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CONTROL OF SEED DETERIORATION IN COTTON GENOTYPES– HOW?

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The fuzzy seeds of cotton genotypes 70 E, Bikaneri Narma, AC.738, PIL.43, PIL.8, T.7 and M.12 stored under laboratory conditions for one, two, three and four years were dry dressed with a mixture of calcium oxychloride and calcium carbonate (3:1) @ 5 g kg^{-1} and iodine vapours impregnated in the calcium carbonate @ 3g kg^{-1} and kept in airtight container under ambient condition for seven days had shown that halogenation increased the seed vigour and viability, irrespective of age of seeds and reduced the pathogenicity of stored seeds.

Keywords : Cotton seed viability; Halogenation; Long term storage; Vigour.

Introduction

Cotton is the chief of fibre crops grown in India on commercial scale, as this is the prime source of raw material to the Indian textile industry. Cotton sustains huge employment in the rural and urban sectors, plays a key role in the economic and trade activities within the country. Seeds formed the basic and vital input for cotton cultivation; hence, necessary care is required to look for better seeds with high planting value. While in storage cotton seeds tend to loose their viability due to its oil containing nature and easy absorption of atmospheric moisture when stored at high RH levels. Therefore, prevent the loss of seed viability and deterioration of other qualities especially during long-term storage[1]. The establishment of a stand of vigourously growing seedlings is one of the important pre-requisites for cotton production. In spite of high initial seed vigour and viability, deterioration is fast due to lack of conducive storage environment. To avert such situation, an inexpensive, simple and practicable technology to prolong the shelf life of cotton seeds through storage is immensely needed. Based on these backdrops, the experiment was formulated with halogens as seed treatment to control the physiological deterioration in seven cotton genotypes.

Materials and Methods

The fuzzy cotton seeds belonging to seven genotypes *viz.*, 70 E, Bikaneri Narma, AC.738, PIL.43, PIL.8, T.7 and M.12 were stored under laboratory conditions with no seed treatments for one, two, three and four years. These seeds were dry dressed with a mixture of calcium oxychloride and calcium carbonate (3:1) @ 5 g kg^{-1} and iodine vapours impregnated in the calcium carbonate @ 3 g kg^{-1} to serve as a source of chlorine and iodine, respectively. The halogenated seeds of each genotype were packed in airtight containers and kept for seven days under ambient condition along with untreated control seeds. After seven days, the seeds were evaluated for viability by placing four replications of 100 seeds each in sand medium[2]. The normal seedlings were counted after a germination period of 12 days and expressed in percentage. The seedling vigour index was calculated by multiplying germination percentage and seedling length as per Abdul-Baki and Anderson[3]. Apart from physiological quality, the biochemical components such as electrical conductivity of seed leachate[4], reducing sugar[5] and dehydrogenase enzyme activity[6] were estimated. The presence of storage fungi, were tested using blotter method prescribed by ISTA[2]. The data recorded were analyzed statistically for significance as described by Gomez and Gomez[7]. The data expressed in percentages were transformed into corresponding arcsine values before analysis, wherever necessary.

Results and Discussion

The investigation on seeds of seven cotton genotypes which were given dry dressing of chlorine and iodine based halogen formulations brought out that the over all maximum germination of 80% was registered in one year stored seeds and as low as 16% in four year stored seeds. Across the period of storage and seed treatments, the genotype M.12 registered the highest germination of 64% followed by AC.738 (57%) and it was lowest in T.7 (45%). Seeds treated with either chlorine or iodine expressed a positive significant difference of 9% and 8%, respectively on germination improvement over untreated seeds. However, the effect of chlorine and iodine were found to be similar. Between chlorine and iodine treatments, the genotypes PIL.43, PIL.8, M.12 and T.7 are found highly responsive to iodine treatment. Irrespective of age of seed, the difference in improvement of germination between chlorine and iodine treatment were found to be 2% to 3%

Table 1. Effect of halogen treatments on viability (%) of cotton seeds stored under ambient condition.

