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Original Research Article

Effect of Hormonal, Chemical and Hydropriming on Seed Yield and Quality Parameters of Late Sown Wheat (*Triticum aestivum* L.)

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A B S T R A C T

An experiment was conducted in 2012-13 and 2013-14 at Department of Seed Science & Technology in C. S. A. university of Agriculture and Technology, Kanpur by using Nested block design and complete randomized design with three replications respectively, to evaluate the effect of different seed primings technique on seed yield and quality parameters of on late sown wheat with variety K-9423 (Unnat Halna). Seeds were primed for 12, 18, 24 and 30hrs in four priming media 9Water, $CaCl_2$1%, $KNO_3$1%, $GA_3$50ppm) and unprimed as control. Observations were recorded on seed yield and seed quality parameters. Result showed that the significant variation between control V/S treatments in different priming hours. Highest brick gravel test value (63.28) and least Leachet test value (0.226) were observed when seed primed by GA_3 for 18, 30hrs respectively. Accelerated aging test in 24hrs and highest seed germination percent, brick gravel test value and earliest days to maturity in 18hrs. Significantly positive as well as negative desired traits associated quality parameters might be used to improve the seed quality.

Keywords

Hormonal, Chemical, Hydropriming, Yield, Quality parameters, Wheat

Introduction

Wheat (*Triticum aestivum* L.) is the second important food crop being next to rice. It is an most important cereal in many developed and developing countries of the world. It is widely used for animal feed and industrial raw material beside food in the developed countries where as the developing countries it is generally used for food. India is the second largest producer of wheat in the world next only to China and the crop has registered fastest growth to Indian agriculture. In world, wheat is cultivated over an area of 304.18 m ha with total production and productivity of 92.29 million tonnes and 3.03 t ha^{-1}, respectively. However in India, it is cultivated an area of 30.40 m ha with total production and productivity of 94.88 mt and 3.18 t ha^{-1}, respectively. In Uttar Pradesh, the acreages, production and productivity of wheat is about 9.67 m ha, 30.01 mt and 3.11 t ha^{-1}, respectively [1]. [2] defined seed priming as a pre-sowing treatment in osmotic solution, which allows seeds to imbibe water to proceed to the first stage of germination but prevents radicle protrusion through the seed coat. Seed priming can be included halo-priming, hydro-priming, osmo-priming, osmo-conditioning, osmo-hardening, hormo-priming, hardening, matrix-priming and others. Halo-priming and hydro-priming defined as soaking seeds in salt solutions and water respectively. Since primed seeds are usually lose their storage life, thus they should be sown immediately after priming [3].

Rapid and uniform field emergence is an important factor to achieve high yield with respect to both quality and quantity in annual crops. For achieving this specific physiological need, seed priming has been found a double beneficial technology to enhance rapid and uniform emergence and to achieve high vigour as well as better yield in field crops. Many studies have been carried out on the effect of seed priming's on germination and growth rate of crops. Recently, there has been renewed interest in seed priming (also known as hydro-priming) to improve establishment. This approach consists of soaking seeds in water (usually overnight), surface drying and planting the same day. This decreases the time that the seed spends in the seedbed simply imbibing water. Once sown, seeds spend significant amounts of time just absorbing water from the soil. So, by reducing the imbibition time to minimum (through seed priming), germination rate of seed can be increased and seedlings emergence improved [4].

In recent years, seed priming has been tested in over 1000 trials in India, Pakistan, Nepal, Bangladesh and Zimbabwe on a range of crops including maize (*Zea mays*), sorghum (*Sorghum bicolor*), rice (*Oryza sativa*), wheat and Chickpea (*Cicer arietinum*) [5]. It has been reported that seed soaked with 2.5 % KCL for 16 hrs reduced both coleoptiles and radical length of wheat. It has also been found that if seed is soaked in 2.5 % potassium chloride (KCl) for 12 hrs before sowing increases wheat yield by 15 %. Furthermore, in previous studies, it has also been recorded that seed soaking with 0.5 to 1% solution of KCl or potassium sulfate (K_2SO_4) significantly increased plant height, yield attributes, and seed yield in wheat. Earlier studies showed that the success of seed priming is affected by the complex interaction of factors including priming agent, plant species, priming duration, temperature, seed vigour and dehydration, and also storage conditions of the primed seed. Seed priming techniques have been used to increase germination characteristics and improve germination uniformity in more field crops under stressed conditions [6]. Seed priming can be taken to counteract the adverse effects of abiotic stress. Seed priming increases seed reserve utilization, seedling dry weight and seed reserve depletion percentage in mountain rye and wheat [7]. Plant growth regulators not only increase the yield but also improve the quality of crops. It is now fully recognized that vital physiological activities of the plants are regulated by the chemical substances called "hormone".

