The Bioscan 11(1): 363-368, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

RESPONSE OF ACCELERATED AGEING ON SEEDS OF RADISH (*RAPHANUS SATIVUS* L.) CV. ARKA NISHANTH

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KEYWORDS
Radish(*Raphanussativus*L.)
Accelerated ageing

Received on :
18.11.2015

Accepted on :
10.02.2016

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ABSTRACT
A Laboratory experiment was conducted at Department of Seed Science and Technology,GKVK, UAS, Bangalore during summer 2014 to assess the response of accelerated ageing on seeds of radish (*Raphanussativus*L.)cv. Arka nishanth.The resultant seeds of gibberllic acid and micronutrients of seedswas subjected to the accelerated ageing at 45 ± 2^0C for 100% RH for various time intervals (0, 2, 4, 6, 8,10days) and seed quality tests of the seed material completed (germination percentage, shoot length, root length, mean seedling length, mean seedling dry weight, seedling vigour index I&II, electrical conductivity), before and after ageing treatments. The seed showed a gradual and sequential reduction in germination percentage and seedling vigour as accelerated ageing duration increased. Seedleachate conductivity increased with ageing duration.

INTRODUCTION

Radish (*Raphanussativus*L.) is one of the important vegetable crop in India. It is a large, fleshy root and white to purple hermaphrodite flowers clustered in a terminal raceme. It is originated from Europe and Asia; radish is a fast growing vegetable crop of the family Brassicaceae. Radish is a cross-pollinated crop due to saprophytic system of self-incompatibility. The seed production of radish is done by two methods.(1) Seed to seed and (2) Root to seed method (Singh, 2001).Radish leaves contain 89 per cent water, 3.9 per cent protein, 0.6 per cent fat, 4.1 per cent carbohydrate, 31 mg calcium, 6 mg phosphorus, 8 mg iron, 8 I.U vit-A, 21 mg Vit-B, 21 mg Vit-C, 1.4 mg nicotinic acid and 2.7 mg riboflavin (Singh *et al*., 2004). Radish is useful in the treatment of liver, gall bladder troubles, sleepleness, chronic diaria, neuralgic headaches, urinary complaints, piles and gastrodynia (Sadhu, 1993).Major radish producing states are West Bengal, Bihar, Uttar Pradesh, Punjab, Assam, Haryana, Gujarat and Himachal Pradesh are major radish producing states. The area under radish in India is 160,000 ha with a root production of 2286,000 MT (Anon., 2012). In Karnataka; radish is grown in an area of 5307 ha with root production of 60153 MT.Good quality seed is also one of the important means to increase productivity in any crop. Lot of emphases have been given by government of India to improve the quality of seed and planting materials which has not only opened new vistas in increasing production and productivity but also provided ample opportunities for export of quality seed. Accelerated ageing techniques have great potential for understanding the mechanism of ageing and associated deterioration processes of seeds. The process of deterioration under accelerated ageing conditions are essentially similar to those under normal conditions, however, the major difference is that the rate of deterioration is much faster, thus, making it possible to study within reasonable time frame. A number of studies have been carried out in past to analyze the physiological and biochemical changes associated with accelerated aged seeds (Aiazzi *et al*., 1996 in *Atriplexcordobensis*; Goel and Sheoran, 2003 in cotton; Vieira *et al*., 2004 in soybean).

Seed moisture and storage temperature are the two most important factors influencing loss of viability during storage .The rate of seed deterioration was greatly increased by exposing seeds under high humidity (100%) and high temperature (45 ± 2^0C) conditions .Information can be obtained on the probable longevity of a seed under more normal conditions and seed storability can be predicted in a few days with the help of accelerated aging test.