Genotypes/ Treatment	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	12 (20.2)	20 (26.5)	30 (33.2)	21 (26.7)	31 (33.8)	38 (38.0)	38 (38.0)	36 (36.6)	65 (53.7)	72 (58.1)	74 (59.3)	70 (57.0)	62 (51.9)	78 (62.1)	76 (60.8)	72 (58.3)	50 (44.7)
Bikaneri Narma	12 (20.2)	38 (38.0)	21 (27.0)	24 (28.4)	34 (35.4)	39 (38.6)	35 (36.3)	36 (36.6)	61 (51.4)	67 (54.9)	75 (60.0)	68 (55.4)	75 (60.0)	88 (69.8)	83 (65.7)	82 (65.2)	52 (46.4)
AC 738	33 (34.9)	34 (35.6)	36 (36.9)	34 (35.8)	39 (38.6)	45 (42.1)	42 (40.4)	42 (40.4)	68 (55.6)	76 (61.0)	69 (56.2)	71 (57.6)	73 (58.7)	80 (63.5)	83 (65.9)	79 (62.7)	57 (49.1)
PIL 43	2 (8.1)	5 (12.9)	6 (14.0)	4 (11.7)	35 (36.2)	41 (39.8)	48 (43.9)	41 (39.9)	64 (53.1)	69 (56.2)	75 (60.0)	69 (56.4)	75 (60.0)	79 (63.2)	82 (64.9)	79 (62.7)	48 (42.7)
PIL 8	0 (0.0)	0 (0.0)	3 (9.8)	1 (3.2)	32 (34.2)	57 (49.1)	72 (58.2)	54 (47.2)	65 (53.7)	75 (60.0)	76 (60.8)	72 (58.2)	80 (63.7)	88 (70.0)	85 (67.3)	84 (67.0)	53 (43.9)
T7	0 (0.0)	9 (17.2)	28 (31.9)	12 (16.4)	19 (25.8)	21 (27.2)	24 (29.3)	21 (27.5)	62 (51.9)	72 (58.1)	66 (54.3)	67 (54.8)	73 (58.7)	83 (65.7)	83 (65.7)	80 (63.4)	45 (40.5)
M12	8 (16.4)	42 (40.3)	7 (15.0)	19 (23.9)	66 (54.3)	73 (58.7)	77 (61.4)	72 (58.2)	76 (60.7)	81 (64.2)	80 (63.5)	79 (62.8)	84 (66.6)	94 (76.0)	79 (62.9)	86 (68.5)	64 (53.3)
Mean	10 (14.3)	21 (24.4)	19 (24.0)	16 (20.9)	37 (36.9)	45 (41.9)	48 (43.9)	43 (40.9)	66 (54.3)	74 (58.9)	74 (59.2)	71 (57.5)	75 (59.9)	84 (67.2)	82 (64.7)	80 (64.0)	53 (45.8)
Grand mean		To	T1	T2													
		47 (41.4)	56 (48.1)	55 (48.0)													
		A	G	T	AxG	GxT	AxT										
SEd		1.17	1.54	1.01	3.08	2.67	2.02										
CD(P=0.05)		2.32	3.07	2.01	6.13	5.31	NS										

T0-Control, T1- Chlorine, T2-Iodine
G-Genotypes; A- Age of the seeds; T- Treatments

(Figures in parentheses indicate arc sine transformed values)

Table 2. Effect of halogen treatments on vigour index of cotton seedlings (seeds stored under ambient condition).

Genotypes/ Treatments	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	199	365	504	356	585	707	737	676	1129	1291	1710	1376	1168	1534	1527	1409	954
Bikaneri Narma	141	475	307	307	536	650	578	588	1332	1477	1622	1477	1871	1931	1878	1893	1066
AC 738	369	502	666	512	600	718	699	672	1460	1564	1729	1584	1648	1940	2026	1871	1160
PIL 43	19	58	72	49	461	808	998	755	1269	1412	1393	1358	1598	1953	1681	1744	977
PIL 8	0	0	42	14	575	1410	968	984	1426	1765	1627	1606	1620	1977	1871	1823	1107
T7	0	194	273	155	315	394	451	386	1423	1754	1662	1613	1683	2110	2233	2009	1041
M12	121	616	307	348	1608	1766	1582	1652	1349	1544	1635	1509	1931	2111	2062	2035	1386
Mean	121	315	309	249	668	922	859	816	1341	1544	1625	1503	1645	1937	1897	1826	1099
Grand Mean		To	T1	T2													
		944	1179	1173													
		A	G	T	AxG	GxT	AxT										
SEd		32.0	42.4	27.7	84.8	73.4	55.5										
CD(P=0.05)		**63.7**	**84.3**	**55.2**	**168.6**	**NS**	**NS**										

T0-Control, T1- Chlorine, T2-Iodine
G-Genotypes; A- Age of the seeds; T- Treatments

Table 3. Effect of halogen treatments on electrical conductivity of seed leachate (dSm^{-1}) (seeds stored under ambient condition).