Materials and Methods

The experiment was carried out for two consecutive years 2012-13 and 2013-14 at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. Geographically, Kanpur is situated in sub tropical zone at $25^0 26'$ and $26^0 58'$ N latitude and $79^0 32'$ and $80^0 34'$ E longitude with an altitude of 125.90 m above Mean Sea Level.

The mean annual rainfall is about 816 mm. The composition of soil of the experimental site is alluvial in nature having fine sand 62.20 and 62.50 %, silt 24.00 and 23.80 %, clay 13.70 and 13.80 %, pH 8.52 and 8.54, organic carbon 0.47 (Low) and 0.44 % (Low), EC 0.42 and 0.41 ds m^{-1}, available N 225 (Low) and 221 kg ha^{-1} (Low), available P 20 (Medium) and 19 kg ha^{-1} (Medium), available K 249 (Medium) and 245 kg ha^{-1} (Medium), available zinc 0.9 (Low) and 1.0 kg ha^{-1} (Low) and available iron 9.2 (Normal) and 9.4 kg ha^{-1} (Normal) during 2012-13 and 2013-14, respectively. Experimental materials for the experimentation were consisted of wheat variety K-9423 (Unnat Halna) with net plot size 7.9 m^2 by using Nested block design.

Preparation of Solution

For the preparation of 1% solution of KNO_3, 10 gram KNO_3 was weighted and put into a measuring flask and poured the distilled water up to 1000 ml.

Likewise, for $CaCl_2$ (1%) solution 10 gram $CaCl_2$ was taken in a measuring flask and made up to 1000 ml of distilled water.

For the preparation of the growth regulator 1 gram chemical was taken in an individual neat and clean beaker. This chemical was dissolved separately in a few drop of alcohol.

The alcoholic solution added to 500 ml of distilled water with constant stirring the volume of solution finally constituted to one liter. This was the 1000 ppm stock solution of GA_3. The flask containing GA_3 solution was covered with muslin cloth to avoid any contamination.

For preparation of 50 ppm for growth regulator 50 ml of solution from the stock solution was taken in a well cleaned measuring flask and water is added to constitute to 1000 ml. for 50 ppm, 50 mg of chemical was used to make 1000 ml solution.

Soaking of the seed in solution

After preparation of solution KNO_3, $CaCl_2$, GA_3 along with water Seed of wheat variety was soaked in desired solution for 12 hrs, 18 hrs, 24 hrs and 30 hrs at room temperature, simultaneously a control, in which seeds were without soaking.

The feeder dose of NPK @ of 120:60:40 Kg ha^{-1} was also applied. Standard procedure for experimentation was followed. Standard procedure for experimentation was followed. Observations were recorded on yield and quality characters viz. 1000 Seed Weight (g), Standard Germination (%), Seedling length (cm), Seedling Vigour Index [Germination % × Seedling Length (cm)], Speed of germination, Accelerated aging test, Brick gravel test, Leachet test, seed yield (kg $plot^{-1}$) and seed yield (q ha^{-1}). The various statistical techniques were used for calculation of the data suggested by [8]. Standard germination was following the procedure out lined by ISTA rules [9]. The seedling vigour index was determined by using the formula suggested by [10] as below:

Seedling Vigour Index = Germination Percentage x Seedling Length (cm)

Results and Discussion

Quality parameters

The data on 1000 seed weight given in Table 1 revealed the significant difference among factors as well as between control and treatments. The mean pooled value exhibited that GA_3 (A_4) treatment was found to be best by scoring highest (36.042 gm) test weight followed by $CaCl_2$- A_3 (35.673 gm), water-A_1

(35.279 gm). The lowest (35.190 gm) test weight was recorded with KNO_3 (A_3). Overall highest (37.580 gm) 1000 seed weight was found in A_4 (GA_3) treatment and lowest seed test weight was recorded with A_3 (KNO_3) whereas best performance of individual treatment are concerned (A_1) treatment scored the highest seed test weight (36.485 gm) in B_2 priming hours, A_2 with B_2 (36.700 gm) treatment A3 with B2 (36.460 gm) and A_4 (37.580 g) with B3 treatments. In case priming hours highest pooled mean value (36.642 gm) for this characters was recorded with B_4 (37.580 gm) overall highest mean value was recorded with GA_3 and lowest (34.475 gm) was recorded with B_4 whereas performance of individual priming hours are concerned B_1 contributed the highest test weight (36.460 gm), B_2 with A_4 treatment (36.810 gm) least value was recorded with $CaCl_2$ treatment (34.430 gm) [11].

