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Effect of different priming treatments on seed quality of delinted desi cotton (*Gossypium arboreum* L.) varieties picked at different intervals after fifteen months of controlled storage

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Abstract
The present study was carried out in the Department of Seed Science and Technology Section, CCS Haryana Agricultural University, Hisar, India. The study aimed to evaluate the effect of seed invigoration treatments on seed quality of desi cotton varieties (HD-123, HD-324 and HD-432) picked at different intervals and stored at 20º C with six per cent moisture content in sealed plastic containers. Study evaluated the effect of different seed priming treatments on germination, seedling length, seedling dry weight, vigor indices desi cotton varieties (HD-123, HD-324 and HD-432) to determine and exploit their usefulness in improving cotton seed quality for better seedling establishment. Seed ageing or progressin storage period led to reduction in seed quality, during storage as there is reduction in seed vigor potential and performance, stand establishment, poor emergence and high seedling mortality, thus leading to poor crop stand. Improvement in germination by seed priming may combat this problem as this physiological technique results in faster and synchronous seed germination as found in the study that when cotton seeds were primed for two hr. at 25º C with different chemicals (Control, KH_2PO_4, KNO_3, PEG, GA_3, Hydration- Dehydration) showed increase in seed germination per cent. It was found that seeds primed with GA_3 significantly enhances the seed germination per cent, seedling length, seedling dry weight, vigor indices than other treatments (KNO3, KH2PO4, PEG, Hydration). Maximum germination, seedling length, dry weight, vigor indices, seedling establishment, field emergence index was observed in seeds of second pick treated seeds whereas minimum was observed in third pick seeds.

Keywords: desi cotton, picking stage, seed quality, seed priming, seed germination, seedling dry weight

Introduction
Cotton is the major fibre and industrial crop of the world which is known as “white gold” and it is a member of the *malvaceae* family of flowering plants. It is classified with a genus of tropical and subtropical shrubs known as *Gossypium.* India accounts for 22 percent of total cotton production and it is the largest cotton growing country of the world. India is the second largest producer of cotton after China

Deterioration of stored seed is a serious problem in tropical and sub tropical countries like India where high temperature and humidity accelerate the seed ageing phenomenon. The process of deterioration in seeds comprises a sequence of biochemical and physiological changes initiated immediately after physiological maturity, which lead to reduced vigor, culminating in the loss of germination capacity. Changes in physiology of the seeds are indirectly related to the integrity of their cell membranes (Carvalho *et al.,* 2009) [5], which, in turn depend on the nature of the enzymes and structural proteins of each species. The enzymes have been used in the assessment of physiological and biochemical changes in stored seeds (Santos *et al.,* 2004) [25].

Seed ageing leads to reduction in seed quality, performance and stand establishment. During the process of seed deterioration, there are biochemical changes takes placewhich ultimately alters the structure of the seed. Once seed deterioration has happened, this catabolic process cannot be reversed. It is a sequence of events beginning with a chain of biochemical events, predominantly membrane damage and impairment of biosynthetic reactions, and then the resulting losses of various seed performance attributes, starting with reduced germination rate, reduced field emergence, increased numbers of abnormal seedlings and finally seed death.

Improved seed invigoration techniques are being used in many parts of the world to reduce the germination time, synchronize germination improve germination rate and increase plant stand (Khan, 1992, Lee and kim, 2000) [16, 17] Various seed priming techniques have been developed including hydropriming (soaking in water), halopriming (soaking in inorganic salt solution of different organic osmotica), thermopriming (treating seeds with low or high temperature), solid matrix priming (treating seeds with solid matrices) and bio priming (hydration using biological compounds). Priming in its traditional sense is soaking of seeds in water before sowing and it has been practiced by farmers in India to improve crop stand establishment but the practice was without the knowledge of the safe limit of soaking duration (Harris, 1996) [9]. It is reported that seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Harris *et al.*, 1999) [10]. Seed priming has presented promising, and even surprising results, for many crops including the cotton seeds.

