EFFECT OF HYDROPRIMING ON SEED GERMINATION OF TONGOD WANGI UPLAND RICE

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ABSTRACT

A study was undertaken to investigate the effect of hydropriming on the germination of Tongod Wangi upland rice seeds. All experiment were carried out at the Faculty Sustainable Agriculture, Universiti Malaysia Sabah. Two seed lots: non accelerated aged (non-AA) and accelerated aged (AA) were used. Both lots were hydroprimed for 0, 6, 12, 24 and 48 hours in tap water at 30 ± 2 °C . After priming, seeds were air dried. Seed moisture content and germination were determined. The initial moisture content was found to be 8.37 % for non AA seeds and 19.22 % for AA seeds. Seed germination percentage was recorded to be 86.75 % and 84 % for non AA and AA seeds, respectively. Both AA and non AA seeds displayed the triphasic moisture absorption pattern. Seed germination increased with the increase in hydropriming up to 24 hours. Parameters on seedling growth and development showed that hydropriming of non AA and AA seeds was beneficial for seeds primed for 6 to 12 hours. However, extending the duration of priming to 48 hours resulted in deleterious consequences on seedling growth and development.

KESAN HYDROPRIMING KEATAS PERCAMBAHAN BIJI BENIH PADI BUKIT TONGOD WANGI

ABSTRAK

Satu kajian telah dilakukan untuk mengetahui kesan keatas percambahan biji benih padi bukit Tongod Wangi. Semua eksperimen telah dijalankan di Fakulti Pertanian Lestari, Universiti Malaysia Sabah. Dua lot biji benih: tidak dilakukan penuAAn buatan (non-AA) dan dilakukan penuAAn buatan (AA) telah digunakan. Kedua-dua lot biji benih telah direndam untuk 0, 6, 12, 24 dan 48 jam dalam air paip pada suhu 30 ± 2 °C. Selepas rendaman, biji benih dikering udarakan. Isi kandungan air biji benih dan percambahan telah ditentukan. Isi kandungan air awal bagi biji benih non AA ialah 8.37 % dan bagi biji benih AA pula ialah 19.22 %. Peratusan percambahan biji benih bagi kedua-dua lot ialah 86.75 % (non AA) dan 84 % (AA). Kedua-dua lot biji benih non AA dan AA menunjukkan tren penyerapan tiga fasa. Percambahan biji benih juga meningkat dengan peningkatan jangkamasa rendaman sehingga 24 jam. Parameter tumbesaran dan perkembangan anak benih menunjukkan rendaman antara 6 hingga 12 jam memberi kesan yang baik terhadap biji benih non AA dan AA. Walau bagaimanapun, sekiranya rendaman dtingkatkan sebanyak 48 jam, kesan negatif akan didapati keatas tumbesaran dan perkembangan anak benih.

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LIST OF SYMBOLS, UNITS, AND ABBREVIATIONS

%	Percentage
°C	Degree Celcius
AA	Accelerated Aging
ANOVA	Analysis of variance
cm	Centimetre
DAS	Day After Sowing
FSA	Faculty of Sustainable Agriculture
g	Gram
GI	Germination Index
kg	Kilogram
M	Mass
MC	Moisture Content
RH	Relative Humidity
SVI	Seed Vigor Index
UMS	Universiti Malaysia Sabah

LIST OF FORMULAE

CHAPTER 1

INTRODUCTION

1.1 Background

Seed marks the beginning of each plant production (Milosevic *et al.,* 2010). To enhance rice productivity the quality of seeds sown must be good. Good quality seeds are those that are free from any disease and can give high germinability and vigor (Chhetri, 2009). As seeds are alive, their quality will keep decreasing from time to time. Daniel *et al.,* (2012) stated that all living things, including seed deteriorate with time and if this continues the seed will eventually die. Therefore, the question is how can their physiological maturity be maintained longer. Seed priming technique could be a possible method to enhance seed quality.