Pooled mean data Table 1exhibited the significant highest germination (96.33%) recorded with GA_3 50 ppm (A_4) treatment, followed by $CaCl_2$ 1% (A_2-94.99%) and water (A_1-93.41%). Least percentage of germination (91.28%) was recorded with $KNO_3$1% (A_3) treatment. Among the treatments GA_3 50 ppm primed seeds achieved the overall highest germination (97.69%) in 24 hrs soaking (B_3 period). Overall least germination (90.055) was recorded with KNO_3 1% primed seed in largest duration of 30 hrs. Water primed seed (A_1) exhibited the highest percent of germination (94.38%) in B_1 (12 hrs) priming duration, $CaCl_2$ (A_2) and KNO_3 (A_3) both primer exhibited the highest standard germination 95.66 and 92.55 respectively in B_2 (18 hrs soaking duration), GA_3 (A_4) in B_3 (97.69%) soaking period 24 hours. Pooled mean value of B_2 (18 hrs soaking) treatment exhibited the highest germination (94.55%) followed by B_1 (12 hrs soaking-94.43%) and B_3 (24 hrs soaking-94.23%) the least standard germination (92.83%) was recorded with B_4 (30 hrs soaking) treatment. Overall highest germination (97.69%) was recorded in B_3 (24 hrs) priming duration. Overall least germination (90.05%) was observed in B_4 (30 hrs). Whereas performance of individual priming hours are concerned B_1 contributed highest germination (94.38%) in A_1 treatments B_2 in A_4 (96.12%), B_3 in GA_3 (97.69%) and B_4 in A_4 (95.14%) treatment [12].

The pooled mean value exhibited the highest seedling length (25.344 cm) in A_4 (GA_3 50 ppm) treatment it was followed by A_2- $CaCl_2$ (24.25 cm) and A_1-water (22.615 cm) in Table 2. The least seedling length (21.078 cm) was recorded with A_3 ($KNO_3$1%) treatment. Overall highest seedling length (26.190 cm) was recorded with GA_3 and least seedling length (20.530 cm) was observed KNO_3 1%. Whereas individual performance of different treatments are concerned water primed seed (A_1) exhibited the highest seedling length (23.455 cm) in B_1 priming duration, $CaCl_2$ 1% in B_3 (25.400) KNO_3 1% in B_2 22.145 and GA_3 in B_3 26.190 cm). The pooled data of different priming durations given in Table 2 revealed the highest seedling length (23.709 cm) in B_3 followed by B_2 (23.437 cm) and B_1 (23.254 cm). The least seedling length (22.887 cm) was observed with B_4 priming hours. Whereas performance of individual priming hours are concerned B_1 (12hrs),B_2 (18hrs), B_3 (24hrs) and B_4 (30hrs) excelled the highest performance 24.465 cm, 25.255 cm, 26.190 cm and 25. respectively [13].

The pooled data given in Table 2 on seedling vigour index divulged the significant variation among the factors as well as in between control V/S treatments. $GA_3$50 ppm (A_4) was found to be best contributor for seedling vigour index by contributing

(2441.665) value for this trait. It was followed by $CaCl_2$1% (A_2-23036.731) and water (A_1-2112.596). Overall highest vigour index was recorded with GA_3 (A_4) treatment while least seedling vigour index (1897.545). Least seedling vigour index was recorded with KNO_3 (A_3) treatment whereas performance of individual treatments with respect to priming hours A_1 (water) excelled highest seedling vigour index (2213.505) with B_1 (12hrs), A_2 ($CaCl_2$) treatment with B_3 (24hrs-2408.050) A_3 (KNO_3) with B_2 (18hrs-2049.520) and A_4 (GA_3) treatment with B_3 (24hrs-2558.475) priming duration. In case of priming duration the mean value of B_3 (24 hrs) Priming duration was found to be significantly superior by scoring (2238.787) values of this traits. It was followed by B_2 (18 hrs-2217.569) and B_1 (12 hrs soaking-2198.236). The highest SVI (2558.475) was recorded with B_3 treatment and least value of this character was recorded with B_4 treatment. In respect of individual performance of different priming duration B_1, B_2, B_3 and B_4 treatments scored the highest value 2357.930, 2427.040, 2558.475 and 2422.615) respectively with GA_3 (A_4) treatments [14].

