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Effect of Seed Priming on Growth and Yield of Wheat (*Triticum aestivum* L.) Under Non-Saline Conditions*

[1]I. Rajpar, [2]Y.M. Khanif and [1]A.A. Memon
[1]Department of Soil Science, Faculty of Crop Production,
Sindh Agriculture University Tandojam, Pakistan
[2]Department of Land management, Faculty of Agriculture, University Putra Malaysia,
43400 UPM Serdang, Selangor, Malaysia

Abstract: A field experiment, in non-saline clay soil was performed to determine the effect of seed priming with fresh water and gypsum on the growth, ion (P and K) contents and yield of five wheat cultivars (Mehran-89, T.J-83, Abadgar, Anmol and V-7001). Four seed priming treatments, namely T_1 (No priming), T_2 (seed priming with fresh water), T_3 (seed priming with 0.2% gypsum) and T_4 (seed priming with 0.4% gypsum) were tested. Seed priming treatments had no significant effect on the straw dry weight and ion contents (P and K^+) determined in grains. However, seedlings were significantly faster in emergence, took fewer days to mature and gave significantly higher grain yield per hectare. Seed priming with fresh water and 0.2% gypsum appeared to be the most effective treatments tested. Cultivars did not differ significantly amongst themselves in terms of days to emergence and maturity, straw dry weight, grain yield and ion contents in seed priming treatments. This study demonstrated that prior to sowing, seed priming with fresh water may improve wheat yield under non-saline conditions.

Key words: Seed priming, wheat yield, gypsum, fresh water

Introduction

"On farm" seed priming-soaking seeds overnight in water, surface-drying them then sowing in the normal fashion-markedly improves the stand, establishment, early vigor and yield in range of crops (Harris *et al*., 1999; Mandal *et al*., 1999; Musa *et al*., 1999; Rashid *et al*., 2002). Rapid establishment and greater vigor also results in faster development, earlier flowering and maturity and higher yields (Harris *et al*., 1999). These effects of such simple, low-cost, low-risk intervention also have positive impacts on the wider farming system and the technology has proved to be highly popular with farmers.

Seed priming has been extensively used to improve germination of many plant species (Harris *et al*., 2002). Seed priming is a controlled hydration process that involves exposing seeds to low water potentials that restrict germination but permits pre-germinative physiological and biochemical changes to occur (Bradford, 1986). Upon re-hydration, primed seeds may exhibit faster rate of germination, more uniform emergence, greater tolerance to environmental stress and reduced dormancy in many plant species (Khan, 1992).

The two most common types of priming treatments are osmotic and solid matrix. These priming treatments rely on the osmotic and matrix property of the priming solution or media, respectively. Pre-hydration in water has emerged as a useful and effective priming technique that is cheaper and manageable in comparison to osmotic and matrix treatments (Oluoch and Welbaum, 1996). Seed

Corresponding Author: Y.M. Khanif, Department of Land management, Faculty of Agriculture, University Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

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priming, or osmo-conditioning, is a proven method for increasing the rate of seedling establishment through improved germination speed and uniformity. These benefits are more obvious under poor temperature and/or moisture conditions. Seeds are soaked in an osmotic solution that draws water into the seeds to begin the germination process, but the process is stopped before completion. The primed seeds, when planted, are more likely to germinate than are untreated seeds because they are in a metabolically advanced state.

In Pakistan most of the wheat is sown in the post-monsoon season following the harvest of rice. There are yield decreases if sowing is delayed. Byerlee *et al.* (1987) calculated that about 39 kg ha^{-1} grain yield is lost for every day's delay after the optimal sowing date in Pakistan. Where rice is the previous crop, the need to turn a paddy field into a seedbed for wheat as quickly as possible is paramount, late rice harvesting and long turnaround times are major constraints on wheat yield, often as a result of poor stand establishment which is major constraint on production in many crops. Fields without a reasonable number of well-spaced, vigorous plants cannot be expected to produce good yields, even if other resources are not limiting.

This study was conducted to investigate the potential of seed priming with five cultivars of wheat (Mehran-89, T.J-83, V-7001, Abadgar and Anmol) commonly grown in Sindh.

Materials and Methods

The present investigation was carried out at the field of Agricultural Chemistry Section, Agricultural Research Institute Tando Jam, Pakistan, during, winter, 2003-2004. Prior to sowing the land was prepared thoroughly by plowing (4-5 times), clod crushing and leveling. After preparation, the land was soaked with two heavy irrigations. The experiment was laid out in split-plot design with four replications and four seed priming treatments. Plot size was 33 × 22 m (726 m^2) with 80 sub-plots of 3.8×1.7 m (6.46 m^2) size. Composite soil samples before sowing were collected from two (0-15 and 16-30 cm) soil depths. Soil texture was analyzed using the Bouyoucos hydrometer method. Electrical conductivity (EC_e) and pH were determined following the method of Rowell (1994).

