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Short Communication

Effect of pre-sowing seed treatments on seed quality parameters of durum wheat (*Triticum durum* Desf.) under laboratory conditions

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Wheat is a major staple food crop for more than one third of the world population and is the main staple food of Asia. It originated in South Western Asia and belongs to the family *Poaceae*. Durum wheat (*Triticum durum* Desf.), is a tetraploid species of wheat. It is called pasta wheat or macaroni wheat. It was developed by artificial selection of the domesticated emmer wheat strains formerly grown in Central Europe and the Near East around 7000 BC. It predominantly grows in the Middle East (Mohammadi and Haghparast, 2022). Durum in Latin means "hard" and these species is the hardest of all wheat.

Durum wheat (*Triticum durum* Desf.) is grown on 8 to 10% of the total wheat-cultivated area. India is one of the prime producers of durum wheat with 1.5 million hectares dedicated to its cultivation each year, accounting for approximately 10% of total wheat production. Madhya Pradesh, Gujarat, Maharashtra, Karnataka and Southern Rajasthan are suitable for durum cultivation. In India during *Rabi* season 2022-23 total cultivated area of wheat was 34.15 million hectare with the production of around 106 million ton. Total wheat growing area in Uttar Pradesh was 10.24 million hectare with total wheat production was 18 million metric tons whereas, durum wheat covered around 1.5-2.0 million hectare, with production of 1.5 million metric ton.

During grain filling stages of late sown wheat, high temperature limits the seed yield (Farooq *et al.*, 2011) because soluble starch synthase involved in synthesis and deposition of starch is extremely sensitive to high temperature whose activity decreases when temperature touches the level beyond 20°C which decreases grain weight and shrinks size of the wheat seed.Drought stress during developmental stages in wheat has been considered one of the major factors that affect the grain yield and quality. This is particularly true if stress occurs during the early growth stages, compromising stand establishment and the final crop yield and productivity.

Abiotic stresses such as drought and salinity stress are widespread problems around the world (Soltani *et al.*, 2006). Seed germination and seedling growth of wheat like other crops, were negatively affected by salinity stress. Soil salinity is a major abiotic stress which adversely affects physiological and metabolic processes, leading to diminished growth and yield (Azizpour *et al.*, 2010). Excess amount of salt in the soil adversely affects plant growth and development. Processes such as seed germination, seedling growth and vigour, vegetative growth, flowering and fruit set are adversely affected by high salt concentration.

Pre-sowing treatments of seeds are easy, low risk and potent approach to overcome the environmental stress problems in crop plants. Among various strategies, seed priming and coating has been developed and used extensively to improve seed quality parameters.

Priming is one of the common techniques of controlled hydration of seed which uses principles of pre-soaking seed in water and dried back to storage moisture content to activate the pre-germination activity in seed, it partially hydrates seeds without allowing radicle emergence. Consequently, primed seeds are equipped with advanced germination and exhibit improved germination rate and uniformity. Seed priming as a cost-effective approach is being used for different crops and in different countries to improve yield (Farooq *et al.*, 2019). Seed priming technique improves the germination, seedling emergence, growth and yield attributes of crop. It decreases the time between sowing and emergence, enhance germination homogeny and seedling growth. Seed coating is considered one of the best methods to promote sustainable agriculture where the physical and physiological properties of seeds can be enhanced to increase seed vigour, seed health and overall germination of seed. To improve vigour, seeds are often exposed to pre-germination treatment. Pre-sowing seed technologies like seed priming and coating can help to overcome the negative effects of drought and salinity on performance of seed and improve the quality of seeds.

An experiment was conducted during 2023 and 2024 at Department of Seed Science and Technology, Anand, Gujarat with theobjective to study the effect of pre-sowing seed treatments on seedgermination and vigour of durum wheat underlaboratory conditions. The seeds of durum wheat varieties GW 1, GW 1346 and GADW 3 were obtained from Agricultural Research Station, AAU, Dhandhuka.

Methodology for Seed Priming

Seeds of the varieties were subjected to priming with KNO_3, salicylic acid, $CaCl_2$ and H_2O_2 for 6 hours. For the priming treatment, seeds were soaked in priming solutions having double the volume of seed. It was ensured that seeds remained immersed in the solution, so as to avoid precocious germination during the treatment period. Priming was given in the flasks at room temperature and dried back to the original moisture content under shade after 6 hours duration (Ghobadi *et al.*, 2012).

