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STANDARDIZATION OF ACCELERATED AGEING DURATION FOR SCREENING OF RICE GENOTYPES FOR SEED LONGEVITY

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ABSTRACT

Accelerated ageing test has good correlation to field emergence and storage potential of the seed. In this regard, an attempt was made to standardize accelerated ageing duration for screening rice genotypes for seed longevity. Fresh seeds of 10 rice genotypesviz., AC35534, BR2655, IET16348, Jaya, KMP 175, PS 370, Rasi, Samrat, Tellahamsa and Vanaprava were subjected to accelerated ageing for 5, 10, 15, 20, 25 and 30 days at 40±1^{0}C and 100% relative humidity. Seeds of ten genotyes undergone accelerated ageing were showed significant variation in ability to germinate and produce vigorous seedlings. Seed germination per cent in majority of the genotyes tested viz. AC 35534, KMP 175, PS 370, Samrat, Tellahamsa and Vanaprava, were reduced to around 50 per cent of the initial by 20 days of accelerated ageing whereas per cent reduction in seed germination of other genotyesviz., BR2655, IET 16348, Jaya and Rasiwere crossed 40% by 20 days of accelerated ageing and 60% by 25 days of accelerated ageing. Hence, 20 days of accelerated ageing is considered as optimum duration of ageing for screening the genotypes for seed longevity in Rice.

KEYWORDS: Accelerated ageing, Rice, Seed germination, Seed longevity

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Original Article

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important and extensively cultivated cereal crop stand next to wheat in the global food grain production. It is grown in more than a hundred countries, with a total harvested area of approximately 158 million hectares, producing more than 700 million tons annually (470 million tons of milled rice). Nearly 640 million tons of rice is grown in Asia, representing 90% of global production (*http:www.ricepedia.org*).India being the second largest producer of rice but still lacks behind to meet the requirement due to the rising demand, saturation of cultivable land (Dhanwani*et al.*, 2013)and availability of quality seeds for sowing.

Use of quality seeds for sowing is one of the potential means of enhancing rice productivity. The benefits of various production inputs and improved farming technologies can be gained only when highly vigorous seeds are used for sowing. Seeds that have high vigor will have high quality. Seed vigor not only influences the productivity but also the storability of seeds. Vigorous seeds can store well, produce uniform stand, develop into vigorous and productive plants.

Maintenance of seed vigour and viability during storage is a matter of prime concern in India. Owing to the prevailing subtropical climate in major parts of the country, seeds of most crop species show rapid deterioration

and rice is no exception. (Ramanadane and Ponnuswamy, 2004). In general, there is difference among species (Agrawal, 1976) and also among varieties within a species (Agrawal, 1978) with respect to loss of seed viability during storage of rice which depends on the ability of seed to resist degradation changes and protection mechanisms, specific for each plant species and even specific to varieties. So, seeds of different varieties of same species vary in rate of ageing which decides their storability. Accelerated aging test is a stress test. The seeds are stressed prior to the germination test. Seeds are placed in temperature of 40 ± 1^0C and nearly 100% relative humidity for varying lengths of time, depending on the kind of seeds, after which agermination test is made. The basis for this test is that higher vigor seeds tolerate the high temperature-high humidity treatment and thus retain their capability to produce normal seedlings in the germination test. It was first developed by Delouche (1965) quoted in AOSA (1983) for seed longevity. Since then several researchers have carriedout and aging treatment has been recommended for wide range of crop species(AOSA, 1983).

Accelerated ageing test has good correlation to field emergence and storage potential of the seed. In order to evaluate the storage potential of different varieties, accelerated ageing test is being employed especially in soybean. Although the accelerated ageing test is recommended to measure soybean seed vigour, a uniform accelerated ageing procedure has not been developed for testing rice (*Oryza sativa* L.) seed. The duration of accelerated ageing, time taken to reduce the germination potential to 50% of the initial, varies with varieties produced in the same climatic condition mainly due to genetic nature. In this context, an attempt was made to standardize the ageing duration to screen the genotyes for seed longevity.

MATERIALS AND METHODS

The seeds of 10 rice genotypes*viz.*, AC35534, BR2655, IET16348, Jaya, KMP 175, PS 370, Rasi, Samrat, Tellahamsa and Vanaprava multiplied in Zonal Agricultural Research Station, Mandya of UAS, Bengaluru during *kharif*, 2014 were used in this study. Twenty five gram of fresh seeds having moisture content of 11-12 % were subjected to accelerated ageing for the period of 5, 10, 15, 20, 25 and 30 days. Seeds were packed in paper bag with uniform pin head size perforation all over and placed in a sealed ageing glass jar containing sufficient distilled water to maintain 100 per cent relative humidity and incubated at a temperature of 40 ± 1° C. Separate glass jars were used for each ageing period containing seeds of all ten genotypes. After the each ageing period, seeds were taken out and tested for following seed quality parameters along with unaged seed.