The seed of five wheat cultivars (Mehran-89, V-7001, T.J-83, Anmol and Abadgar) was primed for 10 hours by placing them into the fresh water (T_2), 0.2% gypsum (T_3) and 0.4% gypsum (T_4). Prior to sowing, the primed seed was air-dried back to its original moisture content. Sowing was done by hand drilling method. The recommended rate of nitrogen (150 kg N ha^{-1}) was applied in the form of Urea and diammonium phosphate (DAP). Urea was applied in three splits (at sowing, at 1st irrigation and at 2nd irrigation). Phosphorus at the rate of 75 kg P_2O_5 ha^{-1} was applied in the form of DAP at the time of sowing only.

At maturity three plants from each treatment of all replications were harvested at random. Ears were separated from straw, placed in separate paper bags and oven-dried at 78°C for 48 h. Grains were separated from ears by threshing with hands. Straw and grain yields were recorded. Grain samples were prepared by ash digestion and concentrations of phosphorus and potassium were determined by spectrophotometer and flame photometer respectively. All plant data were subjected to analysis of variance and the significant differences between means were tested by calculating Least Significant Difference (LSD) values at 5% probability level.

Results and Discussion

The results indicated no marked variation in topsoil and subsoil properties (Table 1). At both (0-15 and 15-30 cm) depths the soil was clay in texture, moderately alkaline in reaction, calcareous in nature, non-saline and non-sodic. Although, soil had chlorides and bicarbonates at both depths, the

Table 1: Some physico- chemical properties of experimental soil (before sowing)

	0-15 cm			15-30 cm		
Texture	Sand (%)	Silt (%)	Clay (%)	Sand (%)	Silt (%)	Clay (%)
	30	24	46	33	25	42
Textural Class	-	Clay	-	-	Clay	-
ECe (dS m^{-1})	-	1.67	-	-	0.82	-
pH (1:2.5)	-	7.54	-	-	7.63	-
$CaCO_3$ (%)	-	8.33	-	-	7.66	-

Table 2: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on days to emergence of five wheat cultivars

	Cultivars					
Treatment	Mehran-89	V-7001	T.J-83	Anmol	Abadgar	Mean
Control	8.00	7.50	7.75	7.50	7.25	7.60
Fresh water	6.75	6.25	5.75	5.75	6.00	6.10
0.2% Gypsum	7.00	6.25	6.50	6.25	5.50	6.30
0.4% Gypsum	7.50	7.25	6.75	6.75	5.00	6.65
Mean	7.31	6.81	6.69	6.56	5.94	
Factors	SED	LSD				
Seed priming	0.227	0.460**				
Cultivars	0.239	0.522**				
Seed priming*cultivars	0.507	NS				

Table 3: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on days to maturity taken by five wheat cultivars

	Cultivars					
Treatment	Mehran-89	V-7001	TJ-83	Anmol	Abadgar	Mean
Control	115.75	116.00	116.00	116.25	115.25	115.85
Fresh water	110.50	110.25	110.00	110.50	110.50	110.35
0.2% Gypsum	111.25	111.50	111.50	111.25	111.50	111.40
0.4% Gypsum	111.75	111.00	111.25	110.75	110.50	111.05
Mean	112.31	112.19	112.19	112.19	111.94	
Factors	SED	LSD				
Seed priming	0.3812	0.7735**				
Cultivars	0.2923	N S				
Seed priming*cultivars	0.8524	N S				

values observed were still in the range of non-saline soils (USSL, 1954). The calcium and magnesium contents in soil at both depths were adequate enough for wheat growth (Rajpar and Wright, 2000).

The effect of seed priming treatments on days to emergence (Table 3) and maturity (Table 4) was significant ($p<0.05$). Compared to the control, seedlings in priming treatments took significantly fewer days to emerge and reached maturity earlier (Table 2). The increase in the rate of emergence and early maturity in seed priming treatments was possibly due to advancement in metabolic state (Oluoch and Welbaum, 1996; Harris *et al*., 1999). This advancement in maturity is desirable in semi-arid and tropical countries, where wheat is grown as winter crop and hot and dry climate during grain filling in April often result in premature ripening, leading to substantial yield losses (Rajpar and Wright, 2000). It is also evident from the reports of other workers including, Ashraf and Foolad (2005) that during seed germination, the soil environment does not often remain conducive to rapid germination and seedling growth, possibly due to several biotic and a-biotic stresses.

The plants established from primed seed were significantly taller in height (Table 5) and produced significantly higher grain yield per hectare (Table 6). It is well documented (Harris *et al*., 1999) that seed priming markedly improves stand, establishment and early vigor in several crop species, which results in faster development, earlier flowering and maturity and higher yields.