Priming has shown positive impacts on farming systems and livehood for farmers and at the same time has been popular among the farming community (Harris *et al.,* 2001, Musa *et al.,* 2001). Bewley and Black (1982) said that seed priming leads to the initiation of primary metabolic processes, so the time required for germination is reduced. This positive effect could be due to the stimulatory effect of priming on later stages of the germination process through the mediates of cell division in germinated seeds (Sivritepe *et al,.* 2003). Farooq *et al.,* (2006b) stated that seed priming treatment affected on metabolic, bio-chemical and enzymatic status of seed, thereby raising its power in order to better play their biological functions, such as germination and seedling establishment. Priming is a low risk technology (Harris et al., 1999) and low cost solution for poor stand establishment (Farooq et al., 2006a, 2009).

1.2 Justification of Study

Rapid seed deterioration is one of problems faced by farmers. One seed producer would store in his warehouse seeds for at least six months to one year before selling them to farmers (Chhetri, 2009). As the quality of seed would deteriorate over time, the longer the seed were kept, the poorer the quality of the seed would be. Deterioriation is an irreversible, inexorable and inevitable process and varies with the seed lot (Delouche *et al.*, 1973).

To ensure seed quality in terms of viability, vigor and longevity, a step must be taken. Therefore, priming is one of the methods to solve this problem. Priming is done on the premise that seeds have a built-in system to counter the impact of deteriorative events and when given the right conditions, seeds have active mechanisms to repair (De-Guzman and Aquino, 2007). For rice, beneficial effects of hydropriming on seed longevity had also been reported (Basu and Pal, 1979). Hydropriming gives favorable effect on rice seed of traditional and farmer-bred varieties, in terms of enhanced seed quality and ultimately seed germinability after storage (De-Guzman and Aquino, 2007).

Tongod Wangi is an upland rice commonly sown in the rural areas of Sabah. Farmers would sow seeds available to them regardless of quality. Hydropriming seeds prior to sowing would perhaps improve germination and vigor of these seeds.

1.3 Objective

The objective of this study is to evaluate the effect of hydropriming on germination of Tongod Wangi upland rice seeds.

1.4 Hypotheses

The proposed hypothesis for this study are:

H_0: There is no significant different on the effect of hydropriming on germination of Tongod Wangi upland rice seed.
H_a: There is significant different on the effect of hydropriming on germination of Tongod Wangi upland rice seed.

CHAPTER 2

LITERATURE REVIEW

2.1 Sabah Upland Rice Characteristic.

In Malaysia, rice is cultivated in lowland area as wet rice (peninsular Malaysia, 503, 184 ha) and upland area (Sabah and Sarawak, 165,888 ha)(DOA, 2005). In 2005, the total national rice production (TNRP) was approximately 2.24 million metric tonnes, which was contributed by eight granary areas. Nevertheless, this only catered for 60 – 65% of the domestic requirement. Thus, Malaysia still imports 458,600 metric tonnes of rice to fulfil the requirement of its population (DOA, 2005).

Sabah is a part in Borneo Island. It is the second largest state in Malaysia with an area of 73, 619 square kilometres and has about 3.1 million population in it in 2010 (Imang and Ngah, 2010). As agriculture is the second largest economic sector in Sabah, production of rice were included. It is an important food crop particularly fo rural population. Upland rice cultivation is practiced mostly by the rural communities living especially in Sabah and Sarawak. For farmers, it is still an important agricultural activity for home use and sometimes they sell their surplus to earn some money (Hanafi *et al.,* 2009).

Upland rice is typically grown under slash-and-burn technique. It is due to the poor technology and innovation of upland rice cultivation in Malaysia (Saito *et al.,* 2005). In the study of Hanafi *et al.*, (2009), for cultivated rice, the forest land used are within 1- 2 years and then will be abandoned for 3-5 years to permit a re-growth of the forest species and restore soil fertility.

Besides that, Hanafi *et al.,* (2009) also found that a total of 35 varieties of upland rice seeds, collected from their survey of the upland rice farmers at various locations in Malaysia, including Sabah and Sarawak. These varieties were inherited from the previous generation of farmers. Upland rice has many desirable characteristics. Some were good in their fragrance, colours, sizes and shapes. These qualities contribute to their popularity among the farmers and health-conscious consumers as an organic food. In addition, even a farmer have several varieties of upland rice seed. They selected only some to be cultivated. Based on their preference of taste and all good characteristics of the seed itself (Hanafi, *et al.,* 2009).