Keeping in view the importance of crop and effect of seed invigoration treatment on stored cotton seeds the present study was planned.

Material and Methods

The present investigation was carried out in Department of Seed Science and Technology, CCS HAU. Desi cotton were picked at different intervals, starting with fifty per cent boll opening and total three pickings were done. After delinting, seeds of all three picking were stored at 20 ± 1^{0}C with 6 % moisture content up to 15 months in a sealed plastic container. After fifteen months of storage initial quality of seeds were analyzed and seeds were treated with different chemicals (Control, KH_2PO_4, KNO_3, PEG, GA_3, Hydration- Dehydration) to enhance its quality. KH_2PO_4 (10 gm/l) 10 gm of KH_2PO_4 was dissolved in one litre of distilled water, GA_3 (0.1 gm/l) 50 miligram of gibberic acid was dissolved in one litre of water to make one litre solution of gibberlic acid solution. One to four drops of acetone were also added to mix GA_3 as it is not dissolved in water. KNO_3 (30 gm/l) 30 gram of KNO3 was added in one litre of water to make one litre solution, PEG (100 gm/ lit) 100 gm PEG was dissolved in one litre of water to make solution of one litre. Priming treatment were given to cotton seeds after 15 months of storage for enhancement of quality. Seeds were primed at 25± 1^{0}C for 2 hours. After priming cotton seeds were dried to original moisture content and seed quality was evaluated.

Standard germination per cent as per ISTA, 2011

Final count was recorded on 12 th day (ISTA, 2011) [13]. Normal seedlings were expressed as percent germination.

Seedling Length (cm)

Seedling length (cm) of ten randomly selected normal seedlings was recorded and average seedling length was expressed in centimeters (cm).

Dry Weight (mg) For dry weight ten randomly taken normal seedlings whose length was measured were dried in a hot air oven for 24 h at 103 ±1° C.

Vigour Indices (Abdul-Baki and Anderson, 1973)

(a) Vigour Index-I [Germination (%) ×Seedling length (cm)]

(b) Vigour index-II [Germination (%) ×Seedling weight (g)]

Electrical conductivity test (µS cm^{-1}g^{-1}) as per ISTA, 1999.

Three replicates of 50 normal seeds were soaked in a 100 ml beaker containing 75 ml of distilled water and kept at 25^{0}C. The leachetes were measured after 24 h with systronic conductivity meter 306 and it was expressed as µS cm^{-1}g^{-1}.

Mean Emergence Time (days)

The mean emergence time (MET) was calculated for each treatment combination using the formula cited by Ellis and Roberts (1980) [7].

$MET = \sum nt / \sum n$ Where,

n- number of seeds newly germinated at time
't' t - Days from sowing
$\sum n$ - Final emergence of seedlings

Field Emergence Index

The number of seedlings emerged were counted on each day up to seedling establishment. The field emergence index (speed of emergence) was calculated as described by Maguire (1962) [18].

$$\frac{\text{No. of seedlings emerged}}{\text{Day of first count}} + \text{------} + \frac{\text{No. of seedlings emerged}}{\text{Day of final count}}$$

Statistical Analysis

The data presented in this thesis are the mean value of different parameters. The statistical method described by Panse and Sukatme (1967) was followed for analysis and interpretation of the experimental results.

Result and Discussion

According to Table 4.3.1d when percent increase in germination was worked out in primed seeds of all desi varieties, maximum enhancement was observed in third picking seeds where maximum fall in germination was found after fifteen months of storage in all desi varieties. Among desi varieties, maximum increase (18.52%) in germination was observed in HD-324 followed by (9.52%) in HD-432and minimum (3.54%) increase was observed in HD-123. Maximum percent increase in germination (15.32%) was observed in GA3 treatment and minimum (5.64%) noticed in Hydration treatment. Among pickings, maximum percent increase was found in third picking (14.52%) and minimum noticed in first picking (5.89%).

