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SCREENING OF RICE GENOTYPE FOR THEIR STORABILITY AT GERMINATION STAGE

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Abstract

Studies were carried out at seed technology unit of department of plant breeding and genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry (UT) to investigate (i) Screening of rice genotypes at germination stage for their tolerance to ageing/storage potential using accelerated ageing test by employing various seed quality parameters. Seeds of 34 genotypes subjected to accelerated ageing (43±2°C temperature and 95% RH) for five days to screen the rice genotypes for seed storability shown significant variation in ability to germinate and produce vigorous seedlings. The results showed significant decline in seed germination and vigour quality parameters upon accelerated ageing. The seed quality parameters showed significant differences due to genotypes and ageing their interaction. Seeds of P# 353-225-326 completely lost germination after five days of accelerated ageing which represent a very poor storer. P# 155-49-138 recorded highest value of seed vigour after ageing, followed by P# 353- 225-325, TKM 9 (local variety) and P# 482-30-29. In general, rice genotypes P# 155-49-138, TKM 9 (local variety), P# 482-30-29 and P# 353-225-325 showed greater storage potential/storability while P# 353-225-326, P# 155-49-228 registered lower storage potentional/storability in terms of seed germination and seedling vigour. The result showed significant decline in seed germination and seedling vigour in all genotypes/varieties upon salt stress and accelerated ageing but the degree of reduction was varied significantly among varieties/ genotypes. This results could helpful in identification of tolerant varieties which can be studied further.

Key words: Rice genotypes, Accelerated ageing, Germination and Quality parameters.

Introduction

Rice (*Oryza* spp.) is an important cereal crop and is mainly used for human consumption. A 100 g of rice provides 345.0 k cal, 78.2 g of carbohydrates and 6.8 g of protein (Gopalan *et al*., 2007) inclusive of considerable amount of recommended Zinc and Niacin. Rice protein is biologically richest as it digestibility is very high (88%). Rice provides almost 50 – 80% of daily calorie intake amongst the poor class of the society. It's a staple food and cash crop for more than three billion people in the world (Ma *et al*., 2007). Asian farmers constitute about 92% of the world's total rice producing group (Mitin, 2009). In Asia 90% of rice is produced by small farmers who are solely dependent on rice for their livelihood and food security (ANU, 2006).

Accelerated ageing test is a quick test based on increased seed deterioration under hot and humid condition of storage. It has been used to estimate seed vigour and deterioration during storage (Delouche and Baskin, 1973; McDonald, 1999; Modaressi and Van damme, 2003) and has good correlation to field emergence and storage potential of the seed. The degree of tolerance for accelerated ageing conditions has been related to the survivability of the seed in storage (Delouche and Baskin, 1973). Accelerated ageing conditions could help breeders to determination differences in a variety's potential to resist seed deterioration during storage. Siddique *et al*., (1988) used accelerated ageing test to screen different rice varieties tolerance to ageing and developed a rapid screening test that can evaluate rice seeds tolerance to adverse environmental conditions and the results indicated that rice varieties differ significantly in their ability to maintain seed viability through artificial ageing. Therefore, the present investigation was attempted for the objective of screening of rice genotypes at germination stage for their tolerance to ageing/potential using accelerated ageing

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test.

Materials and Methods

Thirty four rice genotypes in which 30 genotypes (V1 to 30) derived from Recombinant Inbreed Lines (RIL) of ADT 45/FL478 Cross and developed through single seed descent method of selection and four varieties (V31 to V34) were collected from the Department of Plant Breeding and Genetics, PAJANCOA&RI, Karaikal and used in germination tests to evaluate their storage potential / storability using accelerated ageing test. The details of the genotypes used for the experiment are given in table 1.

Seed samples of each genotype were packed in muslin cloth and kept in Accelerated ageing chamber and exposed the seeds to 43±2°C temperature and 100% RH for 5 days using Hot air oven, then seeds were dried under shade overnight and germination test was conducted along with Non-aged seeds (Delouche and Baskin, 1973).

Germination test: Thirty four (34) seeds of each genotype were allowed to germinate on filter paper/ germination paper in 10 cm diameter Petri dish. The Petri dishes were kept under laboratory conditions in a Randomized Complete Block Design (Factorial) with three replications. Filter papers were kept under moist with equal volume of normal water for all Petri dishes during the experiment at room temperature (25±2) and

Table 1: Details of rice genotypes used for the Experiment.