Genotypes/ Treatments	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	0.474	0.448	0.401	0.441	0.439	0.438	0.352	0.410	0.408	0.314	0.295	0.339	0.294	0.283	0.276	0.284	0.368
Bikaneri Narma	0.453	0.408	0.348	0.400	0.459	0.443	0.320	0.407	0.362	0.407	0.358	0.375	0.376	0.344	0.327	0.349	0.383
AC 738	0.516	0.479	0.454	0.483	0.505	0.463	0.436	0.468	0.470	0.451	0.409	0.443	0.436	0.315	0.398	0.383	0.444
PIL 43	0.461	0.455	0.472	0.463	0.474	0.429	0.434	0.445	0.451	0.439	0.467	0.452	0.432	0.423	0.383	0.413	0.443
PIL 8	0.482	0.474	0.481	0.479	0.481	0.476	0.475	0.477	0.414	0.417	0.347	0.392	0.324	0.366	0.343	0.344	0.423
T7	0.759	0.709	0.686	0.718	0.861	0.765	0.781	0.802	0.605	0.734	0.624	0.654	0.621	0.591	0.543	0.585	0.690
M12	0.540	0.540	0.501	0.527	0.420	0.445	0.410	0.425	0.413	0.388	0.351	0.384	0.363	0.376	0.343	0.360	0.424
Mean	0.525	0.502	0.477	0.501	0.520	0.494	0.458	0.491	0.446	0.450	0.407	0.434	0.407	0.385	0.373	0.388	0.454
Grand Mean		**To**	**T1**	**T2**													
		0.475	0.458	0.429													
		A	G	T	AxG	GxT	AxT										
SEd		0.011	0.015	0.009	0.029	0.026	0.019										
CD(P=0.05)		0.022	0.02	0.019	0.059	NS	NS										

T0-Control, T1- Chlorine, T2-Iodine

G-Genotypes; A- Age of the seeds; T- Treatments

Table 4. Effect of halogen treatments on reducing sugar content of seed leachate (mg $seed^{-1}$) (cotton seeds stored under ambient condition).

Genotypes/ Treatments	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	0.112	0.009	0.010	0.010	0.006	0.004	0.004	0.004	0.003	0.002	0.002	0.002	0.004	0.001	0.002	0.002	0.005
Bikaneri Narma	0.008	0.004	0.004	0.005	0.009	0.004	0.005	0.006	0.011	0.005	0.004	0.006	0.003	0.002	0.003	0.002	0.005
AC 738	0.010	0.008	0.004	0.007	0.025	0.008	0.009	0.014	0.006	0.004	0.004	0.004	0.004	0.005	0.002	0.003	0.007
PIL 43	0.014	0.010	0.010	0.011	0.008	0.006	0.008	0.007	0.006	0.005	0.003	0.004	0.004	0.003	0.002	0.003	0.006
PIL 8	0.020	0.019	0.009	0.016	0.004	0.004	0.004	0.004	0.005	0.003	0.002	0.003	0.006	0.004	0.005	0.004	0.007
T7	0.008	0.006	0.004	0.006	0.017	0.004	0.004	0.008	0.009	0.007	0.004	0.006	0.007	0.005	0.003	0.005	0.006
M12	0.006	0.007	0.005	0.006	0.002	0.002	0.002	0.002	0.003	0.003	0.002	0.003	0.004	0.003	0.002	0.003	0.003
Mean	0.011	0.009	0.006	0.009	0.010	0.004	0.005	0.006	0.006	0.004	0.003	0.004	0.004	0.003	0.002	0.003	0.006
Grand Mean		To	T1	T2													
		0.008	0.005	0.004													
		A	G	T	AxG	GxT	AxT										
SEd		0.0002	0.0003	0.0002	0.0006	0.0005	0.0004										
CD (P=0.05)		0.0004	0.0006	0.0004	0.0013	0.0011	0.0008										

T0-Control, T1- Chlorine, T2-Iodine

G-Genotypes; A- Age of the seeds; T- Treatments

Table 5. Effect of halogen treatments on dehydrogenase activity in cotton seeds stored under ambient condition.