The relatively higher seed quality parameters in seeds treated with GA3 was attributed to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growing points and higher activity of enzymes as reported by Earlpuls and Lambeth, (1974Maximum enhancement was observed in third picking seeds where maximum fall in germination was found after fifteen months of storage in all American and desi varieties. It confirms previous studies that maximum increase in germination found in low quality seeds.). Results are in conformity with the findings of Tiwari *et al.*, (2001) [31] who reported that GA3 was able to increase the germination rate and seedling length of onion. Similar results were reported by Warren and Bannet (1997) [33] in tomato, Jyotsana and Srivastava (1998) in pigeonpea, Ashraf and Rauf (2001) [4] in maize.

Table 1: Effect of priming on germination per cent and seedling length (cm) of cotton varieties

Germination per cent									Seedling length						
Variety		T_O	T_1	T_2	T_3	T_4	T_5	mean	T_O	T_1	T_2	T_3	T_4	T_5	mean
H-1098(I)	P1	66.67	70.33	74.33	70	73.33	67.67	70.39	20.09	23.57	28.32	24.9	26.07	24.86	24.63
	P2	69.67	75.33	79.33	73.33	75.67	71.33	74.11	22.04	23.87	28.59	26.44	26.92	28.89	26.12
	P3	56.67	66	68.33	64	66.73	63	64.12	16.61	21.62	24.69	21.54	23.42	20.16	21.34
	Mean	64.33	70.56	74	69.11	71.91	67.33	69.54	19.58	23.02	27.2	24.3	25.47	24.64	24.03
H-1117	P1	64.33	67.33	69	65.67	67.67	65.67	66.61	17.69	21.19	22.95	20.97	22.56	20.77	21.02
	P2	67.67	71.33	75.33	70	74.33	69.33	71.33	18.93	21.84	24.06	21.68	22.27	21.35	21.69
	P3	48	58.33	59.33	59	59	57.67	56.89	14.7	16.89	19.91	16.21	17.68	15.74	16.85
	Mean	60	65.67	67.89	64.89	67	64.22	64.94	17.11	19.97	22.31	19.62	20.84	19.29	19.85
H-1236	P1	67	74.67	76	73	75.7	69.67	72.67	21.05	25.85	27.73	24.07	26.23	23.49	24.74
	P2	70.67	77	83.67	75.33	79.1	72.67	76.41	25	28.16	29.81	26.26	28.22	25.65	27.18
	P3	57.33	65.33	69.66	64.33	67.33	63	64.5	17.17	21.52	25.79	20.69	23.55	19.76	21.41
	Mean	65	72.33	76.44	70.89	74.04	68.44	71.19	21.07	25.17	27.78	23.67	26	22.97	24.44
Grand Mean		63.11	69.52	72.78	68.3	70.99	66.67	68.56	19.25	22.72	25.76	22.53	24.1	22.3	22.78
CD at 5 %		Variety = 0.379,Treatment = 0.536,Variety × Treatment = 0.928, Variety ×Picking ×Treatment = 1.607							Variety = 0.175,Treatment = 0.247, Variety × Treatment = 0.428, Variety × Picking ×Treatment= 0.741						
Picking and treatment interaction															
PICKING															
P1		66	70.78	73.11	69.56	72.23	67.67	69.89	19.61	23.53	26.33	23.31	24.95	23.04	23.46
P2		69.33	74.56	79.44	72.89	76.37	71.11	73.95	21.99	24.62	27.49	24.79	25.8	25.3	25
P3		54	63.22	65.78	62.44	64.36	61.22	61.84	16.16	20.01	23.46	19.48	21.55	18.55	19.87
Mean C		63.11	69.52	72.78	68.3	70.99	66.67	68.56	19.25	22.72	25.76	22.53	24.1	22.3	22.78
CD at 5 %		Picking = 0.379, Treatment = 0.536, Picking × Treatment = 0.928							Picking = 0.175, Treatment =0.247, Picking ×Treatment = 0.428						

Seedling length of desi cotton varieties was significantly influenced by different treatments and different priming treatments significantly enhanced seedling length of cotton varieties. Among different treatments studied, GA_3 gave maximum seedling length (25.76 cm) followed by PEG (24.10 cm) and lowest seedling length (22.30 cm) observed in Hydration. Among varieties maximum seedling length (24.44 cm) observed in HD – 432 whereas lowest (19.85 cm) noticed in HD – 324.