The ageing is an universal phenomena occuring in all living organisms during the natural course of development, however, unfavorable/stress conditions hastens it. Seeds of all plants exhibit a maximum potential for germination immediately after the harvest, which declines gradually with an increased storage period. Seed ageing is one of the key factors responsible for the decline in the yield of various food crops and seed crops particularly the vegetables. Ageing of seeds is evident through parameters viz., delayed germination and emergence, slow growth, increased susceptibility to environmental stresses (Walters, 1998). Many processes have been suggested as possible mechanisms involved in the seed deterioration like chromosomal damage, loss of activity. Hence, keeping above facts in view, the present investigation was carried out to response of accelerated ageing on seeds of radish (*Raphanussativus*l.)cv. Arka nishanth

MATERIALS AND METHODS

The experiment was conducted at Department of Seed Science and Technology, Gandhi Krishi Vignana Kendra campus, University of Agricultural Sciences,Bangalore during 2014. There were 4 micronutrients treatments with three growth regulator and laid out in factorial complete randomized design with four replications.The treatments combinations includes **M_1:** RDF (75:40:40NPK kg ha^{-1}), **M_2:** RDF + Zinc sulphate at 10 kg ha^{-1},**M_3:** RDF + 0.1 % borax spray (at bud initiation stage),**M_4:** RDF + Zinc sulphate at 10 kg ha^{-1} + 0.1% borax spray (at bud initiation stage),**G_0:** Control ,**G_1:** Gibberllic acid at 100 ppm,**G_2:** Gibberllic acid at 120 ppm.The experimental data was statistically analyzed by adopting the analysis of variance technique appropriate to design as per the methods outlined by Sundaraju *et al*. (1972) in computer. Critical differences were calculated at 5 per cent level, where 'F' test was significant.

Plant material

The seeds obtained from previous field experiment used for the study.Healthy, infection free and uniform size seeds cultivar (Arka nishanth) of radish (*Raphanussativus*L.) was used for all experiments.

Accelerated ageing

For accelerated ageing; the seeds were exposed to a temperature 45ºC and RH (Delouche and Baskin, 1985) for various time intervals (0, 2, 4, 6, 8,10days).Seeds which were not exposed to the ageing treatments were referred as '0 day'.

Germination

The germination test was conducted in the laboratory by using between paper method as per ISTA (Anon., 2007). Hundred seeds in four replicates were placed on germination paper and rolled towels were in germination chamber maintained at 25 ± 1ºC and 95 ± 3 per cent relative humidity. The germinated seedlings were evaluated on fourth and 10th day as first and final count, respectively.

Ten seedlings from each treatment and replication were used for measuring the seedling length was kept in the hot air oven at 85 ± 1ºC for 24 hours.

Root and Shoot length (cm)

Ten normal seedlings were selected at random from each treatment. The root length was measured from point of attachment of seed to the tip as the longest root and shoot length was measured from the point as attachment of seed to the growing meristematic tip and expressed in cm.

Mean seedling length (cm)

Ten seedlings taken at randomly from each treatment and replication were separated carefully from the paper towel of laboratory germination test and total length of seedlings after removing the cotyledons was measured using metric scale on the germination table. The mean length of ten seedlings in each treatment and replications was calculated and expressed in centimeters.

Mean seedling dry weight (mg)

Ten seedlings from each treatment and replication were used for measuring the seedling length was kept in the hot air oven at 85 ± 1ºC for 24 hours. The dry weight (mg) was measured and expressed as mean dry weight (mg seedling^{-1})

Seedling vigor index [SVI-I and SVI-II]

The seedling vigour index was calculated as per the formula given by Abdul Baki and Anderson (1973).

SVI-I = Germination (%) x Mean seedling length (cm).

SVI-II = Germination (%) x Mean seedling dry weight (mg).

Electrical conductivity (μSppm^{-1})

Ten seeds of two replications were taken randomly from each treatment in a beaker. Then the seeds were soaked in 25 ml of distilled water for 24 hours at 25 ± 1ºC. The steeped water from soaked seeds was collected and the electrical conductivity (EC) of seed leachate was measured in digital conductivity meter (Model: Systronic conductivity meter 306). After subtracting the EC of the distilled water from the value obtained from the seed leachate, the actual EC due to electrolyte was measured and expressed in μS ppm^{-1} (Anon., 2007).