Genotypes/ Treatments	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	0.81	0.91	0.82	0.85	0.96	1.00	1.07	1.01	1.60	1.78	1.81	1.73	1.81	1.80	3.21	2.27	1.46
Bikaneri Narma	1.28	1.51	2.52	1.77	1.41	1.79	2.54	1.91	1.49	1.75	2.62	1.95	2.32	2.92	2.47	2.57	2.05
AC 738	1.53	1.90	1.91	1.78	1.86	1.84	2.23	1.97	1.57	1.65	1.64	1.62	1.62	1.85	1.88	1.78	1.79
PIL 43	0.85	1.59	1.48	1.30	1.56	2.59	2.55	2.23	2.16	2.68	2.72	2.49	3.06	3.27	3.76	3.36	2.35
PIL 8	1.15	1.22	1.45	1.27	2.15	2.33	1.99	2.16	1.91	2.32	2.15	2.13	2.35	2.26	2.68	2.43	2.00
T7	1.22	1.50	1.48	1.40	1.56	1.58	2.32	1.81	1.69	1.92	2.23	1.95	2.40	2.48	2.69	2.51	1.92
M12	1.68	1.65	2.39	1.90	1.76	1.75	2.32	1.94	1.71	1.77	2.45	1.98	2.22	2.69	2.18	2.36	2.05
Mean	1.22	1.47	1.72	1.47	1.61	1.84	2.15	1.86	1.73	1.97	2.23	1.98	2.25	2.47	2.69	2.47	1.94
Grand Mean		**To**	**T1**	**T2**													
		1.70	1.94	2.20													
		A	G	T	AxG	GxT	AxT										
SEd		0.09	0.11	0.07	0.23	0.20	0.15										
CD(P=0.05)	0.17	0.23	0.15	0.45	NS	NS											

T0-Control, T1- Chlorine, T2-Iodine

G-Genotypes; A- Age of the seeds; T- Treatments

Table 6. Effect of halogen treatments on pathogen infection (%) of cotton seeds stored under ambient condition.

Genotypes/ Treatments	Four year aged				Three year aged				Two year aged				One year aged				Grand Mean
	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	To	T1	T2	Mean	
70 E	52.5	42.5	40.0	45.0	32.5	25.0	27.5	28.3	25.0	22.5	20.0	22.5	15.0	12.5	15.0	14.2	27.5
Bikaneri Narma	40.0	17.5	25.0	27.5	30.0	22.5	30.0	27.5	32.5	22.0	20.0	24.2	20.0	17.5	5.0	14.2	23.3
AC 738	27.5	20.0	26.0	24.5	22.5	15.0	17.5	18.3	25.0	15.0	17.5	19.2	15.0	5.0	7.5	9.2	17.8
PIL 43	50.0	32.5	30.0	37.5	27.5	25.0	17.5	23.3	27.5	10.0	17.5	18.3	22.5	10.0	2.5	11.7	22.7
PIL 8	92.5	52.5	62.5	69.2	32.5	15.0	20.0	22.5	20.0	2.5	10.0	10.8	12.5	2.5	5.0	6.7	27.3
T7	55.0	52.5	52.5	53.3	20.0	17.5	22.5	20.0	17.5	7.5	2.5	9.2	7.5	2.5	2.5	4.2	21.7
M12	40.0	40.0	20.0	33.3	37.5	35.0	20.0	30.8	25.0	20.0	17.5	20.8	7.5	5.0	5.0	5.8	22.7
Mean	51.1	36.8	36.6	41.5	28.9	22.1	22.1	24.4	24.6	13.9	15.0	17.9	14.3	7.9	6.1	9.4	23.9
Grand Mean		**To**	**T1**	**T2**													
		29.7	20.2	20.0													
		A	G	T	AxG	GxT	AxT										
SEd		1.41	1.87	1.22	3.74	3.24	2.45										
CD (P=0.05)		2.81	3.72	2.44	7.44	6.44	NS										

T0-Control, T1- Chlorine, T2-Iodine

G-Genotypes; A- Age of the seeds; T- Treatments

(Table 1). The results are in conformity with the findings of Zhang *et al.*[8] in soybean. Similar observations were reported by Chandramohan[9] and EL-Zayat *et al.*[10] in cotton seeds. In two year old seed lot, the overall germination increased due to chlorine and iodine by 8%. Similarly in one year old seed lot, a significant increase of 9% and 7% germination due to chlorine and iodine treatments, respectively than control was recorded. It is interesting to note that the halogenation treatment controlled the deterioration very significantly, irrespective of the genotypes. The rate of deterioration is maximum in untreated seeds especially with genotypes having poor storage potential.

