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Effect of Various Temperatures and Duration on Deterioration of Rice Seeds

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Abstract: Temperature is one of the most important abiotic stresses that affect both morphological and physiological characters of many rice genotypes. The present study was conducted to evaluate seed aging potential of ten important rice varieties, namely, PARC 336, PARC 337, PARC 338, PARC 339, PARC 340, PARC 341, PARC 342, PARC 343 PARC 344, 345 PARC 346 and PARC 347, for seed deterioration study at different temperatures (25, 35 and 45 °C) and for different time periods (36, 72 and 96 hours). Various physiological parameters, such as, germination percentage, shoot/root lengths, shoot/root dry weights, were significantly affected by temperature stress. The germination response of genotype PARC 339 was the maximum and was found to be significantly different from other tested genotypes. The shoot length was higher in genotype PARC 341, at high temperature (45 °C) for 96 hours, while the root length was maximum of genotype PARC 337 at all temperature as compared to others. Similarly the shoot/root dry weights were significantly different at all temperature and time periods in all tested genotypes. The present study might serve as a model to screen temperature tolerant rice lines at different time periods.

Key words: Rice, Seed aging, Temperature, Physiological parameter.

INTRODUCTION

The seeds, which have a high profitable value, need special attention to their physiological potential. Both, seed viability and quality, are highly affected at preservation stage by both biotic (bacteria, insect, fungi and viruses) and abiotic factors (temperature, humidity and moisture content). Seeds are stored in Gene bank under low temperature and seed moisture conditions, to extend its seed viability. The loss of seed viability is a natural phenomenon and its viability decrease even under the optimum storage and temperature conditions (Kapoor *et al*., 2010; Hartmann Filho *et al*., 2016). The loss of seed viability varies from one species to another and even among the same species. For conservation of seed for long period in gene bank, it is necessary to monitor its vigour and viability during adverse environmental condition.

Seed decline is also affected by seed moisture content and temperature of storage space, which lead to more rapid seed deterioration (Ellis, 1992; Dutra and Vieira, 2006). Many biochemical and physiological factors have been reported for seed deterioration. However, for measurement of seed vigour, many aging tests have been developed (Kalpana and Rao, 1995). Among these, artificial seed aging test is considered as one of the most important tests, being used to evaluate seed vigour of various crop species (Teklroney, 1993). In this test, seeds are treated at different temperature and relative humidity levels. As a result, the low quality seeds decline rapidly as compared to healthy and fresh seeds (Marcos Filho, 1999; Torres *et al*., 1997).

Several researchers have conducted research work to identifying high and low vigour seeds of wheat (Modarresi *et al*., 2002), pea (Hampton *et al*., 2004), pumpkin and zucchini (Dutra and Vieira, 2006), kale (Komba *et al*., 2006), soybean (Torres *et al*., 2004; Hartmann Filho *et al*., 2016) and radish (Jain *et al*., 2006). In the present study, we have been developed an efficient protocol to study seed aging at 25, 35 and 45 °C for 48, 72, and 96 hours in important rice genotypes.

MATERIALS AND METHODS

The seed deterioration process was examined for twelve important rice varieties, namely, PARC 336, PARC 337, PARC 338, PARC 339, PARC 340, PARC 341, PARC 342, PARC 343, PARC 344, PARC 345, PARC 346 and PARC 347. The seed materials were acquired from Rice Program, National Agricultural Research Centre (NARC), Islamabad, Pakistan. This experiment was carried out in triplicates at seed preservation laboratory, Plant

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Accelerating aging was performed by subjecting the seed to three different temperatures (35, 25 and 45 °C) for three different time periods (48, 72 and 96 hours). Twenty five seeds of each accession were sown on paper towel. Test of germination was done through ISTA rule (Anonymous, 1993). The seeds were kept on double sheet of towel paper, which was moistened with distilled water. The seeds were covered with another towel paper and finally rolled and kept in incubator at constant temperature (25 °C). Germination data was recorded from day one to day six. The final germination data was recorded on the basis of normal seedling growth. To calculate the seedling growth, normal seedling was used, both shoot and root length was estimated. Axis from each replication were cut from seedling axis of the remaining seed pots and dried in an oven for 24 hours at 80 °C. The controlled plants were given no treatment and were grown at room temperature.