S. No.	Geno types	Line no. / variety name	Description
1.	V1	P#636-3-7	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
2.	V2	P#15-8-6	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
3.	V3	P#636-3-6	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
4.	V4	P#130-5-11	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
5.	V5	P#869-4-19	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
6.	V6	P#130-5-10	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
7.	V7	P#130-5-12	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
8.	V8	P#429-5-2-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
9.	V9	P#542-6-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
10.	V10	P#869-4-15	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
11.	V11	P#93-7-4	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
12.	V12	P#605-1-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
13.	V13	P#15-8-2	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
14.	V14	P#679-7-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
15.	V15	P#605-4-9	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
16.	V16	P#224-4-8	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
17.	V17	P#605-6-3	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
18.	V18	P#15-8-7	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
19.	V19	P#224-4-3	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
20.	V20	P#605-6-2	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
21.	V21	P#605-5-2	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
22.	V22	P#636-3-4	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
23.	V23	P#281-4-9	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
24.	V24	P#679-7-5	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
25.	V25	P#281-4-8	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
26.	V26	P#605-5-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
27.	V27	P#15-1-7	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
28.	V28	P#99-5-1-1	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
29.	V29	P#839-5-5	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
30.	V30	P#839-1-5	Recombinant Inbred Lines (RIL) of ADT 45/FL478 cross
31.	V31	TKM 9	Local variety
32.	V32	ADT 37	Local variety
33.	V33	ADT 43	Local variety
34.	V34	ADT 45	Local variety

12 hours of light. Petri dishes were examined on daily basis for 14 days after sowing and seeds were considered germinated when the radicle was at least 2mm in length. Germination characters were recorded on 14th day after sowing.

Table 2: Effect of accelerated ageing on germination percentage and speed of germination in rice varieties/genotypes.

Geno types	Germination per cent			Percentage Reduction	Speed of germination			Percentage reduction
	Initial (A_0)	Aged (A_1)	Mean		Initial (A_0)	Aged (A1)	Mean	
V1	80	35	57.5	56.2	46.3	17.5	31.9	62.2
V2	95	85	90	10.5	43.3	41.2	42.25	4.8
V3	90	0	45	100	45.3	0	22.65	100
V4	90	90	90	0	40.5	38.8	39.65	4.1
V5	100	100	100	0	47.5	47.5	47.5	0
V6	100	90	95	10	47.5	45	46.25	5.2
V7	90	60	75	33.3	43.5	35	39.25	19.5
V8	90	15	52.5	83.3	45.3	7.5	32.9	83.4
V9	90	75	82.5	16.6	44.5	35.2	39.85	20.8
V10	95	95	95	0	48.1	47.5	47.8	1.2
V11	95	75	85	21	48.5	32.5	40.2	32.9
V12	100	65	82.5	35	49	37.6	43.3	23.2
V13	90	30	60	66.6	45.4	32.5	38.95	28.4
V14	90	65	77.5	27.7	45.2	32.5	37.5	28
V15	95	95	95	0	47	46.2	46.6	1.7
V16	90	55	72.5	38.8	44.5	27.5	36	38.2
V17	90	85	87.5	5.5	45.3	42.5	43.9	6.1
V18	65	30	47.5	53.8	42.1	15	28.55	64.3
V19	90	10	50	88.8	44.6	3.3	23.95	92.6
V20	95	90	92.5	5.2	49.2	30.3	39.75	39
V21	90	75	82.5	16.6	46.2	37.5	41.85	18.8
V22	75	70	72.5	6.6	44.2	37.5	40.85	15.1
V23	95	70	80	26.3	49.2	41.5	45.35	15.6
V24	90	90	90	0	47.3	45	25.65	4.8
V25	90	70	80	22.2	46.5	35	40.75	24.7
V26	90	45	67.5	50	47.2	30	38.6	36.8
V27	95	50	72.5	47.3	48.6	25	36.8	48.4
V28	95	65	80	31.5	49.3	32.5	50.9	34
V29	80	65	72.5	18.7	44	32.5	38.25	26.1
V30	95	75	85	21	49.5	37.5	43.5	24.2
V31	100	80	90	20	49	28	38.5	42.8
V32	95	80	87.5	15.7	49.1	27	38.05	45
V33	95	80	87.5	15.7	49.2	46.5	47.85	5.1
V34	95	60	77.5	36.8	50	26	38	48
MEAN	91.17	65.29	78.16	28.84	46.52	32.2	39.2	30.73
V					V			CD
								(0.05)
A					A			0.06**
								0.06**
VxA					VxA			0.36**

a) Germination percentage (Ruan *et al.*, 2002): Total germination percentage (%) was computed as Germination (%) = Number of germinated seeds / total number of seeds tested x 100.