The data given in Table 2 revealed the significant highest speed of germination (24.910) was recorded with KNO_3 followed by $CaCl_2$ (23.609) and water (23.463). Among treatments the lowest value (22.653) was recorded with KNO_3 primed seed in largest duration 30 hrs whereas the performance of different treatments in respect of the priming hours are concerned water primed seed (A_1) exhibited the highest percent of speed of germination (24.475) in B_1 (12 hrs) priming duration. $CaCl_2$ (A_2) and KNO_3 (A_3) both primer exhibited the highest speed of germination 24.925 and 23.270, respectively in B_2 (18 hrs soaking duration). GA_3 (A_4) in B_3 (25.755) 24 hrs soaking period. The pooled data of different priming duration given in Table 2 revealed the highest speed of germination (23.979) in B_2 followed by B_1 (23.802) and B_3 (23.792). The least speed of germination (22.869) was recorded with B_4 (30 hrs) soaking treatment. Over all highest speed of germination (25.755) was recorded with B_3 (24 hrs) priming duration. Whereas performance of individual priming hours are concerned B_1 contributed highest speed of germination % (24.475) in A_1 treatment, B_2 in A_2 (24.925) B_3 in GA_3 (25.755) and B_4 in A_4 (24.090) treatment [15].

The mean pooled value of GA_3 given in Table 3 exhibited the significant highest (86.942) germination after accelerated aging test followed by $CaCl_2$ (85.435) and water (83.278). The least per cent (81.925) of seed germination after accelerated aging test (48 hrs) was recorded with KNO_3 treatments. The overall highest value (87.265) of accelerated aging test (48 hrs) was recorded with GA_3 treatment.

The performance of individual treatment in different priming hours for accelerated aging test (48 hours) revealed that A_1 treatment scored the highest value (83.875) with B_3 priming duration A_2 treatment with B_3 (86.660) A_3 treatment with B_2 (83.450) and A_4 treatment with B_3 (87.265). Significant variation has been reported among the different treatments of priming duration B_3 treatment was found to be best (85.212) for the said character followed by B_2 (85.151) and B_1 (84.044) treatments least value on (83.175) accelerated aging test was recorded with B_4 treatment. Overall highest germination (87.265) after accelerated aging test (48 hrs) was recorded with B_3 treatment. Whereas performance of individual treatments of priming duration are concerned B_1, B_2, B_3 & B_4 treatments scored the highest value 86.940, 87.080, 87.265 and 86.480 respectively in GA_3 (A_4) treatment.

Table.1 Effect of different seed primings technique on seed yield and quality parameters of late sown Wheat (pooled data of two years)

Treatment	1000 Seed Weight (g)					Standard Germination (%)				
	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A
A (1) WATER	34.825	36.485	35.050	34.795	35.289	76.339 (94.38)	75.623 (93.86)	74.980 (93.31)	73.604 (92.06)	75.137 (93.41)
A (2) $CaCl_2$ (1%)	36.460	36.700	35.100	34.430	35.673	77.654 (95.45)	77.938 (95.66)	76.794 (94.80)	75.864 (94.06)	77.062 (94.99)
A (3) KNO_3 (1%)	34.765	36.460	35.060	34.475	35.190	72.985 (91.47)	74.131 (92.55)	72.589 (91.07)	71.584 (90.05)	72.822 (91.28)
A (4) GA_3 50 ppm)	34.910	36.810	37.580	34.865	36.042	79.000 (96.38)	78.616 (96.12)	81.226 (97.69)	77.227 (95.14)	79.017 (96.33)
Mean B	34.740	36.614	35.697	34.642	35.548	76.495 (94.43)	76.577 (94.55)	76.397 (94.23)	74.569 (92.83)	76.010 (94.01)
Control Mean					34.490					72.366 (90.84)
Factor	**SE (d)**			**CD (p=0.05)**		**SE (d)**		**CD (p=0.05)**		
A	0.454			0.899		0.489		0.969		
Cont. V/S Treat.	0.341			0.675		0.367		0.726		

Back values are presented in parenthesis.