Maximum seedling dry weight was observed in GA3 (0.252 mg followed by PEG (0.239 mg) and lowest seedling dry weight (0.214 mg) observed in control. Among varieties maximum seedling dry weight (0.253mg) in HD – 432 whereas lowest (0.211 mg) noticed in HD – 324. The interaction result showed, maximum seedling dry weight (0.294 mg) with GA3 treatment in second picking whereas lowest (0.182mg) observed in Hydration under third picking. The maximum seedling dry weight (0.253 mg) observed in second picking seeds whereas lowest seedling dry weight (0.211 mg) observed in third picking. Increase in seedling length in in all varieties after priming, because there is activation of a amylase and antioxidant enzyme during priming treatment. The a amylase is a key enzyme for the germination and subsequent seedling growth of seeds (Mitsui, 1987; Mitsunga *et al.*, 2007) [19]. Priming increases seedling length and seedling dry weight as plant hormones increase the rate of absorption of water and available nutrients thereby resulting in better growth. The hormones might also have substantially enhanced cell enlargement and rapid increase in cell division. Results are in conformity with the earlier findings of Sedghi *et al*., (2010) [26] Ghodrat and Rousta (2012**)** in onion, Toklu, F. (2015) in lentil.

Data indicated that different priming treatments significantly enhanced vigour index I of desi cotton varieties. Among different treatments studied, GA3 gave highest vigour index I (1893) followed by PEG (1727) and lowest vigour index I (1501) observed in Hydration. Among varieties, maximum vigour index I (1760) found in HD – 432 whereas, lowest (1306) noticed in HD – 324. The interaction table showed maximum vigour index I (2192) with GA3 treatment under second picking followed by PEG (1975) whereas lowest vigour index I (1141) observed under Hydration in third picking. The maximum vigour index I (1858) observed in second picking whereas, lowest vigour index I (1244) observed in third picking. The three way interaction between picking, treatment and variety, maximum vigour index I (2494) was observed in HD – 432 under second picking in GA_3 treatment whereas lowest vigour index I (908) observed in HD – 324 under third picking in Hydration treatment.

Table 2: Effect of priming on seedling dry weight and vigor index I of cotton varieties

Seedling dry weight (mg)									Vigor index -I						
Variety		**T_O**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**Mean**	**T_O**	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**Mean**
H-1098(I)	P1	0.221	0.242	0.265	0.238	0.248	0.227	0.24	1,338	1,657	2,105	1,743	1,912	1,682	1,740
	P2	0.244	0.258	0.279	0.255	0.262	0.248	0.258	1,535	1,798	2,268	1,939	2,037	2,061	1,940
	P3	0.198	0.169	0.218	0.14	0.175	0.142	0.174	942	1,427	1,687	1,379	1,562	1,270	1,378
	Mean	0.221	0.223	0.254	0.211	0.228	0.206	0.224	1,272	1,627	2,020	1,687	1,837	1,671	1,686
H-1117	P1	0.176	0.215	0.232	0.208	0.22	0.198	0.208	1,138	1,427	1,584	1,377	1,527	1,364	1,403
	P2	0.198	0.251	0.261	0.218	0.255	0.204	0.231	1,281	1,558	1,812	1,517	1,655	1,480	1,551
	P3	0.181	0.199	0.204	0.191	0.201	0.182	0.193	705	985	1,181	956	1,043	908	963
	Mean	0.185	0.222	0.232	0.206	0.225	0.195	0.211	1,042	1,323	1,526	1,283	1,409	1,251	1,306
H-1236	P1	0.243	0.269	0.272	0.262	0.269	0.261	0.263	1,410	1,930	2,107	1,757	1,985	1,637	1,804
	P2	0.255	0.271	0.294	0.271	0.285	0.258	0.272	1,766	2,168	2,494	1,978	2,232	1,864	2,084