b) Speed of germination (Maguire, 1962): Germination was conducted daily up to the final count day *i.e* 14 day. Emergence of radical with 2 mm was taken as criteria for germination was calculated by using the formula and expressed as absolute number: Speed of germination = $X_1/Y_1 + X_2 - X_1/Y_2 + X_n - (X_n-1)/Y_n$.

c) Total seedling length (Yokoi *et al.*, 2002): Seedling length was recorded on 14th day after the seeds were placed for germination. It is the measure of the total of root and shoot of the rice seedling, means values were expressed in cm. Total length = Shoot length + root length.

d) Seedling Fresh Weight: 10 normal seedlings in each replication were taken on random at 14 days after sowing and fresh weight was measured using electronic weighing balance and the mean values were expressed in mg.

e) Seedling fresh weight reduction: Seedling fresh weight reduction= Plant fresh weight at control – plant fresh weight at salt stress/ Fresh weight at control x 100.

f) Seedling Dry Matter Production: Ten normal seedlings obtained from the standard germination test were dried in a hot air oven at 85°C for 48 hrs cooled in a desiccators weighed and expressed as mg/seedlings.

g) Seedling dry weight reduction: Seedling dry weight reduction= Plant dry weight at control – plant dry weight at salt stress/ Dry weight at control x 100.

h) Vigour Index (Abdul – Baki and Anderson, 1970): Vigour Index = Germination% X Total Seedling Length (cm).

Results and Discussion

Screening of rice genotypes for their tolerance to storability using accelerated ageing test:

Seeds of 34 genotypes undergone accelerated ageing for 5 days shown significant variation in ability to germinate and produce vigorous seedlings.

Germination percentage:

Germination percentage showed significant differences due to genotypes and ageing and their interaction. A significant decline in seed germination of all the genotypes upon ageing was ranged from 0 to 100 per cent. Seeds of V 3 completely lost germination after 5 days of accelerated ageing while V19 and V8 recorded 89 and 83 per cent reduction, respectively. Whereas, no reduction was observed in V4, V5, V10, V15 and V24 and lowest reduction in V20 (5.2%), V17 (5.5) and V22 (6.6) followed by V6 (10%) table 2.

Table 3: Effect of accelerated ageing on Total seedling length (cm) and Dry matter production (mg/seedlings) in rice varieties/ genotypes.

Geno types	Germination per cent			Percentage Reduction	Speed of germination			Percentage reduction
	Initial (A_0)	Aged (A_1)	Mean		Initial (A_0)	Aged (A1)	Mean	
V1	14.9	13.1	14	12.0	157	56	106.5	64.3
V2	12.2	11.8	12	3.2	135	114	124.5	15.5
V3	10.2	0	5.1	100	158	0	79	100
V4	15.3	6.6	10.95	56.8	84	9	46.5	89.2
V5	13.7	9.9	11.8	27.7	166	78	122	53.0
V6	13.3	8.8	11.05	33.8	178	73	125.5	58.9
V7	11.9	10.8	11.35	9.2	185	87	136	52.9
V8	11.7	7.3	9.5	37.6	158	56	107	64.5
V9	10.2	10.0	10.1	1.9	63	48	55.5	23.8
V10	11.0	7.6	9.3	30.9	171	132	151.5	22.8
V11	13.4	11.9	12.65	11.1	167	148	157.5	11.3
V12	13.8	9.2	11.5	33.3	131	94	112.5	28.2
V13	12.4	11.4	11.9	3.4	124	32	78	74.1
V14	11.5	11.1	11.3	4.5	151	142	146.5	5.9
V15	11.1	10.6	10.85	4.5	127	50	88.5	60.6
V16	12.6	11.9	12.25	5.5	156	141	148.5	9.6
V17	12.3	10.0	11.15	18.6	134	122	128	8.9
V18	11.7	8.4	10.05	28.2	151	82	116.5	45.6
V19	14.8	6.5	10.65	56.0	168	34	101	79.7
V20	11.2	9.1	10.15	18.75	127	119	123	6.2
V21	11.6	8.0	9.8	31.0	148	89	118.5	39.2
V22	11.6	11.3	11.45	2.5	188	87	137.5	53.7
V23	11.9	9.3	10.6	21.8	145	128	136.5	11.7
V24	12.5	10.0	11.25	20	129	101	115	21.7
V25	12.4	11.6	12	6.4	130	60	95	53.8
V26	10.5	9.5	10	9.5	141	130	135.5	7.8
V27	12.9	12.2	12.55	5.4	119	101	110	15.1
V28	11.6	11.0	11.3	5.1	135	122	128.5	9.6
V29	14.2	13.4	13.8	5.6	100	56	78	44.0
V30	13.8	11.1	12.45	19.5	147	64	105.5	56.4
V31	10.6	10.2	10.4	3.7	108	38	73	64.8
V32	8.1	7.3	7.7	9.8	120	64	92	46.6
V33	12.2	9.1	10.65	25.4	127	120	123.5	5.5
V34	9.5	9.0	9.25	5.2	133	126	129.5	5.2
V	CD				V	CD (0.05)		
	(0.05)					0.10**		
A	0.06**				A	0.10**		
	0.06**					0.56**		
VxA	0.39**				VxA			

