EFFECT OF COLD AND AMBIENT ENVIRONMENT STORAGE ON THE RICE SEED QUALITY

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ABSTRACT

Rice cultivation is the second largest agricultural activity after the oil palm industry in Malaysia. The area of rice cultivation was 689 810 hectares in 2018. Rice production showed a positive growth of 2 138 788 tons in 1994 to 3 064 822 tons in 2018. Rice cultivation starts from the seeds that need to be supplied and stored so that the continuation of rice cultivation and the supply of national rice can continue to be guaranteed. The improvement of the storage system of rice seeds in Mardi Parit Perak has been implemented. The ability of the benefits of a storage room with a temperature of 15-200C and relative humidity 50-60% on the quality of three varieties rice seeds have been studied. Measurement of the analysis of germination, colour, insect control and bulk density (BD) of rice seeds during storage are some of the studies carried out. Germination of rice seeds is still above 80% stored in the storage room compared to stored outside the room. Insect insects are successfully prevented if kept in storage rooms. The need and help of the storage room at that temperature and humidity have been able to maintain germination and prevent insects from rice seeds and further guarantee the country's food security.

Keywords: Rice seeds, germination, storage room, temperature and humidity, food security

INTRODUCTION

Rice is one of the most important food crops, it is consumed as a staple food by more than half of the world's population and fulfils over 21% of total caloric requirements (Sharma et al., 2019; Khush 2005). Paddy is stored in different types of storage such as rooms and silo for certain periods till they reach the consumers which play an important role in the proper preservation of its.

Temperature and moisture content of the grain provide the basis for extension of storage period, alternatively upon further processing of paddy. Temperature also is a substantial biotic stress that affects both morphological and physiological features of rice during storage. The use of low–temperature storage system could efficaciously depress insect insect activities and mold growth (Banks and Fields 1995; Kawamura et al., 2000) while storage at high temperature and/or humidity conditions could be deteriorative for rice growth and germination (Wang et al., 2018). Rice seeds stored in a natural environment or a high temperature condition showed lower physiological quality but those stored at a low temperature exhibited higher physiological and physical quality (Marques et al., 2019; Jungtheerapanich et al., 2017).

Insect depend on their food supply to obtain the moisture they require for their life processes. The higher the moisture of the grain, the higher the rate of increase of insects. Microorganisms are unable to multiply when the ERH is below 65%. Because insects cannot control their body temperature, their rates of development and reproduction increase with rising temperature (up to a critical limit). Consequently, most of them become inactive at low temperatures (10–15°C) (Shlomo and Jonathan 2005). Among the insect that commonly found in rice seeds are Rice Weevil (*Sithopilus Oryzae*, SO), Angoumois Grain Moth (*Sitatroga Cirealella*, SC), Lesser Grain Borer (*Ryzhoperta Dominica*, RD), Saw-Toothet Grain Bettle (*Oryzaepilus Surinamensis*, OS) and Rust-red Flour Bettle (*Triboleum Casteneum*, TC).

The most common and universally accepted method to determine seed viability is the germination test. A standard germination test is conducted under standardized conditions as outlined by International Seed Testing Association (Anon. 1985). Determination of colour can be carried out by visual inspection instruments. Determination of colour by human inspection is extremely varied from observer to observer. Therefore, standard colour is often used, measured by L*a*b* units, using either a colorimeter or specific data acquisition and image processing systems. The L*a*b* is an international standard for colour measurements, adopted by the Commission Internationale d'Eclairage (CIE) in 1976 and widely used in agriculture. L* is the luminance or lightness component, which ranges from 0 to 100, a*(from green to red) and b* (from blue to yellow) are the two chromatic components, which range from –120 to 120 (Mohebbi et al., 2011; Wan et al., 2011; Afshari-Jouybari and Farahnaky 2011). The objective of this study was to assess and comparing the bulk density (BD), seed color changes, germination and insect control of the paddy seed that stored inside and outside of the controlled environment.

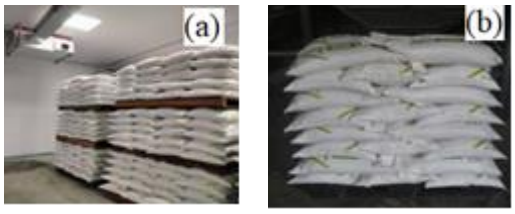
Table 1. Response of stored-product insects to temperature (Fields, P. G. 1992)

Zone	Temperature (°C)	Effect
Lethal	50 - 60	Death in minutes
	45 - 50	Death in hours
Supraoptimal	35	Development stops
	33 - 35	Development slows
Optimal	25 - 33	Maximum rate of development
Suboptimal	13 - 25	Development slows
	13 - 20	Development stops
	5 - 13	Death in weeks to months (unacclimated)
Lethal, movement stops	0 - 5	Death in weeks (unacclimated)
	–10 - 0	Death in days to weeks (unacclimated)
	–25 - –15	Death in minutes to hours, insects freeze