Table.2 Effect of different seed primings technique on seed yield and quality parameters of late sown wheat (pooled data of two years)

Treatment	Seedling length (cm)					Seedling Vigour Index					Speed of germination				
	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean -A
A (1) WATER	23.455	22.285	22.410	22.310	22.615	2213.550	2091.665	2091.080	2054.090	2112.596	24.475	23.375	23.120	22.880	23.463
A (2) $CaCl_2$ (1%)	24.295	24.060	25.400	23.245	24.250	2318.985	2301.455	2408.050	2186.435	2303.731	23.110	24.925	23.810	22.590	23.609
A (3) KNO_3 (1%)	20.800	22.145	20.835	20.530	21.078	1902.475	2049.520	1897.545	1849.215	1924.564	22.945	23.270	22.480	21.915	22.653
A (4) GA_3 50 ppm)	24.465	25.255	26.190	25.465	25.344	2357.930	2427.640	2558.475	2422.615	2441.665	24.675	25.120	25.755	24.090	24.910
Mean B	23.254	23.437	23.709	22.887	23.322	2198.236	2217.569	2238.787	2127.964	2195.639	23.802	23.979	23.792	22.869	23.659
Control Mean					23.410					2126.580					21.390
Factor	**SE (d)**			**CD (p=0.05)**		**SE (d)**			**CD (p=0.05)**		**SE (d)**			**CD (p=0.05)**	
A	0.133			0.263		30.076			59.551		0.456			0.899	
Cont. V/S Treat.	0.099			0.196		22.557			44.663		0.342			0.674	

Table.3 Effect of different seed primings technique on seed yield and quality parameters of late sown Wheat (pooled data of two years)

Treatment	Accelerated aging test (after 48 hrs)					Accelerated aging test (after 96 hrs)					Accelerated aging test (after 144 hrs)				
	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A
A (1) WATER	82.974	84.210	83.875	82.050	83.278	71.895	75.140	77.015	69.960	73.503	70.010	70.900	71.920	69.105	70.484
A (2) $CaCl_2$ (1%)	85.210	85.860	86.660	84.010	85.435	79.010	79.855	80.005	76.100	78.743	72.695	72.965	74.815	71.295	72.943
A (3) KNO_3 (1%)	81.050	83.450	83.050	80.150	81.925	72.095	76.930	77.170	70.010	74.052	68.060	69.925	71.590	66.235	68.953
A (4) GA_3 50 ppm)	86.940	87.080	87.265	86.480	86.942	80.800	81.050	80.190	78.935	80.244	75.895	76.130	76.950	74.020	75.749
Mean B	84.044	85.151	85.212	83.175	84.395	75.950	78.244	78.595	73.752	76.636	71.665	72.480	73.819	70.163	72.032
Control Mean					79.975					68.875					58.155
Factor	SE (d)			CD (p=0.05)		SE (d)			CD (p=0.05)		SE (d)			CD (p=0.05)	
A	0.620			1.221		0.578			1.139		0.919			1.810	
Cont. V/S Treat.	0.465			0.916		0.433			0.854		0.689			1.357	

Table.4 Effect of different seed primings technique on seed yield and quality parameters of late sown Wheat (pooled data of two years).

Treatment	Brick gravel test					Leachet test					Seed Yield (q ha^{-1})				
	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A	B (1) 12 hrs Soaking	B (2) 18 hrs Soaking	B (3) 24 hrs Soaking	B (4) 30 hrs Soaking	Mean-A
A (1) WATER	56.260	59.045	58.650	57.200	57.789	0.635	0.635	0.648	0.615	0.633	40.389	40.886	42.847	38.525	40.661
A (2) $CaCl_2$ (1%)	61.845	62.540	60.560	59.655	61.150	0.455	0.465	0.465	0.455	0.460	42.658	43.860	43.037	40.000	42.388
A (3) KNO_3 (1%)	56.680	57.400	56.365	55.390	56.459	0.245	0.230	0.240	0.225	0.235	40.000	42.151	41.886	36.265	40.075
A (4) GA_3 50 ppm)	62.875	63.660	64.300	62.285	63.281	0.220	0.220	0.225	0.240	0.226	43.417	44.050	44.683	41.012	43.290
Mean B	59.415	60.662	59.969	58.633	59.698	0.389	0.387	0.395	0.384	0.389	41.616	42.736	43.113	38.950	41.603
Control Mean					56.235					0.635					37.030
Factor	SE (d)			CD (p=0.05)		SE (d)			CD (p=0.05)		SE (d)			CD (p=0.05)	
A	0.815			1.605		0.011			0.022		0.875			1.749	
Cont. V/S Treat.	0.611			1.204		0.008			0.017		0.656			1.312	

Table.5 Matrix correlation (r) between seed yield and quality parameters.