Table 4: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on plant height (cm) at maturity of five wheat cultivars

	Cultivar					
Treatment	Mehran-89	V-7001	TJ-83	Amnol	Abadgar	Mean
Control	90.20	96.80	98.70	103.10	103.30	98.42
Fresh water	92.70	101.80	99.60	105.52	103.80	100.68
0.2% Gypsum	93.23	98.40	96.25	106.10	99.10	98.62
0.4% Gypsum	101.30	99.30	97.30	97.90	99.80	99.12
Mean	94.36	99.08	97.96	103.16	101.50	
Factor	SED	LSD				
Seed priming	0.555	1.127**				
Cultivars	0.699	1.53**				
Seed priming*cultivars	1.242	2.52**				

Table 5: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on straw yield of five wheat cultivars

	Cultivar					
Treatment	Mehran-89	V-7001	TJ-83	Amnol	Abadgar	Mean
Control	2918.7	2888.7	2910.3	2882.0	2882.5	2896.4
Fresh water	2977.0	3207.5	2989.9	3008.8	3186.8	3074.0
0.2% Gypsum	2926.9	3048.2	2918.4	2935.6	3030.1	2971.9
0.4% Gypsum	2946.1	2934.8	2937.1	2950.2	2932.4	2940.1
Mean	2942.2	3019.8	2938.9	2944.2	3008.0	
Factor	SED	LSD				
Seed priming	78.07	NS				
Cultivars	70.16	NS				
Seed priming*cultivars	174.56	NS				

Table 6: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on grain yield of five wheat cultivars

	Cultivar					
Treatment	Mehran-89	V-7001	TJ-83	Amnol	Abadgar	Mean
Control	2323.7	2171.8	2569.9	2693.5	2586.2	2469.0
Fresh water	2896.0	2979.4	3019.6	2944.4	3203.4	3008.5
0.2% Gypsum	2683.3	2661.8	2963.6	2822.5	2634.0	2753.0
0.4% Gypsum	2834.7	2613.3	3103.3	2910.8	3031.0	2898.6
Mean	2684.4	2606.6	2914.1	2842.8	2863.7	
Factors	SED	LSD				
Seed priming	125.15	253.93***				
Cultivars	142.08	NS				
Seed priming*cultivars	279.85	NS				

The effects were more promising when seeds were primed with fresh water than with 0.2 and 0.4% gypsum. Among, the 2 gypsum treatments, seed primed with 0.2% gypsum tended to be more effective than with 0.4% gypsum. This was possibly due to the hydration process, which can cause marked biochemical changes in seed such as breakdown and transport of reserve materials, especially transport from endosperm to the growing parts of the embryo and synthesis of new materials (Mayer and Polijakoff-Mayber, 1989). According to Mayer and Polijakoff-Mayber, (1989) that the desiccated seed is well-equipped functional unit that can undergo many biochemical reactions if the initial hydration of proteins in particular enzyme proteins has taken place

Averaged overall seed priming treatments, the difference between cultivars was significant ($p<0.05$) for days from sowing to emergence, plant height and ion contents. Cultivar Abadgar was earlier and Mehran-89 was later in emergence than other test cultivars. The effect of interaction of seed priming treatments*cultivars for most of the parameters remained non-significant.

Table 7: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on P content of grains of five wheat cultivars

	Cultivar					
Treatment	Mehran-89	V-7001	T.J-83	Anmol	Abadgar	Mean
Control	0.322	0.327	0.311	0.335	0.333	0.326
Fresh. Water	0.335	0.336	0.329	0.384	0.351	0.347
0.2% Gypsum	0.325	0.345	0.322	0.350	0.345	0.337
0.4% Gypsum	0.330	0.327	0.305	0.335	0.333	0.326
Mean	0.328	0.334	0.317	0.351	0.341	
Factor	SED	LSD				
Seed priming	0.017	NS				
Cultivars	0.010	0.022*				
Seed priming*cultivars	0.037	NS				

Table 8: Effect of seed priming with fresh water, 0.2% gypsum and 0.4% gypsum on K^+ contents in grains of different wheat cultivars under non-saline conditions

	Cultivars					
Treatment	Mehran-89	V-7001	T.J-83	Anmol	Abadgar	Mean
Control	0.580	0.590	0.560	0.600	0.600	0.590
Fresh Water	0.600	0.610	0.590	0.690	0.630	0.620
0.2% Gypsum	0.580	0.620	0.580	0.630	0.620	0.610
0.4% Gypsum	0.590	0.590	0.550	0.600	0.600	0.590
Mean	0.590	0.600	0.570	0.630	0.610	
Factor	SED	LSD				
Seed priming	0.0303	NS				
Cultivars	0.0178	0.039*				
Seed priming*cultivars	0.068	NS				

The effect of seed priming treatments and the interaction of seed priming *cultivars for P and K^+ contents (Table 7) in grains was not significant. However, the difference between cultivars for P and K^+ contents of grain was significant ($p<0.05$). Cultivars TJ-83 and Mehran-89 accumulated significantly lower P and K^+ in grains than other three cultivars. That was possibly due to genetic variability amongst the cultivars.

Conclusions

This study demonstrated that prior to sowing, seed priming with fresh water can improve wheat yield under non-saline conditions.

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