RESULTS AND DISCUSSION

Germination rate: Our findings showed that temperature affected the germination frequency up to several folds. The germination rates among genotypes varied and genotype PARC 339 showed better morphological performance than other genotypes. However, the genotypes and temperature interaction was highly significant. PARC 339, at 25 °C, showed the highest (99.56%) germination percentage, while genotype PARC 341 showed the lowest germination rate (59.56%) at 45 °C. Interaction of varieties and temperature was non-significant. Although, the maximum mean value was recorded in PARC 347 (99.11%) and PARC 341 (80.44%) at 48 and 96 hours, respectively, while, minimum value was recorded in PARC 343, at 96 hours (Table 1). These results illustrated that germination percentage decreased with increase in temperature. These results also indicated that, the genotype difference in germination percentage was present in rice genotypes therefore, some genotypes showed more rapid deterioration than others. These results are similar to the findings of Jatoi *et al*. (2001), who found that germination frequency decreased with the increase of temperature stress in many important peas' cultivars. It might be considered from this result that the facts of seed deterioration facilitate the estimation of seed longevity during the storage period. According to Hartmann Filho *et al*. (2016), the increase in the temperature of drying air affects the normal morpho-physiological performances of soybean seedling. Murata *et al*. (1980) reported that germination decline occurred in rose seed, due to increase in moisture content and temperature. The sudden changes during aging process affect seed vigour and its viability (Powell, 2006). The abiotic stress affects the morphol-biochemical process of *Brassica rapa* and tomato genotypes (Jan *et al*., 2016; Shah *et al*., 2014, Arif *et al*., 2015).

Table 1: Germination percentage of rice seeds as affected by different temperature and duration.

	Temperature °C			Duration		
Variety	**25**	**35**	**45**	**48 hrs**	**72 hrs**	**96 hrs**
PARC336	97.78A	96.44A	94.22AD	94.667	96.889	96.889
PARC337	95.56AC	94.22AD	75.11H	88.889	89.333	86.667
PARC338	94.67AD	98.22A	77.33H	91.556	89.778	88.889
PARC339	99.56A	98.67A	97.33A	98.667	97.778	99.111
PARC340	98.67A	95.56AC	93.78AE	96.889	96.889	94.222
PARC341	96.44A	95.56AC	59.56I	85.778	85.333	80.444
PARC342	95.11AC	96.44A	77.78H	88.444	88.444	92.444
PARC343	97.78A	96.00AB	97.78A	97.778	96.444	97.333
PARC344	96.89A	96.44A	93.78AE	96.000	96.889	94.222
PARC345	98.67A	96.44A	64.89I	85.333	86.667	88.000
PARC346	93.89AE	96.44A	78.22H	90.222	88.000	89.333
PARC347	97.33A	97.33A	99.11A	99.111	97.778	96.889
LSD	**4.957**					

Shoot length: Shoot length of all genotypes was significantly affected by different temperature. The interaction between genotypes and different temperatures was highly significant. The maximum shoot length (4.89 cm) was found in PARC 341 at 25°C for 96 hours and the minimum (2.66 cm) was recorded in PARC 342 at 35 °C for 48 hours, while the interaction between genotypes and different storage duration was non-significant. PARC 341 showed the maximum mean value (4.890) at 96 hours and the maximum value 3.13 at 72 hrs were recorded in PARC 339 (Table 2). In most genotype, the shoot length decreased with the increase in temperature. Our result can be justified with the findings of Iqbal and Smith (1996) as they noted a decrease in shoot length at high temperature. Komba *et al*. (2006) studied that 41 °C for 72 hours is best accelerated aging condition for kale (*B. oleracea* L.).