Methodology for Seed Coating

Wheat seeds were treated with two coating agents calcium peroxide, sodium lauryl sulphate, *Bacillus subtilis* and Bio NPK. For seed coating, a semi auto Laboratory Seed Treater (Model ML2000, (Model ML2000, SATECH Germany) was used. For seed coating treatment, wheat seeds were introduced from inlet in the coating pan having width, length and height 400 × 600 × 750 mm, respectively, followed by the application of coating agent and binding agent with inert matter. Talcum powder used as inert material and Corboxy Methyl Cellulose (CMC) was used as a binder to attach the coating agent with seeds. After seed coating, the seeds were extracted from the seed coating machine through outlet and were dried.

Germination (%)

The laboratory germination test was conducted as per ISTA procedure by adopting soil substrata method (Anonymous 2015). 50 seeds from each treatment were taken and sow in soil substrata in tray at laboratory with three repetitions. The trays were kept at 20 ± 0.5^{o} C temperature and 95 ± 1 per cent relative humidity. First count was recorded on fourth day of germination and the final count for normal seedlings was recorded on eighth day of germination.

Seedling root length (cm)

Ten normal seedlings were selected randomly from the germination paper during final count of germination test for the root length measurement. The root length was measured from the tip of primary root to base of the hypocotyle.

Seedling shoot length (cm)

Ten normal seedlings were selected for root length measurement also used for the measurement of shoot length. The shoot length was measured from the base of primary leaf to the base of hypocotyle.

Seedling length (cm)

Ten normal seedlings were selected for measurement the seedling length. The length between the collar region and the tip of the primary shoot measured as shoot length. The length between the collar region and the tip of primary root measured as root length.

Seedling length (cm) = Shoot length (cm) + Root length (cm).

Seedling fresh weight (g)

Ten normal seedlings were selected for measurement of seedling fresh weight. The primary leaves were removed and weighed while still moist.

Seedling dry weight (g)

Ten normal seedlings were selected for measurement of root and shoot length used for the seedling dry weight measurement. These seedlings were kept in hot air oven for 24 hours at temperature of 80° C. The dry weight of seedlings was recorded.

Seedling vigour index I

The seedling vigour index I was calculated using the procedure suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling Vigour Index I = Germination (%) × Seedling length (cm)

Seedling vigour index II

The seedling vigour index II was calculated using the procedure suggested by Abdul-Baki and Anderson (1973).

Seedling Vigour Index-II = Germination (%) × Seedling dry weight (g)

The treatment KNO_3 (1 %) (T_2) recorded significantly highest germination (88.56 %) may be due to effect of priming on oxidative metabolism by increasing activity of antioxidant enzymes such as peroxidise and superoxide dismutase. It stimulates ATPase function, RNA processing and water uptake. Difference in germination among three different wheat varieties was due to different anti oxidant enzyme activities govern by genetic constitution of that cultivar. The reason for increasing salinity tolerance in the plants grown from treated seeds is due to higher capacity of seeds adapted to osmotic conditions. KNO_3 priming was proved to be effective in decreasing salt effects and increasing germination percentage. these results are in agreement with the findings of Mirza *et al.*, (2021), Esatu *et al.*, (2022) and Haque (2024) in wheat.

The superiority in seedling root length with KNO_3 priming was related to more nitrogen and potassium accumulation in seeds. The increase in germination and seedling root length may be due to the activity of α-amylase due to seed priming. Root length of different wheat varieties GW 1 (V_1) and GADW 3 (V_3) recorded higher root length than GW 1346 (V_2) which may be cause of different amylase activities, they are key enzymes that play a vital role in hydrolyzing the seed starch reserve, thereby supplying sugars to the developing embryo. Similar results are also reported by Abnavi and Ghobadi (2012), Reza *et al.*, (2013) and Jabbarpour *et al.*, (2014) in wheat.

The significant effects of KNO_3 priming may be due to increased RNA and protein synthesis, more availability of ATP and faster embryo growth which resulted in higher seedling shoot length. Halo-priming has also shown to activate seed germination through ATPase activation, acid phosphatase and RNA synthase which improved shoot length. These research findings were found to be similar with Abnavi *et al.*, (2012) in wheat.