Germination Percent

The laboratory germination test was carried out using 100 seeds of four replication in paper medium (ISTA, 2007). The test conditions of 25 ± 2°C temperature and 95 ± 3 per cent relative humidity were maintained in the germination room. At the end of 14 days, number of normal seedlings was counted and the mean was expressed as germination per cent.

Root Length

Root length of ten normal seedlings from each replication of the germination test was measured from collar region to the root tip and the mean was expressed in centimeter.

Shoot Length

Shoot length of ten normal seedlings from each replication of the germination test was measured from collar region to the shoot apex and the mean was expressed in centimeter.

Dry Matter Production

The seedlings used for growth measurement were dried in hot air oven maintained at 80 ± 2°C for 24 h and cooled in desiccator filled with silica gel for 30 min. The dry weight of seedlings was recorded using an electronic balance and mean was calculated and expressed as mg seedling^{-1}.

Seedling Vigour Index

The seedling vigour index was computed by adopting the formula suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Seedling vigour index-II = Germination (%) x Dry Matter Production (mg/seedling)

RESULTS AND DISCUSSIONS

Seeds of ten rice genotypes undergone accelerated ageing were shown significant variation in ability to germinate and produce vigorous seedlings. Initial seed germination of ten genotypes did not varied among genotypes and which is about 98-99% as the seeds were of afresh and not undergone any degradation changes. Seed germination significantly decreased with duration of accelerated ageing. However, the rate of reduction in seed germination was varied significantly among the genotypes which was higher in Tellahamsa, Vanaprava and Samrat and lower in Jaya and IET 16348. The highest reduction in germination was observed in Samrat with 4, 17, 36, 59, 79 and 87% of initial germination at 5, 10, 15, 20, 25 and 30 days of accelerated ageing, respectively and could maintain only 13% seed germination after 30 days of accelerated ageing. While, lowest reduction was observed in Jaya with 2, 10, 27, 36, 58 and 75% of initial germination at 5, 10, 15, 20, 25 and 30 days of accelerated ageing, respectively and maintained germination of 25% at 30 days of accelerated ageing. (Table 1)

Over the ageing period, there was 4, 15, 32, 50, 70 and 82% reduction in seed germination at 5, 10, 15, 20, 25 and 30 days of accelerated ageing, respectively. Seed germination per cent in majority of the genotypes tested *viz.* AC 35534, KMP 175, PS 370, Samrat, Tellahamsa and Vanaprava, was reduced to around 50 per cent of the initial by 20 days of accelerated ageing whereas per cent reduction in seed germination of other genotypes*viz.*, BR2655, IET 16348, Jaya and Rasi crossed only 40% at 20 days of accelerated ageing but, it 60% at 25 days of accelerated ageing (Figure 1).

Similar study has been carried out by Vijayakumar and Vijayakumar (2015) and they observed a significant decline in germination of all the seven soybean cultivars tested with the advancement of ageing duration. But, the rate of reduction in germination was varied among cultivars which was highest in NRC 93 followed by MAU 61 and lowest in EC 18761 which was on par with CO1. Seed germination of most of the tested cultivars was reduced to around 50 per cent of the initial by 7 days of accelerated ageing. Hence, they selected 7 days of accelerated ageing as optimum duration to screen the cultivars for seed storability in soybean.

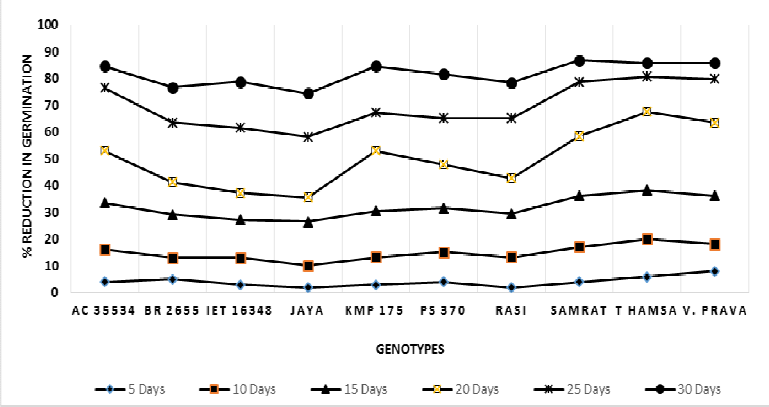

Figure 1: PerCent Reduction in Seed Germination of Rice Genotypes Over the Accelerated Ageing Period