RESULTS AND DISCUSSION

The seeds obtained from the 12 treatments from previous field experiment used for the study. Seeds were subjected to accelerated ageing for 2, 4, 6, 8,10 days at 45 ± 2ºC for 100% RH and the following observation was recorded (Delouche and Baskin, 1985). The experiment was carried out in the PG laboratory of Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Bangalore.

Storage potential was evaluated by using accelerated ageing technique. Accelerated ageing results in the progressive loss of seed viability and vigour.

Effect of Micronutrients and gibberllic acid concentrations

The application of recommended dose of fertilizer + Zinc sulphate @10 kg ha^{-1} as soil application +0.1 % borax spray at bud initiation stage exhibits 92.20% germination which declined to 11.01% and recommended dose of fertilizer exhibits 83.66% germination which declined to 1.58% after eight days of ageing (Table 1). Among gibberllic acid concentrations, control exhibits more susceptibility to the ageing over the treatments. Besides, germination, root length,shoot length mean seedling length and mean seedling dry weight also elicited a significant decline in control over the treatments. The decline in all these parameters contributed to the decline in the seedling vigour index-I and seedling vigour index-II. Ageing results in results in non-functioning of cell division which essential for germination process and development of normal seedling. This collapse results in decreased germination in terms of normal seedling, seedling length, seedling dry weight and increased the number of abnormal seedlings. Seeds became almost unable to support de novo protein synthesis. The results are in accordance with NeeruJain *et al*. (2006) in radish. Scialabb *et al*. (2002) in radish; Mavi and Demir (2007) in melon seed; Khan *et al*. (2005) in turnip; Al-maskri *et al*. (2002) in Cucumber Seeds; Mumtaz Khan *et al*. (2003) in Pea seeds,

Electrical conductivity test of seed leachates measures the amount of electrolytes that are leaked in to the imbibing medium from seeds. This test reflects the integrity of cell membrane subsequent to the treatment. The increased

Table 1: Accelerated ageing test response on seed quality as influenced by micronutrients and gibberllic acid in radish cv. Arkanishanth