Speed of germination:

The differences in respect of speed of germination due to genotypes and ageing and their interaction were highly significant. Among the genotypes, V5 recorded no reduction percentage (0%) whereas V10 (1.2%), V15 (1.7%), V4 (4.1%), V2 (4.8%), V24 (4.8%) and V33 (5.1%) registered lowest reduction percentage over control, while V3 (100%) followed by V19 (92.6%) recorded highest percentage of reduction table 2.

Total seedling length:

The differences in total seedling length varied significantly between genotypes and ageing and their interaction. V9 (1.9%) recorded lowest reduction in total seedling length (which maintained 10.0 cm) followed by V22, V2, V13 while all the seeds are dead in V3 and drastic reduction of 56.8% and 56% noticed in V4 (6.6 cm) and V19 (6.5 cm), respectively table 3.

Seedling fresh weight:

The differences in seedling fresh weight varied significantly between genotypes and ageing and their interaction. V 16 recorded lowest reduction in fresh weight (which maintained 872mg) followed by V20, V23, V29, V21 which all the seeds are dead in V 3 and drastic reduction noticed in V 31 (93), V 4 (88), V8 (147) table 4.

Seedling dry matter production:

The differences in respect of seedling dry matter production due to genotypes, ageing and their interaction were highly significant. Among the genotypes V34 has recorded least reduction percentage (5.2%) followed by V33 (5.5%), V 14 (5.9%) over control, While V3 (100%) followed by V4 (89.2), V19 (79.7), recorded highest percentage of reduction table 4.

Vigour index:

Vigour index showed significant differences due to genotypes, ageing and their interaction. Significant decline in seed vigour of all the genotypes upon ageing was recorded. Seeds of V3 completely lost germination after five days of accelerated ageing which represent a very poor storer. V15 (1007) recorded highest value of seed vigour after ageing, followed by V2 (1003), V5 (990) respectively. The lowest seed vigour after accelerated ageing was recorded in V19 (65) followed by V8 (109), and V18 (252) respectively table 5.

Discussion

Seeds of 34 genotypes subjected accelerated ageing (43±2°C temperature and 95% RH) for five days to screen the genotypes for the seed storability shown significant variation in ability to germinate and produce vigorous seedlings. The results showed significant decline in seed germination and vigour parameters upon accelerated ageing. The seed quality parameters showed significant differences due to genotypes and genotypes and ageing and their interaction. Seeds of V3 completely lost germination after 5 days of accelerated ageing while V19 and V8 recorded 89 and 83 percent reduction, respectively. Whereas, no reduction was observed in V4, V5, V10, V15 and V24 and lowest reduction in V20,

Table 4: Effect of accelerated ageing on fresh weight (mg/g) in rice varieties/genotypes.

Geno types	Fresh weight (mg/g)			Percentage Reduction
	Initial(A_0)	Aged (A_1)	Mean	
V1	594	481	537.5	19.0
V2	381	239	310	37.2
V3	585	0	292.5	100
V4	349	88	218.5	74.7
V5	778	387	582.5	50.2
V6	779	403	589.5	48.2
V7	749	649	699	13.3
V8	670	147	408.5	78.0
V9	859	859	859	0
V10	249	231	240	7.2
V11	629	610	619.5	3.0
V12	492	448	470	2.8
V13	504	351	427.5	30.2
V14	520	501	510.5	3.6
V15	605	581	593	3.9
V16	878	872	875	0.6
V17	461	450	455.5	2.3
V18	670	581	625.5	5.6
V19	789	786	789	0
V20	527	450	488.5	2.0
V21	605	590	597.5	2.4
V22	834	481	657.5	42.3
V23	827	810	818.5	2.0
V24	562	542	552	3.5
V25	573	354	463.5	38.2
V26	69	263	161	59.4
V27	951	361	656	61.4
V28	582	562	572	3.4
V29	782	764	773	2.3
V30	585	564	574.5	3.5
V31	471	93	282	77.6
V32	364	238	301	34.6
V33	588	561	574.5	4.5
V34	594	481	537.5	21.2
V	CD			
	(0.05)			
A	1.47**			
	1.47**			
VxA	8.61**			

Table 5: Effect of accelerated ageing on seed vigour in rice varieties/genotypes.

