809-26-3-3
Maturation period	123 - 133 day
Plant height	64.2 - 82.1 cm
Lodging resistance	Durable
Plant habit	Erect and upright
Leaf color	Green
Leaf senescence	Moderate
Number of grain per panicle	114 - 139 seeds
Number of panicle per paddy	13 - 18
Seed shape	Oval long
Eating quality	Moderate
Weight of thousand grains	23.5 - 25.5 gram
Shattering	Moderate
Yield range	5.0 - 7.2 tons per hectare
Resistance against pest	

Red disease	High resistance
Rice blast	Semi resistance
Rice blight	Semi high resistance
Leaf hopper	Semi resistance

Source : Department of Agriculture, Sabah

2.3 Paddy Seed Structure

The paddy seed is a caryopsis in which the single seed is fused with the wall of the ripened ovary which is also known as the pericarp, forming a seed-like grain (Te-Tzu *et al.*, 1965). Caryopsis is a dry one-seeded fruit in which the ovary wall is united with the seed coat. Paddy seeds have one cotyledon, which is small in size and is covered by the endosperm which pairs with the embryo. According to Salehah (2008), the embryo consists of the embryonic axis and cotyledons. Paddy seed is a monocotyledon that has a thin cotyledon called scutellum which acts as a storage structure for nutrients, supply energy for the young seedlings from the absorption of nutrients and protecting the terminal bud. The embryonic axis consists of plumule and radical, which is an important part in the growth of the seeds. Moreover, the husk consists of palea, lemmas, and rachilla which will form to cover the caryopsis paddy seed. Matured caryopsis will be surrounded by the endosperm. Inside the seed coat of the paddy seed are three main layers which consist of pericarp, tegmen and aleurone layer.

The embryo is a very small organ which is located at the edge of the caryopsis. It contains plumule and radical connected by a short stalk called mesocotyl. There is a protective sheath called the coleoptile over the plumule and another, the coleorhiza, surrounding the radicle.

Rice is a monocot. During the process of seed germination, scutellum will dissolve food deposit in endosprem by secreting hydrolase enzyme (Salehah, 2008). In addition, scutellum will also distribute food to the plumule and radicle. Plumule and radical are two important parts in the seed which lies in the embryo in which the plumule will grow the first leaves and radical will form roots. The figure (Figure 2.1) below shows the structure of rice grain.

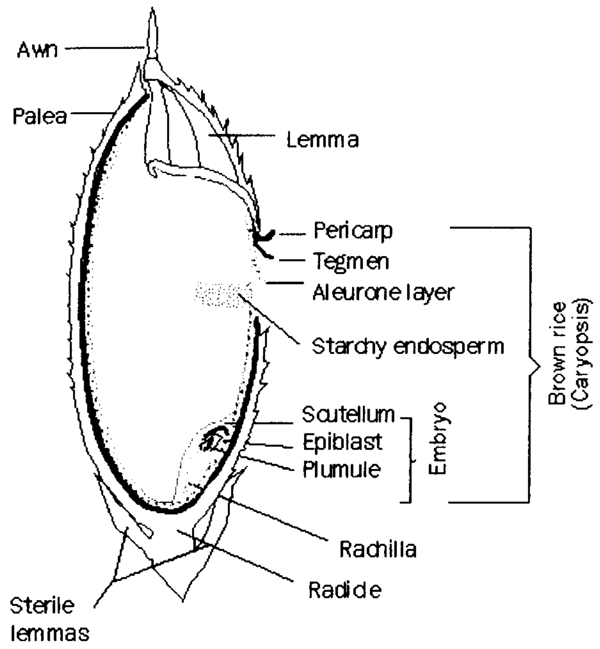

Figure 2.1 The structure of rice grain
Source: Ikisan, 2016

Rice seed storage tissue consists of three parts, namely, endosperm, perisperm and gametophyte (Saadiah, 1995). Endosperm covers the cotyledons which is provides food for the mature ovary. It also contains a layer of aleurone and starchy endosperm (Diosado and Pagsuberon, 1970). Aleurone layer is a layer that forms the outer layer of tissue endosperm. Aleurone contains a starchy layer of parenchyma cells which have a thin wall layer that contains starch and high protein content (De Datta, 1981).

Furthermore, seed coat is the part that protects the embryo so that it is not exposed to the environment that can cause damage to the seed quality. Moreover, it also prevents the entry of microorganisms into the seeds and prevents germination occuring at inappropriate times (Saadiah, 1995). The husk is retained and the whole seed is planted to be used to grow a new rice crop. 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. Paddy are perennial crops which means that it will grow from season to season. However, paddy crops are being planted annually to achieve better yield and production.

2.4 Paddy Seed Morphology

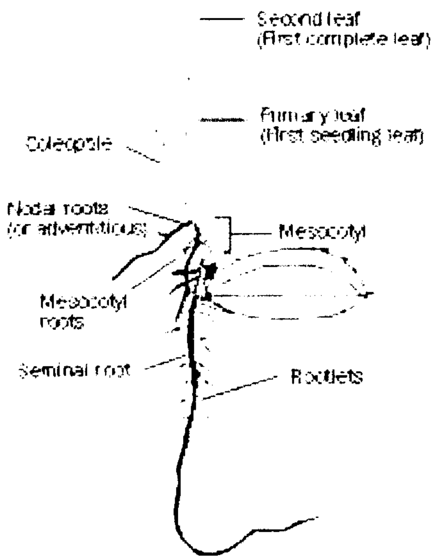

Figure 2.2 Parts of a germinating seedling

Source: Ikisan, 2016

When seed dormancy has been broken and the seed receives adequate water and is exposed to a temperature ranging from about 10-14°C, germination and seedling development will start. In terms of physiological definition, when the radicle or coleoptile (embryonic shoot) emerges from the seed coat, germination occurs. Under aerated conditions the seminal root is the first to emerge through the coleorhiza from the embryo, and this is followed by the coleoptile. Under anaerobic conditions, however, the coleoptile is the first to emerge, with the roots developing when the coleoptile has reached the aerated regions of the environment. If the seed develops in the dark as and when seeds are sown beneath the soil surface, a short stem (mesocotyl) develops, which lifts the crown of the plant just below the soil surface. After the coleoptile emerges it splits and the primary leaf develops.

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