The name of rice varieties is based on their characteristics, origin, or by maintaining the ancestral name by the farmers. Therefore, even the variety may be the same but it may have two different names at different locations or districts (Hanafi *et al,.* 2009). According to Mariam *et al.* (1991), the varieties with different names might sometimes belong to the same variety when some of these varieties were introduced to places with different ethnic backgrounds.

The survey of Hanafi *et al,.* (2009) also showed that the cultivated upland rice varieties required 4 to 6 months to complete their growth and produce grain yield. Each variety has its own growth cycle. Generally, early maturing rice varieties are within 90 – 105 days, medium varieties are within 105 – 130 days, and late-maturing are within 130 – 150 days (Jacquot and Courtois, 1987).

2.2 Seed Moisture

According to Martin and Multon (1988), seed moisture is a measure of quantity of water that is lost by the seed when it is brought into true equilibrium with zero water vapour pressure (RH = 0%), under conditions whereby possible disturbing reactions involving volatiles or chemical reactions (oxidation) are avoided. Water that are expressed on wet-weight basis is not as relevant as the water activity (Aw) or chemical potential of water in the system. The water activity is a measure of the vapour pressure generated by the moisture present in a hygroscopic material such as seed. It reflects the active part of MC or the part which, under normal circumstances, can be exchanged between the seed and its environment (ISTA, 2009).

2.2.1 Moisture Testing During Drying

ISTA (2009) stated that seed moisture testing helps in establishing the speed of drying and also the initial drying temperature. The higher the moisture content of the seed the lower the initial drying temperature. A steep moisture gradient that cause hardening of the outer seed surface is a result of drying too fast. It could also reduce germination capacity of the seed. Lai *et al.,* (1995) stated that throughout the drying process, moisture should be monitored to ensure the drying temperature is appropriate and to determine when a safe moisture content for storage has been reached. Moisture content also can be used to determine the normalised (dry) weight of seed lots without weighing seed lots after drying.

2.2.2 Moisture Testing on Seed Treatment of Priming.

Priming is a seed treatment whereby seeds are hydrated then they are re-dried when germination process had began but radicle emergence has not occured (Tavili *et al.*, 2010). The moisture contents are critical on both of priming treatment and post treatment. The moisture content of seed during drying back could determine the improvements in germination performance gained from priming and are retained during subsequent drying back (Schwember and Bradford, 2005).

2.2.3 Relative Humidity.

Relative humidity is the ratio of the vapour pressure of the moist air to its saturation vapour pressure at its temperature, which is expressed in %. RH is an important control parameter in drying seeds. . There are several different methods to measure the relative humidity, such as electronic humidity sensor hygrometry, paper hygrometry and psychrometric hygrometry.

The modern principle of psychrometric hygrometry is that the humidity is obtained by the dry-and-wet bulb data table directly. The dry bulb are just a common thermometer used to check the temperature of the surrounding while wet-bulb thermometer is basically an ordinary glass thermometer with a wetted cotton wick secured around the bulb (Figure 2.1). Air is forced over the wick, causing it to cool to the wet-bulb temperature. The wet- and dry-bulb temperatures together determine the state point of the air on the psychrometric chart, allowing all other variables to be determined (Thompson, 2002).

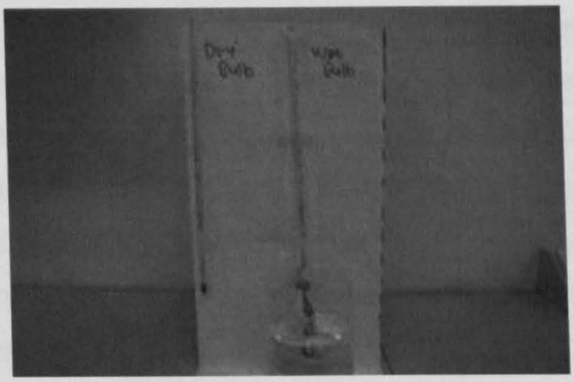

Figure 2.1: A wet- and dry- bulb thermometer set-up.