Observations	2012-13	2013-14	Pooled
Seed yield V/S Yield q/ha^{-1}	1.00000	1.00000	1.00000
Seed yield V/S 1000 Seed weight	.57496**	.64164**	.60986**
Seed yield V/S Standard germination %	.82773**	.80390**	.81948**
Seed yield V/S Seedling length(cm)	.60888**	.57883**	.59309**
Seed yield V/S Seedling Vigour index	.68292**	.64556**	.66787**
Seed yield V/S Speed of germination	.78704**	.79112**	.78866**
Seed yield V/S (Accelerated aging test (after 48hrs)	.87400**	.86792**	.87080**
Seed yield V/S (Accelerated aging test (after 96hrs)	.91466**	.91801**	.91615**
Seed yield V/S (Accelerated aging test (after 144hrs)	.81868**	.81906**	.81887**
Seed yield V/S Brick gravel test	.78500**	.78829**	.83382**
Seed yield V/S Leachet test	-.22308	-.24453	-.24790

The mean pooled value of GA_3 given in Table 3 exhibited the significant highest (80.244) accelerated aging test followed by $CaCl_2$ (78.743) and KNO_0 (74.052). The least percentage of seed germination after accelerated aging test (96 hrs) was recorded with water treatments. The overall highest value (81.050) of accelerated aging test (96 hrs) was recorded with GA_3 treatment while its lowest value was found in (69.960) water treatment. The performance of individual treatment in different priming hours for accelerated aging test (96 hours) revealed that A_1 treatment scored the highest value (77.015) with B_3 priming duration. A_2 treatment with B_3 (80.005) A_3 treatment with B_3 (77.170) and A_4 treatment with B_2 (81.050) priming durations. Among the different treatments of priming duration B_3 treatment was found to be best (78.595) for the said character followed by B_2 (78.244) and B_1 (75.950) treatments least value (73.752) accelerated aging test was recorded with B_4 treatments. Overall highest germination (81.050) after accelerated aging test (96 hrs) was recorded with B_2 treatment. Whereas performance of individual treatments of priming duration are concerned B_1, B_2, B_3 & B_4 treatments scored the highest value 80.800, 81.050, 80.190 and 78.935 respectively in GA_3 (A_4) treatment.

The mean pooled value of GA_3 given in Table 3 exhibited highest (75.749) germination after accelerated aging test followed by $CaCl_2$ (72.943) and water (70.484). The least percentage (68.953) of seed germination after accelerated aging test (144 hrs) was recorded with KNO_3 treatments. The overall highest value (76.950) of accelerated aging test (144 hrs) was recorded with GA_3 treatment while its lowest value was found in (66.235) KNO_3 treatment. The performance of individual treatment in different priming hours for accelerated aging test (144 hours) revealed that A_1 treatment scored the highest value (71.920) with B_3 priming duration. A_2 treatment with B_3 (74.815) A_3 treatment with B_3 (71.590) and A_4 treatment with B_3 (76.950) priming durations. Significant variation has been reported among the different treatments of priming duration B_3 treatment was found to be best (73.819) for said character followed by B_2 (72.480) and B_1 (71.665) treatments least value (70.163) accelerated aging test was recorded with B_4 treatments. Overall highest germination (76.950) after accelerated aging test (144 hrs) was recorded with B_3 treatment. Whereas performance of individual treatments of priming duration are concerned B_1, B_2, B_3 & B_4 treatments scored the highest value

75.895, 76.130, 76.950 and 74.020 respectively in GA_3 (A_4) treatment [16].

Among the treatments GA_3 (A_4) was found to be most superior (Table 4) in brick gravel test by scoring significant highest mean pooled value (63.281), it was followed by $CaCl_2$ (A_2) treatment which scored the (61.150) % germination and water (57.789). The least value (56.459) for this trait was recorded with KNO_3 (A_3) treatments. Overall highest pooled value (64.300) was recorded with A_4 treatment while KNO_3 (A_3) was found to be least scorer (55.390) for this trait.