Treatments	Germination (%) Accelerated ageing duration (days)					Root length (cm)					Shoot length (cm)				
	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8
Micronutrients (M)															
M_1	83	77	49	20	1	7.66	6.44	5.40	4.53	2.63	7.17	6.58	5.36	4.73	3.1
M_2	86	80	51	24	6	10.37	9.24	7.55	6.11	4.49	8.1	7.37	6.2	5.1	3.66
M_3	89	83	52	25	7	11.07	9.92	9.07	7.71	6.65	8.8	7.7	6.45	5.2	4.1
M_4	92	85	54	28	11	13.11	11.78	10.68	9.53	8.47	9.65	9.71	8.04	6.86	5.23
S.Em ±	0.531	0.517	0.294	0.347	0.196	0.149	0.126	0.142	0.128	0.052	0.085	0.106	0.158	0.071	0.041
CD(P = 0.05)	1.523	1.482	0.842	0.994	0.756	0.427	0.362	0.407	0.366	0.148	0.242	0.303	0.453	0.205	0.117
Growth regulator (G)															
G_0	87	81	51	24	6	10.17	9.09	7.92	6.77	5.48	8.31	7.65	6.36	5.36	3.94
G_1	87	81	51	24	6	10.62	9.36	8.18	6.93	5.57	8.37	7.87	6.53	5.47	4.04
G_2	89	83	52	25	6	10.87	9.59	8.43	7.21	5.64	8.62	8.01	6.7	5.59	4.09
S.Em ±	0.459	0.325	0.254	0.300	0.080	0.129	0.109	0.123	0.111	0.045	0.073	0.092	0.079	0.062	0.035
CD(P = 0.05)	1.316	1.250	0.729	NS	0.230	0.370	0.314	0.352	0.317	0.128	0.210	0.263	0.226	0.177	0.101
Micronutrients × Growth regulator (M × G)															
M_1G_0	82	77	48	20	1	6.86	6.34	5.36	4.44	2.54	7.14	6.25	5.27	4.64	3.04
M_2G_0	86	80	50	24	6	9.70	9.01	7.25	5.76	4.40	8.07	7.34	6.26	5.08	3.63
M_3G_0	88	82	52	25	7	11.06	9.86	9.02	7.61	6.56	8.76	7.48	6.4	5.13	3.99
M_4G_0	90	84	53	27	10	13.06	11.15	10.07	9.28	8.40	9.26	9.52	7.52	6.57	5
M_1G_1	82	77	48	19	1	7.61	6.40	5.41	4.54	2.66	7.15	6.65	5.3	4.71	3.11
M_2G_1	86	80	51	24	6	10.66	9.07	7.30	5.87	4.51	8.09	7.37	6.29	5.1	3.67
M_3G_1	89	83	52	25	7	11.07	9.91	9.09	7.67	6.65	8.77	7.74	6.46	5.16	4.15
M_4G_1	91	85	54	28	10	13.12	12.08	10.93	9.65	8.45	9.48	9.71	8.08	6.92	5.25
M_1G_2	85	78	50	20	1	8.53	6.58	5.44	4.61	2.70	7.25	6.82	5.5	4.85	3.15
M_2G_2	87	81	51	25	6	10.76	9.66	8.12	6.72	4.58	8.13	7.41	6.32	5.11	3.67
M_3G_2	90	83	53	25	7	11.07	10.00	9.12	7.85	6.74	8.989	7.89	6.49	5.31	4.18
M_4G_2	94	87	55	29	11	13.14	12.10	11.05	9.65	8.55	10.21	9.91	8.51	7.08	5.37
S.Em ±	0.919	0.894	0.508	0.600	0.160	0.258	0.219	0.246	0.221	0.090	0.146	0.183	0.158	0.124	0.071
CD(P = 0.05)	NS	NS	NS	NS	0.461	0.740	NS	NS	NS	NS	0.419	NS	NS	NS	NS
CV (%)	2.09	2.18	1.96	4.86	4.86	4.89	4.69	6.02	6.35	3.23	3.45	4.67	4.84	4.53	3.52

Micronutrients (M): M_1: RDF (75:40:40 NPK kg ha^{-1}), M_2: RDF + $ZnSO_4$ @10kg ha^{-1}, M_3: RDF + borax 0.1% spray at bud initiation stage, M_4: $M_2 + M_3$

Table 1: Continue.....

