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Effect of Temperature and Storage Period on Seed Germination and Some Morphological Characteristics of Rice (*Oryza sativa* L.) RD 6 cultivar

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Abstract*: Deterioration of rice seed was caused by high temperature and humidity during storage. Seed deterioration involves the reduction of seed germination, vigorous seedling and survival rate. Aim of this research was to investigate seed germination percentage, survival percentage and some morphological characteristics of Oryza sativa L. RD6 cultivar. Paddy was stored under -20, -10, 4 and 25ºC for 0, 2, 4, 6 and 8 months. The result showed that the highest germination percentage (100%) of RD6 was recorded in all treatments that stored at 25ºC. The highest survival percentage (100%) of RD6 was found in treatment that stored at -20 ºC for 6 months. Morphological characteristics of seedlings in all treatments were not significantly different. This data may be useful for rice seed storage research in the future.*

Keywords: *rice seed storage, RD 6 cultivar, seed deterioration*

1. Introduction

Rice (*Oryza sativa* L.) is the foremost staple food for more than 50% of the world's population. It is estimated that by the year 2025, the world's farmers should be producing about 60% more rice than at present of the expected world population at that time [1]. Over 90% of rice is produced and consumed in Asia. *Indica* type rice feeds more than two billion people, predominantly in developing countries. Global population is expected to reach around 10 billion by 2050 [2]. Nowadays, global warming is one problem that affected on plant cultivation, especially rice seed deterioration [3]. Seed deterioration was related to cell membrane, DNA deterioration and enzyme changing in cellular metabolism [4]. This phenomenon caused decrease of rice seed germination percentage [5]. RD 6 is sticky rice which is one of popular commercial variety in Thailand, especially in Northeastern and Northern part of Thailand. Therefore, effect of storage temperature on seed germination percentage, survival percentage and some morphological characteristics of *Oryza sativa* L. RD6 cultivars were investigated.

2. Materials and Method

RD 6 rice seed (189 days after harvesting) were collected from Kalasin Province, Thailand. Only healthy seeds were used in all experiment. Seeds were contained in 4 oz. glass bottle (2,300 seeds were used in each experiment) before warping up with aluminium foil. Seeds from each bottle were divided and stored in various

temperatures; room temperature, 25°C, 4 °C, -10 °C and -20 °C.). Seeds were stored during May 2015 - January 2016. Some morphological and physiological characteristics of seedlings were checked every two months interval.

Treated seeds were checked in term of seed germination in all experiments. Dehusked seed were washed with soft detergent and tap water prior to soak in 70% ethanol for 1 min and then shaked in 20% (v/v) sodium hypochlorite (clorox) with tween 20 for 15 min. Treated seeds were washed using steriled water for 3 times before culture on MS (Murashige and Skoog, 1962) medium. All seeds were cultured for 14 days in culture room at 25±2 **°C** with light intensity at 40 µmol.m^{-2}.s^{-1} for 16 h/day. Some morphological and physiological characteristics of rice seedlings were recorded in term of germination percentage, root number, root length, culm height, leaf number, leaf length and leaf width. Each experiment was repeated at least five times and taked ten replications per treatment. The experiments were planned according to a completely randomized design (CRD). The data were statistically analyzed using two way analysis of variance and the LSD (Least Significant Difference) values calculated at p=0.05 for comparing means of the treatments.

3. Results and Discussion

After *in vitro* propagation for 14 days, the results showed that 25 °C treatment showed the highest germination percentage of rice seed after storage for 0 – 8 months when compared with other treatments. However, survival percentage of this condition (25°C) was decreased when seed were stored for 2, 8, 4 and 6 months. (Table 1). When considerate germination rate of 6 months treatment, the best conditions were stored at 25 °C, 4 °C and -10 °C, which showed 100% germination. The sixth month was optimal period for seasonal cultivation after crop harvesting in Thailand. Therefore, we also focus on six months condition. Root number of control group was significantly decreased when compared with other treatments except 25°C treatment. However, root length of treated plants on 25°C and 4°C treatments were significantly decreased after storage at 2, 4, 6 and 8 months when compared with control plants. The 4°C treatment at 4 months storage showed the highest leaf number when compared with other treatments and control group. However, leaf number was significantly decreased after storage at -10°C for 4 and 2 months, while slightly significant increased at the 6 and 8 months, respectively. Leaf length of all treatments was not significantly different except in 25°C and 4°C treatments. The highest leaf length was recorded in storage condition at -20°C for 8 months. Culm height of control and -20°C treatments were also high when compared with other treatments but when considered at the 6 months storage period, culm high of control, 25°C and 4°C treatments were higher than -10°C and -20°C treatments.