Accelerated aging is a physiological stress test that permits controlled deterioration of seeds due to exposure of seeds to high temperature and high relative humidity (greater than 90%). Seed moisture content and high temperature influence seed metabolism. High relative humidity increases seed moisture, which results in biochemical events such as increase hydrolytic enzyme activity, free fatty acids where as high temperature serves to enhance the rate at which many enzymatic and metabolic reaction occurs and there by increases the metabolic activity of hydrolyzed substrates and enzymes causing more rapid rate of deterioration (Khan *et al.*,2010).Further, during seed deterioration, the free radicals generated as result of lipid peroxidation cause damage to enzymes that are necessary to convert reserve food in the embryo to usable form and thereby affects production of normal seedling (Iqbal *et al.,* 2002) and these free radicals also degrade mitochondrial membrane leading to reduction in energy supply necessary for germination thereby cause failure in seed germination (Gidrol*et al.,* 1998).Genotypes tested were showed a significant difference in their resistance to deteriorative changes occurring in seed during aging which might be due to varied chemical composition and anti-oxidative ability of the genotype.

he root length of genotypes before accelerated ageing ranged from 16.5cm (Samrat) to 21.8cm (PS 370) whereas shoot length ranged from 6.7cm (Samrat) to 11.4cm (PS 370). Root length and shoot length were significantly decreased after each period of accelerated ageing. But, the rate of reduction did not vary significantly among the genotypes. However, IET 16348 and PS 370 shown highest mean root length of 19.8 cm followed by AC 3554, Jaya and KMP 175. While, lowest mean root length was observed in Samrat (14.6cm) (Table 2). The highest mean shoot length was observed in PS 370 (10.3cm) followed by KMP 175 (8.8cm) while, the lowest mean shoot length was noticed in Samrat (6.0cm) followed by BR2655 (6.8cm) (Table 3). Reduced seedling growth due to accelerated ageing is mainly due to both lower respiration and reduced mitochondria in cells (McDonald, 1999).

The dry matter production before accelerated ageing ranged from 5.9mg/seedling (Samrat) to 10.4 mg/seedling (Rasi). Dry matter production decreased significantly over the duration of accelerated ageing but, the rate of reduction was similar among the genotypes. However, Rasi showed highest mean dry matter production (9.3mg/seedling) followed by IET 16348, PS 370 and Vanaprava. Lowest mean dry matter production was noticed in Samrat (5.2mg/seedling) followed by AC 35534 and BR 2655 (Table 4). Reduction in dry matter production due to accelerated aging test is mainly because of poor seedling development (Mosavi*et al.,*2011).

Both seedling vigour index I and II significantly decreased as the accelerated ageing duration advances and the rate of reduction significantly varied among the genotypes. Jaya showed the lowest reduction in vigour index I and II over the ageing period with vigour index I and II of 583 and 175, respectively at 30 days of accelerated ageing. While, the highest reduction was observed in Samrat which maintained vigour index I and II of 218 and 56, respectively at 30 days of accelerated ageing.(Table 5 and 6).Reduced capacity to germinate and produce vigorous seedlings is the main reason for decreased vigour index due to accelerated ageing of seed (Singh, 1989).