Highest fresh weight (1.24 g) was recorded by pre-sowing seed treatment of KNO_3 (1 %) this might be due to highest seedling lengths because highest seedling lengths had the highest biomass which is correlated with highest seedling fresh weight. These results are in accordance with the research findings of Sarlach *et al.*, (2013) in wheat

Seed priming with KNO_3 might have resulted in enhancement of nutrient supply (K^+ and NO_3^-) towards the developing seedling that results in higher seedling fresh weight. The highest seedling length is related to vigorous growth which might be resulted into maximum seedling dry weight. Priming with KNO_3 has also shown to activate seed germination through

Table 1: Effect of Different Pre-sowing Seed Treatments and Wheat Varieties on Seed Germination (%)

Varieties (V)		**V_1**	**V_2**	**V_3**	**Mean**
Treatments (T)	T_1	85.00	71.67	80.33	**79.00**
	T_2	95.67	81.00	89.00	**88.56**
	T_3	82.00	70.00	73.33	**75.11**
	T_4	89.67	73.67	79.33	**80.89**
	T_5	91.67	74.67	84.00	**83.44**
	T_6	94.67	76.00	88.67	**86.44**
	T_7	86.00	71.67	79.67	**79.11**

	T_8	87.33	73.00	83.67	**81.33**
	T_9	92.33	78.67	84.67	**85.22**
	Mean	**89.37**	**74.48**	**82.52**	**82.12**

For comparing the means of	S.Em. ±	CD @ 5%
V	0.33	0.93
T	0.57	1.61
V × T	0.98	2.79
CV (%)	2.07	

V1: GW 1, V2: GW 1346, V3: GADW 3, T1 : Control , T2 : KNO3 (1%) priming, T3 : Salicylic Acid (100 ppm) priming, T4 : CaCl2 (250 ppm) priming, T5 : H2O2 (100 mM) priming, T6 : Sodium Lauryl Sulphate coating, T7 : Calcium Peroxide coating, T8 : Bacillus subtilis coating, T9 : Bio NPK coating

Table 2: Effect of Different Pre-sowing Seed Treatments and Wheat Varieties on Seedling length (cm)

Varieties (V)		V_1	V_2	V_3	Mean
Treatments (T)	T_1	11.28	10.04	11.16	**10.83**
	T_2	13.02	11.37	12.52	**12.30**
	T_3	10.36	9.19	10.12	**9.89**
	T_4	11.58	10.47	11.18	**11.07**
	T_5	11.74	10.63	11.44	**11.27**
	T_6	12.31	11.22	12.01	**11.85**
	T_7	10.64	9.90	11.22	**10.59**
	T_8	11.54	10.21	11.56	**11.10**
	T_9	12.00	11.11	11.71	**11.60**
	Mean	**11.61**	**10.46**	**11.44**	**11.17**

For comparing the means of	S.Em. ±	CD @ 5%
V	0.07	0.21
T	0.13	0.36
V × T	0.22	NS
CV (%)	3.38	

V1: GW 1, V2: GW 1346, V3: GADW 3, T1 : Control , T2 : KNO3 (1%) priming, T3 : Salicylic Acid (100 ppm) priming, T4 : CaCl2 (250 ppm) priming, T5 : H2O2 (100 mM) priming, T6 : Sodium Lauryl Sulphate coating, T7 : Calcium Peroxide coating, T8 : Bacillus subtilis coating, T9 : Bio NPK coating

Table 3: Effect of Different Pre-sowing Seed Treatments and Wheat Varieties on Seedling Dry Weight (g)

Varieties (V)		V_1	V_2	V_3	Mean
Treatments (T)	T_1	0.130	0.100	0.110	**0.113**
	T_2	0.177	0.130	0.147	**0.151**
	T_3	0.115	0.093	0.105	**0.104**
	T_4	0.145	0.110	0.115	**0.123**
	T_5	0.155	0.105	0.125	**0.128**
	T_6	0.170	0.110	0.150	**0.143**
	T_7	0.140	0.095	0.120	**0.118**

	T_8	0.145	0.095	0.125	**0.122**
	T_9	0.165	0.120	0.135	**0.140**
	Mean	**0.149**	**0.106**	**0.126**	**0.127**

For comparing the means of	S.Em. ±	CD @ 5%
V	0.002	0.004
T	0.003	0.008
V × T	0.005	0.013
CV (%)	6.47	

V1: GW 1, V2: GW 1346, V3: GADW 3, T1 : Control , T2 : KNO3 (1%) priming, T3 : Salicylic Acid (100 ppm) priming, T4 : CaCl2 (250 ppm) priming, T5 : H2O2 (100 mM) priming, T6 : Sodium Lauryl Sulphate coating, T7 : Calcium Peroxide coating, T8 : Bacillus subtilis coating, T9 : Bio NPK coating

Table 4: Effect of Different Pre-sowing Seed Treatments and Wheat Varieties on Seedling Vigour Index I

Varieties (V)		V_1	V_2	V_3	Mean
Treatments (T)	T_1	958.99	719.25	896.39	**858.21**
	T_2	1245.47	920.70	1114.62	**1093.60**
	T_3	849.65	643.56	742.03	**745.08**
	T_4	1037.90	771.02	886.67	**898.53**
	T_5	1076.06	794.03	961.33	**943.81**
	T_6	1165.32	852.77	1064.79	**1027.63**
	T_7	913.61	709.77	893.65	**839.01**
	T_8	1007.61	745.50	967.53	**906.88**
	T_9	1107.54	873.69	991.46	**990.90**
	Mean	**1040.24**	**781.14**	**946.50**	**922.63**