	P3	0.203	0.232	0.246	0.213	0.239	0.205	0.223	984	1,406	1,797	1,331	1,586	1,245	1,392
	Mean	0.234	0.257	0.271	0.249	0.264	0.241	0.253	1,387	1,835	2,133	1,689	1,935	1,582	1,760
Grand Mean		0.213	0.234	0.252	0.222	0.239	0.214	0.229	1,233	1,595	1,893	1,553	1,727	1,501	1,584
CD at 5 %		Variety = 0.003,Treatment = 0.004,Variety ×Treatment= 0.006, Variety ×Picking × Treatment = 0.0011							Variety = 13.42,Treatment =18.98, Variety × Treatment =32.88, Variety × Picking ×Treatment= 56.95						
Picking and Treatment Interaction															
Picking															
P1		0.221	0.223	0.254	0.211	0.228	0.206	0.224	1,295	1,671	1,932	1,625	1,808	1,561	1,649
P2		0.234	0.257	0.271	0.249	0.264	0.241	0.253	1,528	1,841	2,192	1,812	1,975	1,802	1,858
P3		0.185	0.222	0.232	0.206	0.225	0.195	0.211	877	1,273	1,555	1,222	1,397	1,141	1,244
Mean C		0.213	0.234	0.252	0.222	0.239	0.214	0.229	1,233	1,595	1,893	1,553	1,727	1,501	1,584
CD at 5 %		Picking= 0.003, Treatment=0.006, Picking ×Treatment = 0.004							Picking =13.42, Treatment =18.98, Picking ×Treatment = 32.88						

The two and three factor interactions between treatments, pickings and variety were found significant for vigour index II. A perusal of data indicated that different priming treatments significantly enhanced vigour index II of desi cotton varieties. Among treatments, GA3 gave highest vigour index II (18.55) followed by PEG (17.14) and lowest vigour index II (14.39) observed in control. Among varieties maximum vigour index II (18.14) observed in HD – 432 whereas lowest (13.82) noticed in HD – 324. The picking and treatment interaction showed maximum (22.14) vigour index II with GA3 treatment in second picking whereas lowest vigour index II (10.70) found in Hydration treatment under third picking. Increase in seedling dry weight may be due to to acceleration some metabolic processes even at low water potential (Sedghi *et al*., 2010) [26]. The increase in seedling vigour index and seedling dry weight was due to increased germination percentage, root length and shoot length of seedlings. Similar results were found by Sedghi *et al.*, (2010) [26] in milk thistle, Narayanareddy and Biradarpatil, (2012) [21] in sunflower and Abraha and Yohannes (2013) [2] in maize.

Table 1: Effect of priming on vigor index II and Electrical conductivity of cotton varieties