Germination and survival percentage were decreased when storage period was decreased. This result was similar to the report of Pradhan and Badola [6] that germination percentage related to temperature and storage period. Moreover, our results are also similar to the report of soy bean seed storage, soy bean seed which storage at 5˚C for 165 days showed higher germination percentage than 25˚C and room temperature condition [7]. However, rice seed germination rate are also decrease depending on seed ageing including high temperature and moisture. Jang and the other [8] suggested that rice seed should be storage at below -15˚C. Low temperature decline seed deterioration that will cause low germination rate, survival rate and sensitive to stress environment [4]. Too high temperature and low temperature may cause ROS (Reactive Oxidation Species) accumulation that affect to hydrolytic enzyme activities such as protease, amylase, phosphatase, phospholipase and other enzyme [9] that importance for early embryo growth and development [10]. Moreover, optimal relative humidity is also significant for rice seed storaging because optimal relative humidity will induce seed softener that is useful for oxygen absorption and respiration in seed germination process. Nevertheless, high relative humidity can cause seed dormancy deceleration that affected on seed storage period. Simple and non-expensive storage conditions of rice seed are also needed. Therefore, this report may be useful as basic data for that goal in the future.

TABLE I: Germination, survival percentage and some morphological characteristics of 14 days rice seedling after storage for 8 months. (Values with different letter indicate sig. differences at $p < 0.05$ by LSD's test; diff. small letter reveal within same column, diff. capital letter reveal within same raw.)