2.3 Germination of the Seed

According to ISTA (2009), germination is the process that transforms the embryo of a seed into an independent photosynthesising plant. It is the transition of dormant embryo that are developed from fertilized ovule into a new photosynthetically active plant (Bove *et al,.* 2001). Germination is terminated when radicle emerged from the seed and it marks the beginning of seedling growth (Bewley, 2001). The seed should be viable, surrounded with suitable temperature, provided with adequate supply of water and oxygen, and in some cases there must be absence of light requirement for a seed to germinate.

ISTA (2009) also stated that the development of a dry seed into new plant involves four groups of processes. There are the imbibition of water, the formation of enzyme systems, the growth starter and radicle emergence and lastly the development of the seedling.

2.3.1 The Imbibition of Water

The seeds are hydrophilic and water is diffused through the seed tissues and adsorbed to the seed coat. Water can soften the seed coat so it allows respiratory gases and the whole seed swells as the cells become turgid (ISTA, 2009). The first process which occurs during germination is the uptake of water by the seed (Mayer and Poljakoff-

Mayber, 1963). The water uptake always follows the triphasic pattern as shown in Figure 2.2 (Bewley, 1997).

The first thing to take place is imbibition. The extent to which imbibition occurs is determined by three factors which is the composition of the seed, the permeability of the seed coat or fruit to water, and availability of water in liquid or gaseous form in the environment (Mayer and Poljakoff- Mayber, 1963). This is a phase where water uptake by the alive and dead seeds are rapid and that happens because of water potential difference between dry seeds and water are large. At initial hours of imbibition there is a rapid increase in fresh weight. Moisture content is increased from about 5 to 75% with the seed regaining the same amount of water that was lost during ripening (ISTA, 2009). Repair to dessication and rehydration-induced membranes damage is initiated during imbibition (Bewley, 2001). Metabolic activity in this phase is resumed thus activates the essential cellular structure and enzymes for the commencement of metabolism in the seeds (Bewley, 2001).

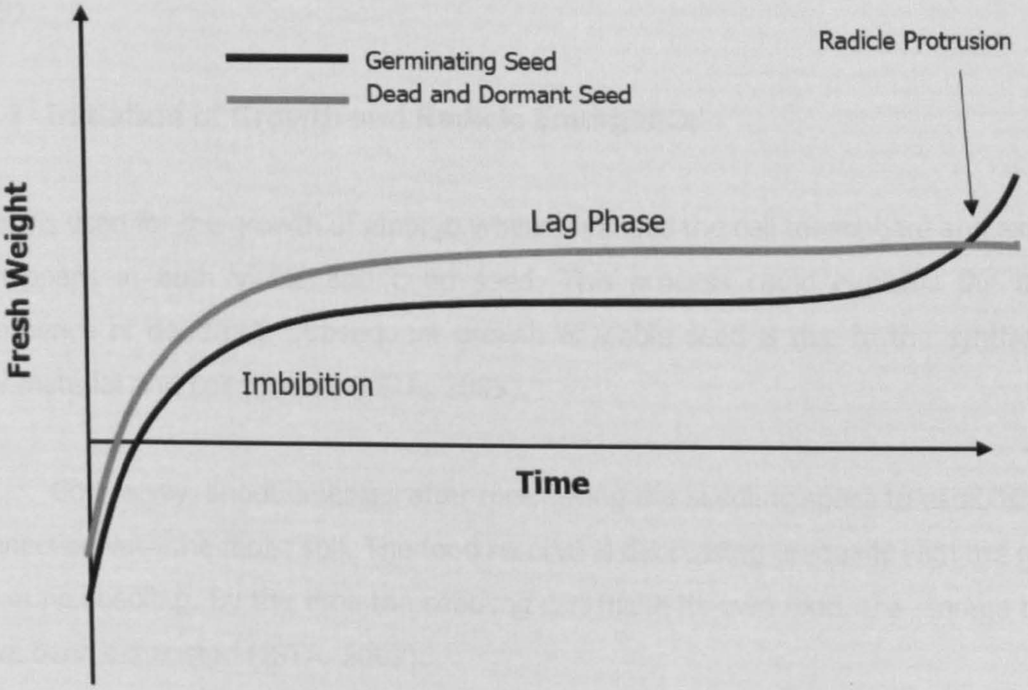

Figure 2.2: Water uptake as changes in fresh weight with time, of dead, dormant and germinating seed (ISTA, 2009)