		Vigor index -II							Electrical conductivity						
Variety		**To**	**T1**	**T2**	**T3**	**T4**	**T5**	**mean**	**To**	**T1**	**T2**	**T3**	**T4**	**T5**	**mean**
H-1098(I)	P1	14.76	17.05	19.73	16.68	18.16	15.33	16.95	0.549	0.451	0.491	0.524	0.491	0.532	0.506
	P2	16.98	19.43	22.13	18.7	19.85	17.69	19.13	0.537	0.509	0.449	0.486	0.401	0.529	0.485
	P3	11.2	11.16	14.92	8.98	11.68	8.97	11.15	0.552	0.509	0.515	0.525	0.501	0.541	0.524
	Mean	14.31	15.88	18.92	14.79	16.57	14	15.74	0.546	0.49	0.485	0.512	0.464	0.534	0.505
H-1117	P1	11.35	14.44	16	13.66	14.86	12.98	13.88	0.595	0.558	0.432	0.561	0.541	0.573	0.543
	P2	13.38	17.93	19.69	15.26	18.98	14.17	16.57	0.567	0.524	0.459	0.535	0.482	0.558	0.521
	P3	8.67	11.59	12.1	11.29	11.84	10.51	11	0.605	0.561	0.508	0.567	0.548	0.585	0.562
	Mean	11.13	14.65	15.93	13.4	15.23	12.55	13.82	0.589	0.548	0.466	0.554	0.524	0.572	0.542
H-1236	P1	16.31	20.06	20.69	19.11	20.33	18.19	19.11	0.527	0.492	0.435	0.506	0.484	0.527	0.495
	P2	18.02	20.89	24.6	20.39	22.52	18.75	20.86	0.487	0.412	0.388	0.427	0.399	0.442	0.426
	P3	11.64	15.17	17.12	13.73	16.07	12.9	14.44	0.541	0.562	0.51	0.565	0.551	0.572	0.55
	Mean	15.32	18.71	20.8	17.74	19.64	16.61	18.14	0.518	0.489	0.444	0.499	0.478	0.514	0.49
Grand Mean		13.59	16.41	18.55	15.31	17.14	14.39	15.9		0.551	0.509	0.465	0.522	0.489	0.54
CD at 5 %		Variety = 0.197,Treatment = 0.278, Variety × Treatment = 0.481, Variety × Picking ×Treatment= 0.834							Variety = 0.004,Treatment = 0.005, Variety × Treatment = 0.009, Variety × Picking ×Treatment= 0.015						
Picking and Treatment Interaction															
Picking															
P1		14.14	17.18	18.81	16.48	17.79	15.5	16.65	0.557	0.5	0.453	0.53	0.506	0.544	0.515
P2		16.12	19.42	22.14	18.12	20.45	16.87	18.85	0.531	0.482	0.432	0.483	0.428	0.51	0.477
P3		10.5	12.64	14.71	11.33	13.2	10.79	12.2	0.566	0.544	0.513	0.553	0.533	0.566	0.546
Mean C		13.59	16.41	18.55	15.31	17.14	14.39	15.90	0.551	0.509	0.466	0.522	0.489	0.54	0.513
CD at 5 %		Picking = 0.197, Treatment =0.278, Picking ×Treatment = 0.481							Picking = 0.003, Treatment =0.005, Picking ×Treatment = 0.007						

Data indicated that different priming treatments significantly lowered electrical conductivity of cotton varieties. Among various treatments, GA3 showed minimum electrical conductivity (0.465) followed by PEG (0.489) and highest (0.540) electrical conductivity in Hydration treatment. Among varieties minimum electrical conductivity (0.490) reported in HD – 432 whereas, maximum (0.542) in HD – 324. The interaction table showed minimum electrical conductivity (0.428) in PEG treatment under second picking whereas highest (0.566) electrical conductivity observed in Hydration treatment under third picking. The lower electrical conductivity of seed leachate for GA3 treated seeds may be due to beneficial effect of strengthening the cell membrane integrity and permeability and it play an important role in mobilization of endosperm reserves during germination of seeds (Weiss and Ori, 2007) and this may be due to better plasma membrane structure by slow hydration while increased seed leachates was probably due to the loss of ability to reorganize cellular membranes rapidly and completely. The results clearly indicates that damage to membrane systems seems to be a major cause of seed viability and germination loss during storage which can be overcome upto a certain extent by priming treatment. The pre-soaking of seeds allows the hydration of membranes and proteins, and the initiation of various metabolic systems as reported by Okcu *et al.*, (2005). Similar results are reported in soybean by Sung and Jeng (1994) [29], Sung and Chu, (1995) [30] in soybean.