Storage temperature	Storage period (month)				
	Germination percentage				
	0	2	4	6	8
Room temperature	100.00	92.00	88.00	88.00	88.00
25°C	100.00	100.00	100.00	100.00	100.00
4°C	100.00	92.00	100.00	100.00	88.00
-10°C	100.00	84.00	100.00	100.00	96.00
-20°C	100.00	88.00	96.00	96.00	96.00
Storage temperature	Survival percentage				
Room temperature	100.00	88.00	88.00	96.00	80.00
25°C	100.00	96.00	84.00	84.00	92.00
4°C	100.00	92.00	84.00	96.00	84.00
-10°C	100.00	84.00	100.00	88.00	84.00
-20°C	100.00	88.00	84.00	100.00	96.00
Storage temperature	Average root number (Mean±SE)				
Room temperature	7.87 ± 0.73^{aA}	7.27 ± 0.81^{aA}	5.27 ± 0.50^{aBC}	7.00 ± 0.49^{aAB}	5.13 ± 0.50^{aAC}
25°C	6.73 ± 0.52^{aA}	7.33 ± 0.60^{aA}	6.13 ± 0.43^{aA}	6.20 ± 0.38^{abA}	6.67 ± 0.62^{bA}
4°C	8.60 ± 0.85^{aA}	6.40 ± 0.71^{abB}	5.13 ± 0.32^{aB}	6.07 ± 0.36^{abB}	4.67 ± 0.41^{aB}
-10°C	8.07 ± 0.61^{aA}	5.40 ± 0.42^{bBC}	6.27 ± 0.61^{aB}	6.53 ± 0.32^{aB}	4.67 ± 0.42^{aC}
-20°C	8.47 ± 0.57^{aA}	6.33 ± 0.36^{abB}	5.27 ± 0.42^{aB}	5.20 ± 0.31^{bB}	5.87 ± 0.39^{abB}
Storage temperature	Average root length (Mean±SE)				
Room temperature	7.09 ± 0.69^{aA}	4.09 ± 0.48^{aB}	5.18 ± 0.70^{B}	6.39 ± 0.61^{aA}	5.75 ± 0.80^{aAB}
25°C	7.87 ± 0.45^{aA}	4.41 ± 0.50^{aB}	5.74 ± 0.49^{aB}	5.11 ± 0.43^{abB}	4.58 ± 0.40^{aB}
4°C	7.84 ± 0.65^{aA}	7.24 ± 0.48^{bAB}	6.09 ± 0.46^{aB}	6.23 ± 0.53^{aB}	5.31 ± 0.56^{aBC}
-10°C	7.25 ± 0.34^{aA}	6.40 ± 0.48^{bAB}	5.76 ± 0.51^{aB}	6.05 ± 0.27^{aAB}	5.87 ± 0.49^{aB}
-20°C	6.68 ± 0.24^{aA}	6.39 ± 0.36^{bAB}	5.22 ± 0.42^{aB}	6.59 ± 0.59^{acAB}	5.53 ± 0.34^{aAB}
Storage temperature	Average leaf number (Mean±SE)				
Room temperature	2.33 ± 0.21^{aA}	2.80 ± 0.22^{aBC}	2.47 ± 0.17^{aAB}	3.20 ± 0.17^{aC}	3.00 ± 0.14^{aCD}
25°C	2.07 ± 0.07^{aA}	2.33 ± 0.16^{bA}	2.20 ± 0.11^{abA}	2.27 ± 0.12^{bA}	2.33 ± 0.13^{bA}
4°C	2.20 ± 0.11^{aAB}	2.00 ± 0.00^{bA}	2.87 ± 0.13^{cC}	2.40 ± 0.13^{bB}	2.40 ± 0.13^{bB}
-10°C	2.13 ± 0.09^{aAB}	2.00 ± 0.00^{bA}	2.07 ± 0.07^{bA}	2.40 ± 0.16^{bBC}	2.53 ± 0.13^{bC}
-20°C	2.07 ± 0.07^{aAB}	2.07 ± 0.07^{bAB}	1.93 ± 0.12^{bA}	2.33 ± 0.13^{bB}	2.67 ± 0.13^{abC}
Storage temperature	Average leaf length (Mean±SE)				
Room temperature	13.83 ± 0.73^{aA}	12.42 ± 1.14^{aA}	13.01 ± 1.06^{aA}	13.08 ± 0.90^{aA}	14.24 ± 1.68^{aA}
25°C	15.17 ± 0.82^{abA}	15.59 ± 0.54^{bA}	12.65 ± 1.15^{abB}	15.44 ± 0.54^{bA}	16.05 ± 0.82^{abA}
4°C	12.45 ± 1.05^{acA}	13.63 ± 0.43^{abA}	9.77 ± 0.77^{bB}	14.51 ± 0.71^{abA}	14.24 ± 1.40^{aA}
-10°C	12.47 ± 0.92^{acA}	14.15 ± 0.44^{abAB}	13.00 ± 0.84^{aA}	16.01 ± 0.21^{bB}	14.37 ± 1.54^{aAB}
-20°C	14.03 ± 0.94^{aA}	14.57 ± 0.39^{bA}	11.57 ± 1.17^{abB}	15.25 ± 0.70^{bA}	18.23 ± 0.85^{bC}
Storage temperature	Average leaf width (Mean±SE)				
Room temperature	0.30 ± 0.01^{abA}	0.28 ± 0.01^{aA}	0.28 ± 0.02^{aA}	0.29 ± 0.01^{aA}	0.26 ± 0.02^{aA}
25°C	0.30 ± 0.01^{abA}	0.29 ± 0.01^{aA}	0.32 ± 0.02^{aA}	0.33 ± 0.01^{abA}	0.28 ± 0.01^{aA}
4°C	0.29 ± 0.01^{aA}	0.30 ± 0.01^{abA}	0.27 ± 0.01^{aA}	0.34 ± 0.02^{bB}	0.29 ± 0.02^{aA}
-10°C	0.31 ± 0.01^{bA}	0.31 ± 0.02^{abA}	0.28 ± 0.02^{aA}	0.30 ± 0.01^{abA}	0.27 ± 0.02^{aA}
-20°C	0.30 ± 0.00^{abAB}	0.34 ± 0.02^{bB}	0.31 ± 0.02^{aAB}	0.30 ± 0.02^{abAB}	0.29 ± 0.02^{aA}
Storage temperature	Average culm height (Mean±SE)				
Room temperature	6.14 ± 0.50^{aA}	6.83 ± 0.36^{aA}	7.47 ± 0.46^{aAB}	8.65 ± 0.71^{aB}	8.50 ± 0.72^{aB}
25°C	6.82 ± 0.55^{aA}	8.25 ± 0.28^{bBC}	7.21 ± 0.52^{aAB}	8.17 ± 0.16^{aBC}	8.63 ± 0.14^{aC}
4°C	6.45 ± 0.39^{aA}	8.43 ± 0.12^{bB}	7.05 ± 0.36^{aA}	8.15 ± 0.20^{aB}	8.05 ± 0.44^{aB}
-10°C	7.11 ± 0.54^{aA}	8.31 ± 0.17^{bA}	7.24 ± 0.34^{aA}	7.81 ± 0.22^{aA}	7.63 ± 0.56^{aA}
-20°C	8.99 ± 0.48^{bA}	8.40 ± 0.10^{bA}	7.06 ± 0.47^{aB}	7.87 ± 0.42^{aAB}	8.95 ± 0.22^{aA}