Treatments	Mean seedling length (cm) Accelerated ageing duration (days)					Mean seedling dry weight (mg)					Seedling vigour index-I				
	0	2	4	6	8	0	2	4	6	8	0	2	4	6	8
Micronutrients (M)															
M_1	14.85	13.03	10.77	9.27	5.74	4.27	3.51	3.16	2.66	2.07	1243	1013	531	187	9
M_2	18.48	16.63	13.85	11.22	8.16	4.49	3.73	3.31	2.82	2.09	1599	1342	709	277	53
M_3	19.88	17.63	15.53	12.92	10.76	4.77	4.01	3.56	2.99	2.22	1776	1468	820	332	80
M_4	22.77	21.50	18.73	16.40	13.71	5.07	4.25	3.78	3.16	2.44	2100	1849	1022	464	151
S.Em ±	0.172	0.151	0.174	0.159	0.065	0.038	0.054	0.039	0.031	0.026	16.800	21.900	10.360	6.110	0.694
CD(P = 0.05)	0.495	0.434	0.498	0.456	0.187	0.111	0.156	0.114	0.091	0.076	48.180	62.820	29.700	17.540	1.992
Growth regulator (G)															
G_0	18.49	16.75	14.29	12.14	9.42	4.58	3.80	3.38	2.84	2.17	1617	1366	740	302	70
G_1	19.00	17.24	14.72	12.41	9.62	4.66	3.90	3.44	2.92	2.20	1672	1416	768	313	72
G_2	19.50	17.60	15.14	12.80	9.74	4.71	3.93	3.53	2.96	2.24	1750	1472	804	330	77
S.Em ±	0.149	0.131	0.150	0.137	0.056	0.033	0.047	0.034	0.027	0.023	14.550	18.970	8.970	5.290	0.600
CD(P = 0.05)	0.429	0.376	0.432	0.395	0.162	0.096	NS	0.098	0.079	0.066	41.730	54.400	25.720	15.190	1.725
Micronutrients × Growth regulator (M × G)															
M_1G_0	14.01	12.60	10.64	9.09	5.59	4.26	3.43	3.13	2.58	2.05	1161	973	521	186	8
M_2G_0	17.78	16.36	13.51	10.85	8.04	4.40	3.71	3.24	2.80	2.08	1530	1314	689	263	52
M_3G_0	19.83	17.34	15.42	12.75	10.56	4.73	3.86	3.46	2.89	2.20	1758	1433	809	325	77
M_4G_0	22.33	20.68	17.60	15.86	13.50	4.93	4.22	3.70	3.10	2.36	2020	1744	942	433	143
M_1G_1	14.77	13.06	10.72	9.26	5.78	4.27	3.55	3.16	2.69	2.08	1220	1006	524	180	10
M_2G_1	18.76	16.45	13.60	10.98	8.18	4.52	3.73	3.34	2.80	2.09	1620	1324	695	273	52
M_3G_1	19.85	17.66	15.56	12.84	10.81	4.76	4.07	3.53	3.03	2.22	1771	1469	821	330	79
M_4G_1	22.61	21.80	19.01	16.58	13.71	5.07	4.26	3.72	3.16	2.40	2075	1865	1031	470	148
M_1G_2	15.78	13.42	10.95	9.47	5.86	4.28	3.56	3.18	2.70	2.08	1349	1061	548	194	9
M_2G_2	18.90	17.08	14.44	11.84	8.26	4.54	3.76	3.35	2.86	2.10	1648	1388	744	297	54
M_3G_2	19.97	17.90	15.61	13.18	10.92	4.83	4.12	3.68	3.06	2.24	1798	1502	831	341	84
M_4G_2	23.36	22.02	19.57	16.74	13.93	5.20	4.28	3.92	3.23	2.55	2205	1937	1092	488	162
S.Em ±	0.299	0.262	0.301	0.275	0.113	0.067	0.094	0.068	0.055	0.046	29.100	37.940	17.940	10.590	1.200
CD(P = 0.05)	NS	NS	0.864	NS	NS	NS	NS	NS	NS	NS	NS	NS	51.450	NS	NS
CV (%)	3.15	3.05	4.09	4.43	2.36	2.90	4.87	3.99	3.80	4.17	3.46	5.37	4.65	6.73	3.28

Micronutrients (M); M_1: RDF (75:40:40 NPK kg ha^{-1}), M_2: RDF + $ZnSO_4$ @10kg ha^{-1}, M_3: RDF + borax 0.1% spray at bud initiation stage, M_4: M_2 + M_3

Table 1: Contin.....