For comparing the means of	S.Em. ±	CD @ 5%
V	6.67	18.96
T	11.55	32.84
V × T	20.00	56.88
CV (%)	3.76	

V1: GW 1, V2: GW 1346, V3: GADW 3, T1 : Control , T2 : KNO3 (1%) priming, T3 : Salicylic Acid (100 ppm) priming, T4 : CaCl2 (250 ppm) priming, T5 : H2O2 (100 mM) priming, T6 : Sodium Lauryl Sulphate coating, T7 : Calcium Peroxide coating, T8 : Bacillus subtilis coating, T9 : Bio NPK coating

Table 5: Effect of Different Pre-sowing Seed Treatments and Wheat Varieties on Seedling Vigour Index II

Varieties (V)		V_1	V_2	V_3	Mean
Treatments (T)	T_1	11.04	7.17	8.84	**9.02**
	T_2	16.90	10.51	13.05	**13.49**
	T_3	9.42	6.54	7.71	**7.89**
	T_4	12.98	8.11	9.13	**10.07**
	T_5	14.21	7.84	10.50	**10.85**
	T_6	16.08	8.35	13.30	**12.58**
	T_7	12.03	6.81	9.55	**9.46**

T_8	12.67	6.94	10.46	**10.02**
T_9	15.23	9.44	11.43	**12.04**
Mean	**13.40**	**7.97**	**10.44**	**10.60**

For comparing the means of	S.Em. ±	CD @ 5%
V	0.12	0.35
T	0.22	0.61
V × T	0.37	1.06
CV (%)	6.08	

V1: GW 1, V2: GW 1346, V3: GADW 3, T1 : Control , T2 : KNO3 (1%) priming, T3 : Salicylic Acid (100 ppm) priming, T4 : CaCl2 (250 ppm) priming, T5 : H2O2 (100 mM) priming, T6 : Sodium Lauryl Sulphate coating, T7 : Calcium Peroxide coating, T8 : Bacillus subtilis coating, T9 : Bio NPK coating

ATPase activation, RNA synthase and acid phosphatase which resulted in higher seedling dry weight**.** The results recorded in the present study are in coincidence with the findings of Abnavi and Ghobadi (2012), Jabbarpour *et al.*, (2014), Kalpana *et al.*, (2015) and Singh *et al.*, (2017a) in wheat.

KNO_3 priming treatment might have resulted in abundant production of photosynthates resulting in high vigour index. Seed priming partially mitigates the harmful effect of salinity by increasing vigour, antioxidative enzyme activity and accumulation of osmolytes. May be the application of KNO_3 increase the seedling growth by attributing to the increased amino acid content in embryo and stimulate the synthesis of hydrolytic enzymes required for digestion of endospermic starch at seed germination. Similar results are also reported by Sarlach *et al.*, (2013), Singh *et al.*, (2017a), Steiner *et al.*, (2018) and Mirza *et al.*, (2021) in wheat.

The significantly highest seedling vigour index II (13.49) was recorded by KNO_3 (1 %) (T_2) this might be due to increase in seedling dry weight. Seed priming presumably permitted cell membrane repair caused by deterioration at salinity stress. This exerted better germination pattern and higher vigour level comparatively to control, KNO_3 primed seeds ultimately produced the vigorous seedlings with increased seedling dry weight of wheat genotypes. These results are in agreement with the findings of Sarlach *et al.*, (2013) and Singh *et al.*, (2017a) in wheat.

Conclusion

Pre-sowing seed treatments alleviate abiotic stress during germination and seedling growth. Priming with KNO_3 followed by sodium lauryl sulphate coating was observed to enhance seed quality parameters in durum wheat varieties. Hence, pre-sowing seed treatments were found to be effective to curtail the abiotic stress by enhancing the seed quality parameters *viz*, germination and vigour.

Author contributions

The conceptualization of research (N.R., K.P. and M.P.); Designing of the experiments (N.R., K.P. and M.P.); Execution of field experiments and data collection (N.R., K.P. and M.P.); Analysis of data and interpretation (N.R., K.P. and M.P.); writing–original draft preparation, N.R., K.P. and M.P.; writing–review and editing, N.R., K.P. and M.P.; Preparation of the manuscript (N.R., K.P. and M.P.).

Conflict of interest

No

Declaration

The authors declare no conflict of interest.

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