Whereas individual performance of different treatments are concerned A_1 (water) A_2 ($CaCl_2$) A_3 (KNO_3) were to be found to be highest scorer by scoring 59.045, 62.540, 57.400 respectively in B_2 treatment. GA_3 50 ppm scored the highest value (64.300) in B_3 treatment. Significant variation for this trait. B_2 (18 hrs) treatment was found to be best by scoring the highest pooled mean value (60.662%) for this traits followed by B3 (24 hrs-59.969) and B1 (12 hrs soaking-59.415). Least brick gravel test value (58.633) was recorded with B_4 treatment. Among different priming hours highest brick gravel test value (64.300) was recorded with B_3 (24hrs) soaking similarly the lowest value for this trait was recorded with B_4 treatments. Whereas performance of each primed duration treatment are concerned B_1 treatment scored highest value (62.875) in A_4, B_2 in A_4 (63.660) B_3 again in A_4 (64.300) and B_4 with A_4 (62.285) [17].

Pooled mean data of this characters in Table 4 revealed that GA_3 was found to be best by scoring least Leachet value (0.226) followed by A_3 treatment (0.235) and $CaCl_2$ by scoring (0.460). Highest Leachet value was recorded with seed treated with water. Overall least Leachet value (0.220) was recorded with B_1 and B_2 priming hours. Similar highest mean value was found with B_3 treatments whereas performance of individual treatment factors are concerned A1 scored the highest value with B_3 treatment (0.648) A_2 with B_1 & B_3 (0.465 each). A_3 scored the highest Leachet value with B_3 treatment. The data revealed significant variation among the priming durations B_4 (30 hrs) priming duration was found to be most conducive by using the least leachet value (0.384) to attain the Leachet test followed by B_2 (18 hrs) soaking (0.387), B_1-12 hrs (0.389) and highest leachet value (0.395) was recorded with B_3 (24 hrs) soaking to attain the leachet test. Whereas different priming hours are concerned individually B_1 took the least value (0.220) in A_4, B_2 in A_4 (0.220), B_3 in A_4 (0.225) and B_4 in A_3 (0.225) [18].

Seed yield

The data on seed yield q ha^{-1} given in Table 4 revealed the significant variation among different treatments and in between control v/s treatment. A4 (GA3) was found to be best in achieving the highest mean seed yield (43.290 q ha^{-1}) followed by A2 $CaCl_2$ (42.388 and A1 water (40.661 q ha^{-1}). A3 (KNO_3) was found to be least effective in enhancing the yield as it scored (40.075 q ha^{-1}) seed yield. Highest seed yield among different priming hours was recorded with (44.683) B_3 treatment and lowest (36.265 q ha^{-1}) was recorded with B_4 (30 hrs) treatment.

Whereas individual performance of different priming hours are concerned B_1, B_2, B_3 and B_4 treatments scored its superiority with A_4 (GA_3) by 43.417, 44.050, 44.683 and 41.012 q ha^{-1} seed yield, respectively. The performance of different priming hours given in Table 4 revealed the significant variation for seed yield q ha^{-1} the mean pooled value (43.113 q ha^{-1}) of B_3 was found best for the said trait B_2 (18 hrs – 42.736) and B1 (41.616 q ha^{-1}). The lowest seed yield (38.950) was scored with B_4 (30 hrs) treatment overall the highest [19].

Matrix correlation (r) between seed yield and quality parameters

It is evident from the table 5 Seed yield reflected the highly significant positive correlation with 1000 seed weight (0.60986), germination % (0.81948), seedling length (0.59309 cm), seedling vigour index (0.66787), speed of germination (0.78866), accelerated aging test after 48 hrs, 96 hrs, 144 hrs (0.87080, 0.91615, 0.81887) and brick gravel test (0.83382) the correlation coefficient between seed yield and Leachet test was found to be negative and non significant.

Thus it is concluded that application of GA_3 50 ppm was found most suitable for harvesting the highest seed yield as well as vigour index and Accelerated aging test in 24hrs and highest seed germination percent, brick gravel test value and earliest days to maturity in 18 hrs. Significantly positive as well as negative desired traits associated with yield and quality parameters might be used to improve the yield and seed quality.

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