Table 1: Effect of Accelerated Ageing on Seed Germination Percent in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	**5 DAYS**	**10 DAYS**	**15 DAYS**	**20 DAYS**	**25 DAYS**	**30 DAYS**	**MEAN**
AC 35534	98 (81.1)	94 (76.5)	82 (64.7)	65 (53.5)	46 (42.8)	23 (28.6)	15 (22.7)	**54 (52.8)**
BR 2655	99 (85.0)	94 (76.5)	86 (68.3)	70 (56.8)	58 (49.6)	36 (37.0)	23 (28.8)	**67 (57.4)**
IET 16348	99 (83.0)	96 (78.0)	86 (68.1)	72 (58.0)	62 (51.8)	38 (37.9)	21 (27.2)	**68 (57.7)**
JAYA	98 (83.6)	96 (78.0)	88 (70.0)	72 (58.0)	63 (52.5)	41 (39.8)	25 (30.1)	**69 (58.9)**
KMP 175	98 (81.1)	95 (77.9)	85 (67.3)	68 (55.5)	46 (42.7)	32 (34.6)	15 (22.7)	**63 (54.5)**
PS 370	98 (81.3)	94 (76.0)	83 (65.7)	67 (54.9)	51 (45.5)	34 (35.8)	18 (25.2)	**64 (54.9)**
RASI	98 (81.6)	96 (78.4)	85 (67.2)	69 (56.1)	56 (48.4)	34 (35.8)	21 (27.4)	**66 (56.4)**
SAMRAT	99 (84.5)	95 (76.9)	82 (64.9)	63 (52.3)	41 (39.6)	21 (27.2)	13 (21.1)	**59 (52.4)**
TELLA HAMSA	99 (83.9)	93 (75.4)	79 (62.7)	61 (51.3)	32 (34.2)	19 (25.8)	14 (21.7)	**57 (50.7)**
VANAPRAVA	99 (83.0)	91 (73.0)	81 (64.2)	63 (52.5)	36 (37.0)	20 (26.7)	14 (21.9)	**58 (51.2)**
Mean	**99 (82.8)**	**94 (76.6)**	**84 (66.3)**	**67 (54.9)**	**49 (44.4)**	**30 (32.9)**	**18 (24.9)**	**62 (54.7)**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	0.65			1.28			1.68	
Ageing (A)	0.54			1.07			1.41	
GXA	1.71			3.39			4.47	

() - values in the parenthesis are arc sine transformed values

Table 2: Effect of Accelerated Ageing on Root Length (Cm) in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	**5 DAYS**	**10 DAYS**	**15 DAYS**	**20 DAYS**	**25 DAYS**	**30 DAYS**	**MEAN**
AC 35534	20.7	20.3	19.7	18.9	18.3	16.5	16.3	**18.7**
BR 2655	18.9	18.7	18.2	17.7	17.0	16.4	15.1	**17.4**
IET 16348	21.2	21.0	20.6	20.1	19.4	18.4	17.8	**19.8**
JAYA	19.9	19.7	19.4	19.0	18.3	17.5	16.8	**18.7**
KMP 175	20.5	20.1	19.5	18.8	17.9	16.9	15.5	**18.5**
PS 370	21.8	21.4	20.8	20.0	19.4	18.6	16.6	**19.8**
RASI	18.5	18.2	17.7	17.1	16.5	15.6	14.2	**16.8**
SAMRAT	16.5	16.1	15.6	14.9	14.2	13.1	11.8	**14.6**
TELLA HAMSA	19.6	19.1	18.7	17.4	17.1	16.4	15.4	**17.7**
VANAPRAVA	20.1	19.6	19.0	18.1	17.2	16.4	15.3	**18.0**

Mean	**19.8**	**19.4**	**18.9**	**18.2**	**17.5**	**16.5**	**15.4**	**18.0**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	0.19			0.39			0.51	
Ageing (A)	0.16			0.32			0.43	
GXA	0.52			NS			NS	

Table 3: Effect of Accelerated Ageing on Shoot Length (Cm) in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	5 DAYS	10 DAYS	15 DAYS	20 DAYS	25 DAYS	30 DAYS	MEAN
AC 35534	8.2	7.8	7.7	7.3	7.1	6.7	6.1	**7.3**
BR 2655	7.4	7.2	7.1	6.9	6.7	6.3	5.8	**6.8**
IET 16348	7.6	7.3	7.3	7.1	6.9	6.5	6.1	**7.0**
JAYA	8.2	8.0	8.1	7.9	7.7	7.3	6.5	**7.7**
KMP 175	9.6	9.4	9.2	8.9	8.5	8.1	7.8	**8.8**
PS 370	11.4	11.1	10.7	10.4	10.0	9.4	9.1	**10.3**
RASI	8.5	8.4	8.1	7.9	7.5	7.1	5.8	**7.6**
SAMRAT	6.7	6.6	6.4	6.0	5.9	5.5	5.0	**6.0**
TELLA HAMSA	8.4	8.3	8.1	7.7	7.3	6.8	6.2	**7.5**
VANAPRAVA	9.5	9.2	8.9	8.4	8.1	7.6	7.4	**8.4**
Mean	**8.6**	**8.3**	**8.2**	**7.9**	**7.6**	**7.1**	**6.6**	**7.7**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	0.08			0.16			0.21	
Ageing (A)	0.07			0.13			0.18	
GXA	0.22			NS			NS	