Treatments	Seedling vigour index-II Accelerated ageing duration (days)					Electrical conductivity (μSppm^{-1})					
	0	2	4	6	8	0	2	4	6	8	10
Micronutrients (M)											
M_1	357	273	156	53	3	81.47	102.20	142.73	200.01	293.42	342.50
M_2	388	301	169	70	13	69.89	98.64	128.66	191.61	284.73	334.23
M_3	426	334	188	77	16	68.31	97.53	121.77	188.44	283.08	328.26
M_4	467	366	206	89	27	57.20	95.78	111.99	176.68	271.02	311.04
S.Em±	4.320	5.270	4.480	0.990	0.765	0.708	1.076	4.388	1.878	2.231	2.904
CD(P=0.05)	12.400	15.110	13.440	2.840	0.267	2.032	3.086	12.393	5.385	6.398	8.328
Growth regulator (G)											
G_0	400	309	174	70	14	72.31	99.30	129.48	193.04	286.06	333.78
G_1	408	319	178	72	15	69.22	98.44	125.48	188.42	281.89	327.93
G_2	422	327	187	75	16	66.13	97.86	123.91	186.08	281.24	325.31
S.Em±	3.740	4.560	4.130	0.850	0.231	0.614	0.932	0.380	1.626	1.932	2.515
CD(P=0.05)	10.740	13.080	12.390	2.460	0.663	1.760	NS	1.091	4.664	NS	7.212
Micronutrients × Growth regulator (M×G)											
M_1G_0	353	265	154	53	3	85.41	103.13	145.93	202.46	297.26	344.09
M_2G_0	379	298	165	67	14	74.54	99.83	131.92	195.77	287.19	338.48
M_3G_0	420	319	181	74	16	69.33	98.34	123.91	191.82	283.91	333.11
M_4G_0	446	356	198	84	25	59.98	95.92	116.16	182.14	275.87	319.44
M_1G_1	353	274	155	52	4	82.89	102.42	141.40	199.39	292.73	343.94
M_2G_1	390	300	171	70	13	68.30	97.64	128.67	186.82	281.82	327.14
M_3G_1	425	338	186	78	16	68.83	97.92	121.18	190.88	283.90	330.16
M_4G_1	465	365	202	90	26	56.85	95.78	110.67	176.61	269.11	310.49
M_1G_2	366	280	159	55	3	76.12	101.06	140.88	198.18	290.26	339.48
M_2G_2	396	306	173	72	14	66.85	98.43	125.40	192.24	285.19	337.06
M_3G_2	434	346	196	79	17	66.77	96.33	120.22	182.61	281.42	321.51
M_4G_2	490	377	219	94	30	54.78	95.63	109.14	171.28	268.09	303.18
S.Em±	7.490	9.120	4.300	1.710	0.462	1.227	1.864	2.651	3.253	3.865	5.031
CD(P=0.05)	NS	NS	NS	NS	1.326	3.520	NS	NS	NS	NS	NS
CV (%)	3.65	5.73	4.79	4.75	6.15	3.54	3.78	4.20	3.43	2.73	3.06

Micronutrients (M); M_1: RDF (75:40:40 NPK kg ha^{-1}), M_2: RDF + $ZnSO_4$ @10kg ha^{-1}, M_3: RDF + borax 0.1% spray at bud initiation stage, M_4:M_2 + M_3

electrolyte leakage can be correlated with the decreased vigour index in seeds .Leaching of electrolytes from the less viable seeds is often attributed to the loss of membrane integrity by distortions of the bilayer configuration and the extent of leakage is directly proportional to the conductivity of solution in which seeds are germinated these results were in conformity with those of Bhanuprakash *et al*. (2006) in onion seeds, Amjad and Anjum (2002) in onion seeds, Ayyappan *et al*. (2006) in cucumber seeds, Neeru Jain *et al*. (2006) in radish. Overall conclusion is that radish seeds quality was reduced during accelerated ageing. The seed showed a gradual reduction in mean germination percentage and vigour as accelerated ageing duration increased. During deterioration, vigour is the first component of seed quality, which is lost, followed by a loss of germination capacity and viability (Trawatha *et al*.,1995).

The results obtained suggest that membrane deterioration leading to a reduction in vigour and germ inability may play a considerable role in radish seed quality loss that may results from prolonged storage in humid tropics.

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