In line with germination, the maximum vigour index value was registered in one year aged seeds (1826), which is significantly superior to the values of rest of the age groups. As the age of seed lot increases, the values of vigour index decreased and it was significantly lowest in four year aged seed lot. Among the seed treatments, chlorine and iodine registered the vigour index at par with each other, but significantly higher than the control (Table 2). It is interesting to note that within a short period of seven days the vapour form of halogens improved the germination and vigour of seed lots. This might be due to counter action of free radical formation and lipid peroxidation reaction along with increased membrane stability. On the other hand, the halogen vapour (both chlorine and iodine) reduced the physiological deterioration by stabilizing the unsaturated fatty acid components of lipoprotein moiety of cellular membranes and possibly reduced lipid per oxidation and free radical reactions. Basu and Rudrapal[11] have suggested that halogen might react with carbon – carbon double bonds of unsaturated fatty acids, making them less susceptible to further oxidation. These findings are in agreement with the earlier study in cotton[12].

The electrical conductivity, reducing sugars and seed health test on pathogen infection have negative association with seed quality. Among the age group of seeds, four year old seeds registered the highest value of electrical conductivity (0.501dSm^{-1}) and reducing sugars (0.009) and lowest value by one year old seeds (0.388dSm^{-1} and 0.003dSm^{-1}, respectively). The increased electrical conductivity of seed leachates of aged seeds may be due to degradation and weakening of cell membrane, which might the cause for leaching of metabolites and electrolytes through the semi-permeable membranes into the imbibing medium during the storage period. A progressive increase in the leaching of electrolytes was observed with increase of age lot. Weakened cell membrane allows the electrolytes to leach at a rapid rate as witnessed in case of four year aged seed lots. This is in consonance with the study of Jayashree[13] in cotton. Among the treatments, significantly less electrical conductivity was recorded in iodinated seeds (0.429dSm^{-1}) compared to chlorinated seeds (0.458dSm^{-1}) (Table 3). The low electrical conductivity values registered for halogenated seeds reflect upon its action at the molecular level to preserve the integrity of the cellular components and cell membrane.

Estimation of sugar content from seed leachate has also showed the similar result as that of electrical conductivity. The sugar content of seed leachate is reduced to 0.004 mg seed^{-1} and 0.005 mg seed^{-1} due to iodine and chlorine treatments, respectively than the control (0.008 mg seed^{-1}) (Table 4). Similar result was reported crop seeds and indicated that high soluble sugar in leachates is associated with low germination and vigour.

The dehydrogenase enzyme activity is a good and stable metabolic marker to understand the degree of vigour *per se* in seeds and has positive correlation with seed quality, which differs significantly among the genotypes, and it is the highest in PIL.43 (2.35 OD) and one year old seeds (2.47 OD). Among the treatments iodinated seeds recorded higher value (2.20 OD) over chlorinated and untreated seeds (Table 5). In aged seeds the loss of energy production during germination might be the reason for reduced dehydrogenase activity as reported by Abdul-Baki and Anderson[3]. This biochemical result corroborated very well with the physiological manifestations of the seed.

The result of the seed infection revealed that wider variations is noticed among the genotypes and it ranges from 17.8% (AC.738) to 27.5% (70E) and also expressed the linear increase in seed infection with increase in age of seeds. The percentage infection was reduced to 20 % and 20.2 % due to iodine and chlorine treatments from 29.7% (control) (Table 6). Similar effect was observed by Christensen[14], which was due to low microbial activity and iodinated seeds under low humidity (30% RH and 45°C). Since the halogen formulation has multibenifits it would be a boon to seed producers as well as farmers to store their valuable seeds. In conclusion it may be recommended that halogenation of cotton seeds using the vapour form of chlorine and iodine followed by packing in moisture vapour proof containers would retain the viability and vigour for several months especially seeds that are indented for long term storage with reasonable protection against storage pests.

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