Table 4: Effect of Accelerated Ageing on Dry Matter Production (Mg/Seedling) in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	5 DAYS	10 DAYS	15 DAYS	20 DAYS	25 DAYS	30 DAYS	MEAN
AC 35534	7.5	7.1	7.0	6.5	6.2	6.0	5.7	**6.6**
BR 2655	7.4	7.1	6.8	6.9	6.4	6.3	5.9	**6.7**
IET 16348	9.6	9.1	9.0	9.0	8.5	8.3	7.6	**8.7**
JAYA	8.7	8.4	8.3	8.2	7.7	7.6	7.0	**8.0**
KMP 175	8.8	8.3	8.2	7.8	7.4	7.2	6.5	**7.7**
PS 370	9.8	9.2	9.1	8.7	8.3	8.1	7.4	**8.7**
RASI	10.4	9.8	9.7	9.3	9.1	8.6	8.4	**9.3**
SAMRAT	5.9	5.5	5.6	5.2	5.0	4.9	4.3	**5.2**
TELLA HAMSA	9.0	8.4	8.4	7.9	7.7	7.2	7.1	**8.0**
VANAPRAVA	9.7	9.4	9.1	8.6	8.2	7.6	7.3	**8.6**
Mean	**8.7**	**8.2**	**8.1**	**7.8**	**7.5**	**7.2**	**6.8**	**7.8**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	0.08			0.17			0.22	
Ageing (A)	0.07			0.14			0.19	
GXA	0.23			NS			NS	

Table 5: Effect of Accelerated Ageing on Vigour Index I in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	5 DAYS	10 DAYS	15 DAYS	20 DAYS	25 DAYS	30 DAYS	MEAN
AC 35534	2832	2642	2243	1700	1168	534	336	**1636**
BR 2655	2604	2434	2176	1724	1377	817	481	**1659**
IET 16348	2851	2716	2397	1958	1629	947	502	**1857**
JAYA	2754	2663	2419	1934	1639	1016	583	**1858**
KMP 175	2950	2805	2442	1883	1214	800	350	**1778**
PS 370	3254	3056	2612	2038	1499	952	463	**1982**
RASI	2646	2556	2194	1728	1343	772	420	**1666**
SAMRAT	2297	2157	1803	1319	825	391	218	**1287**
TELLA HAMSA	2772	2553	2117	1531	781	441	302	**1500**
VANAPRAVA	2930	2624	2257	1671	912	480	318	**1599**
Mean	**2789**	**2621**	**2264**	**1750**	**1235**	**704**	**364**	**1675**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	23.2			45.8			60.4	
Ageing (A)	19.4			38.3			50.5	
GXA	61.4			121.2			159.8	

Table 6: Effect of Accelerated Ageing on Vigour Index II in Rice Genotypes

GENOTYPES	ACCELERATED AGEING PERIOD (DAYS)							
	0 DAYS	5 DAYS	10 DAYS	15 DAYS	20 DAYS	25 DAYS	30 DAYS	MEAN
AC 35534	735	667	574	423	285	138	86	**415**
BR 2655	733	667	585	483	371	227	136	**457**
IET 16348	950	874	774	648	527	315	160	**607**
JAYA	853	806	730	590	485	312	175	**565**
KMP 175	862	789	697	530	340	230	98	**507**
PS 370	960	865	755	583	423	275	133	**571**
RASI	1019	941	825	642	510	292	176	**629**
SAMRAT	584	523	459	328	205	103	56	**322**
TELLA HAMSA	891	781	664	482	246	137	99	**471**
VANAPRAVA	960	855	737	542	295	152	102	**521**
Mean	**855**	**777**	**680**	**525**	**374**	**215**	**113**	**506**
Source of variation	**SEd**			**CD (P=0.05)**			**CD (P=0.01)**	
Genotypes (G)	7.8			15.5			20.5	
Ageing (A)	6.6			13			17.1	
GXA	20.8			41.1			54.2	

CONCLUSIONS

Upon accelerated ageing, the genotypes tested differed in their ability to germinate and produce vigorous seedlings which is mainly due to varied resistance to deteriorative changes. Seed germination per cent in majority of the genotypes tested *viz.* AC 35534, KMP 175, PS 370, Samrat, Tellahamsa and Vanaprava, reduced to around 50 per cent of the initial by 20 days of accelerated ageing. Hence, 20 days of accelerated ageing is considered as optimum duration of ageing for screening the genotypes for seed longevity in rice.

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