Table 4: Effect of priming on Mean germination time and Field emergence index of cotton varieties

Variety		Mean germination time							Field emergence index						
		T_O	T_1	T_2	T_3	T_4	T_5	Mean	T_O	T_1	T_2	T_3	T_4	T_5	Mean
H-1098(I)	P1	4.12	3.55	3.16	3.61	3.21	3.94	3.6	12.9	12.23	12.77	14.83	12.4	14.17	12.88
	P2	3.8	3.63	2.89	3.77	3.54	3.78	3.57	14.1	12	12.1	14	13.67	14.17	12.92
	P3	4.55	4.17	3.15	4.07	3.23	4.22	3.9	12.07	12.9	14.07	13.03	13.2	12.07	13.12
	Mean	4.16	3.78	3.06	3.82	3.33	3.98	3.69	13.02	12.71	13.31	14.22	14.26	13.13	12
H-1117	P1	4.51	3.8	3.52	3.83	3.61	4.11	3.9	13.33	15.93	12.9	15.23	13.2	14.3	13.48
	P2	3.92	3.57	3.3	3.78	3.35	3.83	3.62	13.57	12.4	16.53	12.17	13.7	14.77	13.19
	P3	4.6	4.31	4.12	4.35	4.21	4.45	4.34	14.1	13	16.1	12	15.67	14.67	14.92
	Mean	4.34	3.89	3.65	3.99	3.72	4.13	3.95	13.86	13.24	16.03	14.91	15.14	14.42	14.31
H-1236	P1	4.32	3.59	3.24	3.74	3.27	3.76	3.65	13.53	14.47	11.47	14.2	11.2	11.13	12.3
	P2	3.79	3.46	3.03	3.53	3.23	3.72	3.46	13.97	12.67	11.57	14.13	13.1	12	14.57
	P3	4.96	3.77	3.38	3.58	3.46	3.85	3.83	13.33	13.23	12.1	12.67	14.33	14	14.11
	Mean	4.36	3.61	3.21	3.62	3.32	3.78	3.65	13.61	14.12	15.38	14.33	14.88	14.04	14.39
Grand Mean		4.28	3.76	3.31	3.81	3.46	3.96	3.76	13.5	12.69	12.57	12.49	12.13	14.03	14.57
CD at 5 %		Variety = 0.059,Treatment = 0.083, Variety × Treatment = 0.144, Variety × Picking ×Treatment= 0.25							Variety = 0.004,Treatment = 0.108, Variety × Treatment = NA, Variety × Picking ×Treatment= N/A						
Picking and Treatment Interaction															
PICKING															
P1		4.31	3.64	3.31	3.73	3.36	3.94	3.72	12.92	14.2	12.76	12.21	11.6	12.04	12.29
P2		3.84	3.55	3.07	3.69	3.37	3.78	3.55	11.88	11.48	12.43	11.02	12.49	12.07	12.26
P3		4.7	4.08	3.55	4	3.63	4.17	4.02	11.69	13.42	12.28	10.84	12.29	12.61	12.86
Mean C		4.29	3.76	3.31	3.81	3.46	3.96	3.76	11.5	12.03	12.49	11.69	15.13	12.27	12.37
CD at 5 %		Picking = 0.083, Treatment =0.083, Picking ×Treatment = 0.144							Picking = 0.108, Treatment =128, Picking ×Treatment = N/A						

Data indicated that different priming treatments significantly lowered mean germination time of desi varieties. Among the different treatments studied, GA3 showed lowest mean germination time (3.31) followed by PEG (3.46) and highest mean germination time (3.96) observed in hydration treatment. Among varieties minimum mean germination time (3.65) reported in HD – 432 whereas maximum (3.95) studied in HD – 324. The interaction between picking and treatments showed minimum mean germination time (3.07) in GA3 treatment under second picking followed by (3.31) in first picking with PEG whereas highest mean germination time (4.17) observed in Hydration treatment under third picking.

It is evident from the given table 4.3.7b that field emergence index of cotton varieties was non significantly influenced by different treatments. The two and three factor interactions between treatments, pickings and variety differed non significantly.