2.3.2 Formation of Enzyme System and Utilisation of Food Reserve.

ISTA (2009) stated that in a viable seed, vacuoles are formed from the cell of embryo when imbibition occurs. It is when the water absorbed highest at initial period resulted with rapid increase in seed fresh weight followed by lag phase with only a small change in fresh weight. During the process, enzymatic component systems and the metabolic systems were reactivated.

There is general mobilisation of seed's food reserve during lag phase stage. The carbohydrate, fats/oils and protein are three types of seed storage compounds found in seeds. This insolubility of food storage compounds prevent leaching upon imbibition. In order to use it for energy and growth they have to be converted into enzyme at the first place. The enzymes activated at this lag phase, are used as catalysts for the reactions involved in the breaking down, assimilation and use of all the storage compounds. Physiological germination begin when the rupture of the seed coat and radicle emergence occur and this is used as indicator of the end of the lag phase end (ISTA, 2009).

2.3.3 Initiation of Growth and Radicle Emergence

Water is used for the growth of embryo where it caused the cell to elongate and expand. It happens in both viable and dead seed. This process could explains the radicle emergence of dead cell. Subsequent growth of viable seed is due to the synthesis of new material and cell division (ISTA, 2009).

Commonly, shoot emerges after root, giving the seedling space to establish early connection with the moist soil. The food reserve is decreasing gradually with the growth of young seedling. By the time the seedling can make its own food, the storage tissues have been exhausted (ISTA, 2009).

2.3.4 Growth and Development of the Seedling.

Etioliation, when growth occurs in the absence of light is the process of elongation of the stem which can progress through the soil (ISTA, 2009). There are two types of growth pattern of seedling which is hypogeal and epigeal. The cotyledon of hypogeal germination are below the ground and its epicotyl emerge and elongate from the soil. On the other hand, the cotyledon of epigeal germination are pulled out from the soil due to hypocotyl elongation (ISTA, 2009).

2.4 Hydropriming

Seed priming is an approach to add moisture to seeds allowing seeds to be hydrated partially without radicle emergence (Farooq et al. 2007). Soon *et al.,* (2000) stated that in hydropriming seed are soaked in water and dried before sowing. The seeds can be soaked with or without aeration (Thornton and Powell, 1992). Hydropriming uses no chemical so it is very environmental friendly and safe. However, Pill and Necker (2001), contended that this method can cause un-uniform germination because sometime seed hydration is uneven. On the other hand, Taylor *et al.,* (1998) stated that seed vigour enhancement through priming treatments have proven to be very effective to achieve rapid and uniform seed germination of several vegetable species and rice (Lee *et al.*, 1998). The beauty about hydropriming technique is, it is simple, economical and eco-friendly because only plain water is used (Prasad *et al.*, 2012).

In an earlier study, hydropriming in rice for 40 or 48 h was the most suitable duration for better seedling invigoration (Prasad *et al.,* 2012). In addition, hydropriming of wheat for 24 h resulted in increased grain yield (Kahlon *et al.*, 1992). For De Guzman and Aquino (2007), rice subjected to hydropriming by soaking seeds in water for 10 h and drying back to their initial moisture content, can prolong the storage life of seeds by 4.7 months.

2.5 Accelerated Aging

2.5.1 Deterioration of the Seed

Seed aging has to be recognized as the major cause of reduced seed vigor and viability, and involves the process of deterioriation like the accumulation of degenerative changes until eventually the ability to germinate is lost (Powell, 2006). According Chhetri (2009), seed deterioriation usually begins at physiological maturity and continues during harvest, processing and storage at the rate greatly influenced by genetic, production and environmental factors.

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