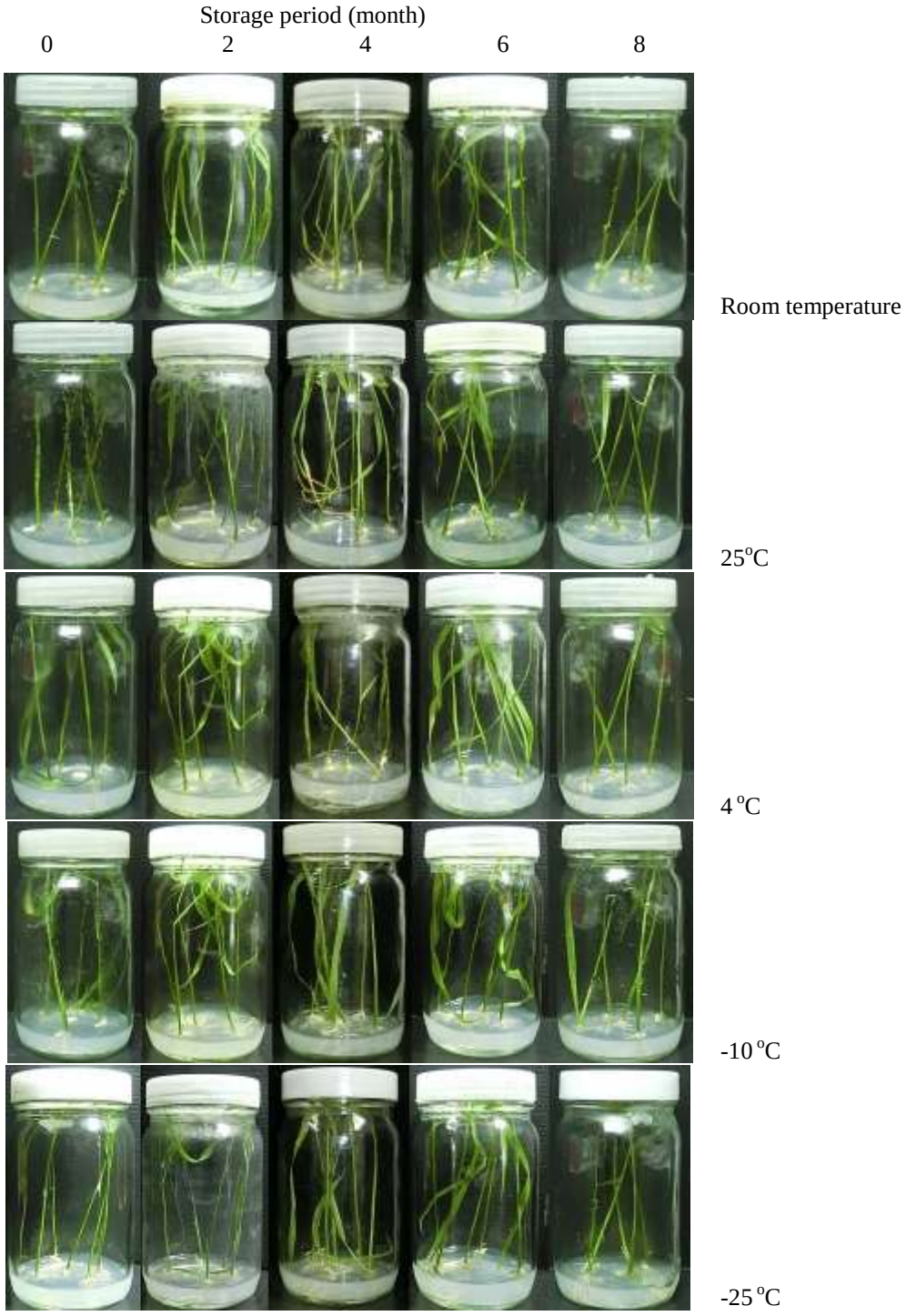

Fig. 1: Rice seedlings of all treatments after germinated for 2 weeks.

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