Table 5: Effect of priming on seedling establishment of cotton varieties

Seedling Establishment								
Variety		T_O	T_1	T_2	T_3	T_4	T_5	Mean
H-1098(I)	P1	60.2	61.7	64.55	63	61.15	62.22	62.34
	P2	63.23	63.45	64.69	64.04	63.37	63.88	63.86
	P3	57.17	57.81	58.47	58.02	57.4	57.92	57.88
	Mean	60.2	60.99	62.57	61.69	60.64	61.34	61.36
H-1117	P1	58.22	58.88	60.91	59.12	58.51	59.04	59.23
	P2	58.19	58.99	61.97	60	58.63	59.44	59.72
	P3	42.19	57.14	58.17	58.05	56.07	57.32	54.57
	Mean	52.87	58.34	60.35	59.06	57.74	58.6	57.84
H-1236	P1	60.84	61.8	64.79	63.23	61.6	62.82	62.7
	P2	63.43	63.48	65.02	64.24	63.54	63.88	64.01
	P3	57.44	57.87	58.74	58.09	57.57	57.99	58.03
	Mean	60.57	61.05	62.85	61.85	60.9	61.56	61.58
Grand Mean		57.88	60.12	61.92	60.87	59.76	60.5	60.26
CD at 5 %		Variety = 0.059,Treatment = 0.083, Variety × Treatment = 0.144, Variety × Picking ×Treatment= 0.25						
Picking and Treatment Interaction								
PICKING								
P1		59.75	61.36	63.42	60.8	61.78	60.42	61.26
P2		61.62	62.4	63.9	61.97	62.76	61.85	62.42
P3		52.27	57.74	58.46	57.61	58.05	57.01	56.86
Mean C		57.88	60.5	61.92	60.13	60.87	59.76	60.18
CD at 5 %		Picking = 0.083, Treatment =0.083, Picking ×Treatment = 0.144						

Maximum seedling establishment (61.92) found in GA3 followed by KNO_3 (60.87) and lowest (59.76) observed in PEG. Among varieties, HD – 432 had highest (61.58) followed by (57.88) noticed in HD – 123 which is statitically at par with HD – 324 (57.84). When seeds were treated with different treatments, second picking showed highest seedling establishment (62.42) whereas, lowest seedling establishment (56.86) noticed in third picking. The interaction effect of different picking and treatments clearly stated that maximum seedling establishment (63.90) observed in GA3 under second

picking whereas lowest noticed in Hydration treatment (57.01) under third picking. The three way interaction showed maximum (65.02) seedling establishment was observed in GA3 in HD -432 under second picking whereas lowest noticed in PEG (56.07) under third picking in HD -324. The probable reason for early emergence of the primed seed may be due to the completion of pre germination metabolic activities making seed ready for radicle protrusion and the primed seed germinated soon after planting compared with untreated dry seed (Arif, 2005) [3]. Like germination percentage, primed seeds had lower Mean Emergence Time (MET) compared with unprimed seeds. These positive effects are probably due to the stimulatory effects of priming on the early stages of germination process by mediation of cell division in germinating seeds (Hassanpouraghdam *et al*., 2009; Sivritepe et al., 2003) [11, 28]. Similar results were reported by Ruan *et al*., (2002) [24] in rice, Dhedhi *et al*., (2006) [6] in groundnut, Jha, (2007) [14] in groundnut, Narayanreddy *et.al*. (2008) in sunflower, Singh *et.al. (*2004) in okra and Sadeghi *et al*., (2011) in soybean.

Conclusion

The present study revealed that among various treatments, all the treatment enhanced germination percent in all seed lots. Maximum germination percent was observed with GA_3 treatment followed by PEG and minimum found in Hydration. Maximum enhancement in seed germination per cent was observed in second pick stored seeds in all varieties. FEI and MET for both American and desi varieties, meaning thereby the treatments which enhanced the SET percentages also emerged more quickly (in less time) and uniformly. The seedling establishment found significantly and positively correlated with vigour indices (VI-I and VI-II), and FEI and negatively with MET.

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