Root length: In root length, the behavior of different temperature was highly significant in all tested rice genotypes. Non-significant interaction was found between genotype and duration while interaction between genotypes and temperature were observed significant. PARC 340 at 25 °C showed the longest (8.38 cm) root length, while PARC 340 shows the lowest root length (5.19 cm) at 35 °C (Table 3). These findings are in line with results of Jatoi *et al*. (2001), who found similar effect on seed germination of pea verities. Hu *et al*. (2005) recorded maximum shoot, root length and shoot/root dry weight at 18 °C for 72 hours in rice.

Table 2: Shoot length percentage of rice seeds as affected by different temperature and duration.

	Temperature °C			Duration		
Variety	**25 °C**	**35 °C**	**45 °C**	**48 hrs**	**72 hrs**	**96 hrs**
PARC 336	4.117 DJ	4.280 BH	3.353 LN	3.958	3.906	3.887
PARC 337	4.186 CJ	4.788 AC	3.246 MO	4.126	4.007	4.087
PARC 338	3.672 HM	2.473 Q	3.483 KM	3.337	3.130	3.162
PARC 339	4.267 BI	3.830 GM	3.941 FL	4.064	4.054	3.919
PARC 340	4.662 AD	3.432 LN	3.921 FL	3.987	3.989	4.040
PARC 341	4.890 A	4.477 AE	3.082 NP	4.174	4.091	4.183
PARC 342	3.844 GM	2.667 PQ	3.596 JN	3.422	3.201	3.483
PARC 343	4.677 AD	4.269 BI	4.170 DJ	4.213	4.628	4.274
PARC 344	4.377 AG	3.794 GM	4.474 AF	4.122	4.186	4.338
PARC 345	4.343 AG	4.837 AB	3.660 IN	4.164	4.466	4.210
PARC 346	4.042 EK	2.780 OQ	3.757 GM	3.586	3.411	3.582
PARC 347	4.637 AE	4.377 AG	4.192 CJ	4.539	4.158	4.509
LSD	**0.5055**					

Table 3: Root length percentage of rice seeds as affected by different temperature and duration.

	Temperature °C			Duration		
Variety	**25 °C**	**35 °C**	**45 °C**	**48 hrs**	**72 hrs**	**96 hrs**
PARC 336	7.218AE	5.899BE	6.121AE	6.516	6.297	6.426
PARC 337	6.389AE	8.071AB	5.938BE	7.046	6.257	7.096
PARC 338	6.226AE	5.019E	6.198AE	6.023	5.590	5.829
PARC 339	7.171AE	6.509AE	8.150AB	7.183	7.400	7.247
PARC 340	8.387A	8.079AB	5.198E	8.506	6.650	6.508
PARC 341	6.528AE	6.521AE	5.906BE	6.650	6.028	6.277
PARC 342	6.359AE	6.160AE	7.100AE	6.809	5.427	7.383
PARC 343	7.247AE	7.563AC	7.727AC	7.576	7.836	7.126
PARC 344	7.373AD	7.257AE	6.197AE	6.419	7.012	7.396
PARC 345	6.067BE	7.140AE	6.882AE	6.630	7.194	6.264
PARC 346	6.807AE	5.636CE	7.220AE	6.409	6.360	6.893
PARC 347	7.409AD	7.110AE	7.914AC	7.701	6.713	8.019
LSD	**1.796**					

Shoot dry weight: Shoot dry weight significantly affected by the temperature and storage duration. In the present study, the genotype PARC 340 gave maximum shoot weight as compared to other tested genotypes. It might be due to genotype differences. In the interaction studies, highly significant interaction was found between genotypes and temperature, whereas, the non-significant interaction was found between genotypes and time duration. The highest dry weight (0.043 mg) at 25 °C was recorded in PARC 340, while, the lowest (0.004 mg) weight was recorded in PARC 338 at 45 °C. A sudden decrease in dry weight was observed among all tested genotypes with the increase of temperature stress of 25, 35 and 45 °C (Table 4). Iqbal and Smith (1996) and Jatoi *et al*. (2001) also reported that the shoot dry weight decreased with an increase in temperature in many plant species.