Geno types	Fresh weight (mg/g)			Percentage Reduction
	Initial(A_0)	Aged (A_1)	Mean	
V1	1192	458	825	52
V2	1159	1003	1081	13.43
V3	918	0	459	100
V4	1377	594	985	66.86
V5	1370	990	1180	27.73
V6	1330	792	1061	40.45
V7	1071	648	859	39.49
V8	1053	109	581	89.64
V9	918	750	834	23.46
V10	1045	722	883	30.90
V11	1273	892	1082	29.92
V12	1380	598	989	56.6
V13	1116	342	729	69.35
V14	1035	721	878	40.33
V15	1054	1007	1030	4.49
V16	1134	654	894	42.32
V17	1107	850	978	23.21
V18	760	252	506	66.84
V19	1332	65	698	95.12
V20	1064	819	941	23.02
V21	1044	600	822	42.52
V22	870	791	830	9.19
V23	1130	651	890	42.38
V24	1125	900	1012	20
V25	1116	812	964	27.24
V26	945	427	686	53.83
V27	1125	610	917	45.7
V28	1102	715	908	35.1
V29	1136	871	1003	23.32
V30	1131	832	1071	26.43
V31	1060	816	938	23.01
V32	769	584	676	24.05
V33	1159	728	943	37.18
V34	902	540	721	40.1
V	CD (0.05)			
A	4.44**			
VxA	4.44**			
	19.22**			

V17, and V22 followed by V6. The line V5 recorded no reduction percentage whereas V10, V15, V4, V2, V24 and V33 registered lowest reduction percentage over control in speed of germination. Similar decreases in the germination percentage after accelerated ageing in rice has also been reported by several workers (Kapoor *et al*., 2011). Reduction in germination is due to degradation of mitochondrial membrane, leading to reduction in energy supply necessary for germination (Gidrol *et al*., 1998). V9 recorded lowest reduction in total seedling length followed by V22, V2, V13. V16 recorded lowest reduction in fresh weight by V20, V23, V29, V21. The genotype V34 recorded least reduction percentage followed by V33, V14 over control in dry matter production. Seeds of V3 completely lost germination after five days of accelerated ageing which represent a very poor storer. V15 recorded highest value of seed vigour after ageing, followed by V2, V22 and V5. In general, rice genotypes V15, V22, V5 and V2 showed greater storage potential/storability while V3, V8 and V19 registered lower storage potential/ storability in terms of seed germination and seedling vigour. The decreased seed vigour is because of reduced capacity to germinate and produce vigorous seedlings which might be due to seed deterioration resulting from accelerated ageing of seed.

Conclusion

Seeds of 34 genotypes subjected accelerated ageing for five days to screen the genotypes for the seed storability shown significant variation in ability to germinate and produce vigorous seedlings. The results showed significant decline in seed germination and vigour parameters upon accelerated ageing. The seed quality parameters showed significant differences due to genotypes and ageing and their interaction. Seeds of V3 completely lost germination after 5 days of accelerated ageing while V19 and V8 recorded 89 and 83 percent reduction, respectively whereas, no reduction was observed in V4, V5, V10, V15 and V24 and lowest reduction in V20, V17 and V22 followed by V6. V5 recorded no reduction percentage whereas V10, V15, V4, V2, V24 and V33 registered lowest reduction over control in speed of germination. V9 recorded lowest reduction in total seedling length followed by V222, V2 and V13. V16 recorded lowest reduction in fresh weight followed by V20, V23, V29 and V21. The genotype V34 recorded least reduction percentage followed by V33, V14 over control in dry matter production. Seeds of V3 completely lost germination after five days of accelerated ageing which represent a very poor storer. V15 recorded highest value of seed vigour after ageing, followed by V2, V22 and V5. In general, rice genotypes V15, V22, V5 and V2 showed greater storage potential/storability while V3, V8 and V19 registered lower storage potential/ storability in terms of germination and seedling vigour.

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