MATERIAL AND METHOD

Three varieties of paddy namely MR315, MR 297 and MR76 was used as sample to study the ability toward resistance on colour change, insect, germination and even bulk density. It was packed in polypropylene woven bags and stored at different location which are in store at certain condition (temperature, 15-20^{0}C and RH, 50-60%) and in store room at ambient condition (temperature 28-30^{0}C and RH 70-80%) as shown in Figure 1(a) and (b) respectively. The moisture content (MC) of samples were ranging 12-13% (stored in cold room) and 13-14% (stored in ambient room).

Figure 1. Paddy seeds stored in (a) cold storage and (b) ambient storage



The bulk density (BD) is one of physical property and meaning the ratio of mass of the paddy to its total (bulk) volume. It was determined by filling a circular container of known volume with paddy. BD analysis of paddy carried out using Seedburo brand equipment (Figure 2(a)). Rice weighing 500 g was used for each test and repeated 3 times. The colour of paddy for each sample was measured using the Chromameter (CR200, Minolta Co. Ltd. Japan) (Figure 2(b)). Measurement was based on the

L*a*b* colour system. The chromameter was calibrated with a standard white tile (L* = 100:01; a* = -0:01; b* = -0:02). Germination tests were carried out for a week. One hundred seeds were used in each of the four replications. Germination was done by sowing 3 x 50 seeds on top of wet tissue paper and placing them in plastic container at ambient condition of temperature 28 to 30^0 C and 80% RH (Figure 2(c)).
The final germination percentage (FG %) was calculated as follows:

$$FG\ (\%) = \frac{\text{Number of normal seedlings}}{\text{Number of total seeds}} \times 100$$

The germination count was done on 5th days after sowing according to the MS 469:2012. Insect attack studies were conducted on rice seeds stored in the storage room and outside the room. Analysis is done every 2 months by examining a 50 g sample to see if there are insects and counting. All the results were comparing and analysed using the ANOVA.

Figure 2. (a) Bulk density (b) Chromameter and (c) Germination

RESULTS AND DISCUSSION

Table 2. Results of BD of rice seed stored for 6 months

	Cold Room (kg/m^3)			Ambient Room (kg/m^3)		
Varieties	MR315	MR297	MR76	MR315	MR297	MR76
BD (kg/m^3) 1st month	42.53a	45.58a	47.70a	41.06a	44.05a	47.57a
BD (kg/m^3) 6th month	42.21a	45.80a	47.13a	36.59b	41.49b	46.41b

Value at same alphabet in the column is not significant

BD of rice seed samples stored for 6 months in two different locations showed in the Table 2. Seeds stored in the storage room have a BD value in the range of 42.21 - 47.70 kg/m^3. We found that from statistic test there are no changed in BD even though it was stored for 6 months. Meanwhile for samples stored outside the storage room is around 36.59 - 47.57 kg/m^3 were decreased in BD. It means the temperature (15-20^{0}C) and RH (55-60%) could play a role to maintains the BD value due to less doubt of biological or others. Data of BD also indicates the purity-degree of the grains since the presence of light foreign matter reduces the grain density (Semple et al., 1992). Since the BD value of seeds stored in cold room shows no changed, it's could be no presence of light foreign matter than the seeds stored in ambient temperature.

Table 3. Results of germination test of rice seed for 6 months

	Cold Room (%)			Ambient Room (%)		
Month/Varieties	MR315	MR297	MR76	MR315	MR297	MR76
2	87(2.94)	88.67(2.45)	89(5.26)	83.67(7.70)	84.67(2.50)	91.33(2.16)
4	84(3.87)	90.33(4.86)	88.33(2.52)	63(6.65)	58.33(13.99)	79.33(4.27)
6	86.67(3.30)	80(4.24)	89.67(1.29)	63(6.65)	21(2.38)	51.33(5.92)

Value in bracket is standard deviation

Table 3 shows the germination results of rice seeds that have been stored in two different locations. The controlled temperature and humidity factors have caused the germination of seeds stored in the storage room to remain above the minimum level of germination which is always above 80% even if stored for 6 months. Seeds stored outside the room at normal temperature and humidity have caused the ability of seed germination to decrease over time, until the 4th month has caused the germination percentage to be below 80%. As discussed in the introduction section, the effect of temperature (below 20^{0}C) and RH (below 60%) has maintained the germination capacity of rice seeds. Study by Teng and Shaharuddin (1982) have stated that when stored under air-conditioned environment of 19 – 23^0 C and 60% RH they can be safely stored dan maintained the germination of seeds for about 18 months. The same findings and reports were also stated by Wang et al., 2018. Marques et al., (2014) and Jungtheerapanich et al., (2017) found that rice seeds that are stored in a normal environment or high temperature conditions make the seeds to be of

low quality compared to if they are stored at a low temperature which causes the quality of the seeds to increase. They stated that the role and factors of temperature and humidity are important and affect the germination of rice seeds.