Root dry weight: Both the temperature and its duration significantly affected root dry weight. The root dry weight values ranged from 0.01 to 0.34 mg at different stress levels. The maximum root dry weight 0.34 mg was observed in PARC 345 at 45 °C, followed by 0.30 mg in PARC 341, respectively. The interaction between genotype and temperature was significant. The highest root dry weight (0.032 mg) was found in PARC 343 at 25 °C, whereas, the lowest weight (0.006 mg) was reported in PARC 938 (Table 5). Significant difference of seed deterioration was observed among the genotypes. Some seed declined

faster than others even under same temperature. Similar results were reported in peas' varieties by Jatoi *et al*. (2001) and Hu *et al*. (2005), their results illustrated that the reduction in both shoot and root dry weight was different, due to genotypic differences.

Table 4: Shoot dry weight percentage of rice seeds as affected by different temperature and duration.

	Temperature °C			Duration		
Variety	**25 °C**	**35 °C**	**45 °C**	**48 hrs**	**72 hrs**	**96 hrs**
PARC 336	0.019 E	0.019 E	0.012 BE	0.02	02	0.01
PARC 337	0.007 DE	0.012 BE	0.019 AE	0.01	0.02	0.01
PARC 338	0.013 BE	0.013 BE	0.004 E	0.01	0.01	0.01
PARC 339	0.023 AE	0.021 AE	0.017 AE	0.02	0.03	0.02
PARC 340	0.043 A	0.034 AD	0.027 AE	0.04	0.04	0.27
PARC 341	0.022 AE	0.023 AE	0.033 D	0.03	0.03	0.02
PARC 342	0.031 AE	0.039 AB	0.022 AE	0.03	0.04	0.02
PARC 343	0.042 A	0.035 AC	0.033 D	0.04	0.05	0.03
PARC 344	0.024 AE	0.031 AE	0.022 AE	0.03	0.03	0.02
PARC 345	0.018 AE	0.022 AE	0.037 C	0.03	0.03	0.02
PARC 346	0.032 AE	0.031 AE	0.018 AE	0.03	0.03	0.02
PARC 347	0.041 A	0.032 AE	0.027 AE	0.03	0.04	0.03
LSD	**0.02199**					

Table 5: Root dry weight percentage of rice seeds as affected by different temperature and duration.

	Temperature °C			Duration		
Variety	**25 °C**	**35 °C**	**45 °C**	**48 hrs**	**72 hrs**	**96 hrs**
PARC336	0.010KN	0.008MN	0.017GN	0.012	0.015	0.009
PARC337	0.024AJ	0.020CL	0.015GN	0.020	0.024	0.016
PARC338	0.010KN	0.015GN	0.006N	0.010	0.013	0.008
PARC339	0.016GN	0.013IN	0.007LN	0.012	0.015	0.009
PARC340	0.031AC	0.018EM	0.014IN	0.021	0.026	0.016
PARC341	0.020CL	0.022AK	0.030AF	0.024	0.030	0.018
PARC342	0.027AH	0.028AH	0.019DM	0.024	0.030	0.019
PARC343	0.032AB	0.031AC	0.027AH	0.030	0.037	0.023
PARC344	0.026AI	0.018EM	0.019DM	0.021	0.026	0.016
PARC345	0.019DM	0.021AK	0.034A	0.025	0.031	0.019
PARC346	0.025AJ	0.033AB	0.014IN	0.024	0.029	0.018
PARC345	0.032AB	0.025AJ	0.026AI	0.028	0.034	0.021
LSD	**0.01001**					

CONCLUSION

Significant variation was observed for both morpho-physiological characters among diverse rice genotypes at different temperature treatments. The genotype PARC 339 showed excellent germination response at high temperature as compared to other genotypes, however, the shoot, root lengths and shoot and root dry weight response vary with genotypes at different temperature for different time periods. It is concluded that response of genotype vary with type of temperature stress. The present study will be useful to screen other temperature tolerant rice genotypes.

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