Table 4. Results of colour test of rice seed for 6 months

	MR315			MR76			MR297		
	L	a	b	L	a	b	L	a	b
Cold Room (1st month)	64.94a	-0.52a	19.97a	64.24a	1.35a	20.32a	58.25a	0.57a	17.90a
Cold Room (6th month)	60.79a	-1.06a	22.22a	63.44a	1.26a	23.64b	61.46a	1.20a	24.06b
Ambient Room (1st month)	64.05a	0.51a	20.71a	65.9a	1.64a	21.87a	64.66a	1.05a	21.77a
Ambient Room (6th month)	60.93b	-0.17b	22.75a	63.80b	1.05b	23.53b	62.40a	0.77a	23.47a

Value at same alphabet in the column is not significant

Table 4 showed that varieties stored in or outside cold room at 1st month demonstrated with red pigmentation (a) at -0.52-1.64, also had yellow pigmentation (b) within 17.90-21.87 and a degree of whiteness (L) of 58.25-65.90. All varieties of rice seeds showed no change in colour (no significant) whether L, a or b for 6 months when the rice was stored in the storage room. Compared to seeds stored outside, almost all seeds changed (significant) colour L, a or b except MR297 according to statistic results. It is possible that as a result of the set temperature and humidity, the change in the colour of the rice seeds can be reduced. The effect of right temperature and RH could be reasoning no colour changes for seed stored in cold room. Golipour et al., (2015) stated that the environmental effects of high temperature will cause a darker color change on the surface of rice seeds.

Table 5. Insect count of rice seed for 6 months

		Tribolium castaneum (TC)	Sitatroga cerealella (SC)	Sithopilos oryzae (SO)	Ryzhopertha dominica (RD)	Other
Cold Room (3th month)	MR 297	0	0	0	0	0
	MRQ 76	0	0	0	0	0
	MR 315	0	0	0	0	0
Cold Room (6th month)	MR 297	0	0	0	0	0
	MRQ 76	0	0	0	0	0
	MR 315	0	0	0	0	0
Ambient Room (3th month)	MR 297	0	0	1	0	11
	MRQ 76	3	0	0	0	0
	MR 315	0	2	1	0	15
Ambient Room (6th month)	MR 297	0	154	4	1	15
	MRQ 76	0	18	0	46	0
	MR 315	14	410	21	0	0

Insects were found to be more common in rice seed containers stored outside the storage room at normal temperature as shown in Table 5. Compared to sacks stored in a room with a set temperature and RH, they successfully prevented live insects from living even for up to 6 months. Until the 6th month, more insects were found in the seeds kept outside the room especially from insect type of *Sitatroga Cerealella* (582 insects) followed by *Ryzhopertha Dominica* (47 insects). *Sitotroga cerealella* is considered as common, top of the list and most destructive insect of cereal grains. Its infestation starts in the standing crop and continues in storage (Bushra S. and Aslam M. 2013).

Temperature and humidity factors that exceed the limits of temperature (20^0C) and RH (60%) have made it easier for insects to breed and damage rice seeds. The traditional storage under normal room temperature of rice grains resulted in significantly higher levels of infestation by rice weevil and greater probabilities of detection of Alternaria sp., Nigrospora oryzae and Fusarium spp. than the cooling or freeze storage methods (Katta et al., 2019). Insects cannot control their body temperature; their rate of development and reproduction is related to temperature and it increases with increasing temperature (up to a critical limit). As a result, most of them become inactive or do not reproduce at a low-level temperature (10–15°C) and will die after a long period at very low temperatures (0–5) (Shlomo, N. & Jonathan, D. (2005). The temperature in this study is around 15-20^0C,

which means that the condition of insects is stopped as stated in Table 1, and it is confirmed by the results of the insect study where no insects were obtained from Table 5.

CONCLUSIONS

It was found that the quality of the seeds which stored for 6 month is more controlled when stored in a cold storage room with a temperature of 15-20^{0}C and humidity between 50-60%. These conditions are able to ensure that the seeds are always under controlled germination, no colour change, BD remains unchanged and not attacked by insects and further guarantee the safety of the rice seeds.

ACKNOWLEDGEMENT

The author acknowledges to MARDI for financial from the Projek Pembangunan PRN 521 which make this study successful.

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