To Evaluate the Performance of Bread Wheat Genotypes as Affected by Seed Priming Duration

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Abstract: Seed priming has been found effective to affect seed dormancy and improve germination. During this experiment two wheat genotypes (TD-1 and Kiran-95) were evaluated against treatments based on 05 seed priming durations (P_1=0 hr (control), P_2=6 hrs, P_3=9 hrs, P_4=12 hrs and P_5=18 hrs) in four replicated RCBD at Agronomy experimental fields, ARI Tandojam. The traits related to crop growth and yield regardless of genotypes were significantly affected by the seed priming durations; while treatment interaction was non-significant (P>0.05). TD-1 wheat genotype proved to be superior in grain yield and associated as well as in harvest index with maximum germination (69.05/m^2), grain yield 4300.10 kg/ha and 50.99% harvest index as compared to genotype Kiran-95 with66.82/m^2 germination, grain yield 3784.20 kg/ha and 41.16% harvest index. Seed priming impact showed that 12 hrs seed priming was more effective than other durations with 76.933/m^2 seed germination, 4654.40 kg/ha grain yield and 50.37% harvest index; while 18 hrs seed priming resulted in 69.82 m^{-2} seed germination, 4278.40 kg/ha grain yield and 46.08% harvest index. The crop sown under 9 or 6 hrs seed priming produced lower values for all the traits; while the control remained the least. It was concluded that seed priming practice has proved to be highly beneficial for all the traits studied including grain yield, and the seed soaked for 12 hrs showed better results with higher grain yield of 4654 kg ha^{-1} and 50.37% harvest index as compared to rest of seed priming durations and control; while increasing seed priming duration up to 18 hrs affected the crop traits adversely. In varieties, the dwarf variety TD-1 showed r higher grain yield of 4300.10 kg ha^{-1} than Kiran-95 (3705.30 kg ha^{-1}).

Keywords: Wheat, genotypes, seed priming duration, growth, yield, harvest index.

INTRODUCTION

Wheat (*Tritium aestivum* L.) is a cereal crop, provides 20% of the total energy needs in human food [1] and wheat flour is used for making bread, baked foods as well as fermented for making beer and alcohol [2] Wheat contribution to value addition in agriculture about 9.9 percent and contributes 2.0 percent to Pakistan GDP. During 2015-16 wheat cultivation was recorded as 9260 thousand hectares; while it was 9204 thousand hectares in the last year registering 0.6 percent increase. Wheat production stood at 25.482 million tons in the year 2015-16 registering an increase of 1.6 percent over wheat produced (25.086 million tons) in the preceding year [3]. Seed germination and seedling establishment are critical stages in plant life cycle. The stand establishment determines the plant density, uniformity and management options in crop production [4]. Priming is a method that improves the rate and uniformity of seed germination [5] in this technique, the seed is soaked in solution of any priming agent and after certain duration of priming, the seeds are dried that initiates germination processes without radical emergence [6]. Several seed priming options have been introduced which include soaking seed in plain water (hydro-priming), seed soaking in solutions of inorganic salts (halo-priming), seed soaking in solutions of organic osmotic (osmo-priming), seed treatment with temperatures (thermo-priming), seed treatment with solid matrix (solid matrices priming) and seed hydration by biological compounds (bio-priming) [7]. Found that seed priming has been used for improving germination, reducing time in seedling emergence and improving stand establishment and grain yield in wheat [8] demonstrated the beneficial impacts of seed soaking on several field crops and these effects are associated with repair and buildup of nucleic acids, increasing protein synthesis as well as membrane repair [9-11] noted that priming enhances the anti-oxidative activities of enzymes in seed;

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MATERIALS AND METHODS

The experiment was laid out at Agronomy Section of ATI Tandojam in 2015, in 04 replication through RCBD and the plot size was 2m x 3m ($6m^2$). The seedbed was prepared for sowing of wheat. The seed of two wheat varieties (TD-1 and Kiran-95) were soaked for different durations (0, 6, 9, 12 and 18 hrs) before sowing. The experimental land was plowed up in off-season and kept open for drying weeds and crushing of clods. After soaking dose all recommended field operations were adopted and finally rotavator followed by planking were operated to obtain desired quality seedbed. All P (as SSP) and $1/3^{rd}$ N were applied at the time of sowing by mixing in soil and remaining $1/3^{rd}$ of N at 1^{st} irrigation and $1/3^{rd}$ of N was applied at 2^{nd} irrigation in the form of urea. The sowing was done with single coulter hand drill at the seeding rate of 125 kg ha^{-1} on 11^{h} November, 2014 maintaining 22.5cm spacing between rows. The first irrigation was given at crown root initiation (21 days after sowing) and later the crop was irrigated on need basis.

RESULTS AND DISCUSSION

Germination (m^{-2})

The germination was significantly ($P<0.05$) influenced by varieties and seed priming durations; while the interactive effect of varieties × seed priming duration was non-significant ($P>0.05$). The results indicated that the seed germination in variety TD-1 was significantly ($P<0.05$) higher (69.05 m^{-2}) than variety Kiran-95 with seed germination of 66.83 m^{-2}. The effect of seed priming duration indicated that seed soaked for 12 hours resulted in maximum seed germination (76.933 m^{-2}), followed by seed priming for 18 hours and 9 hours with average seed germination of 69.82 m^{-2} and 67.86 m^{-2}, respectively. However, the minimum seed germination (59.78 m^{-2}) was observed in control, where the seed was sown without priming. The interactive effect indicated that interaction of variety TD-1 × 12 hrs priming resulted in maximum seed germination (76.933 m^{-2}) and the interaction of variety Kiran-95 × no seed priming (control) resulted in lowest seed germination (58.56 m^{-2}). It was observed that seed viability was better in case of variety TD-1 than the seed of variety Kiran-95; while with increasing seed priming duration upto 12 hours, the seed germination improved significantly and germination decreased with increasing seed priming duration upto 18 hours. Hence, for achieving maximum germination, the wheat seed may be soaked for 12 hours

Plant Height (cm)

The plant height was significantly ($P<0.05$) affected by varieties and seed priming duration; while the effect of varieties × seed priming duration interaction was non-significant ($P>0.05$). Wheat variety Kiran-95 produced greater plant height of 97.69 cm than variety Kiran-95 (67.35 cm). The effect of seed priming duration indicated that seed soaked for 12 hours produced maximum plant height of 86.71 cm, followed by seed priming for 18 hours and 9 hours with average plant height of 85.12 cm and 84.24 cm, respectively. However, the minimum plant height of 75.95 cm was observed in control, where the seed was sown without priming. The interactive effect showed that interaction of variety Kiran-95 × 12 hrs priming produced

Table 1: Effect of Seed Priming Durations on Germination (m^{-2}) of Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	61.00	62.25	69.25	78.50	71.25	69.05^{a}
Kiran-95	58.56	62.64	66.48	75.36	68.40	66.82^{b}
Mean	59.78^{e}	63.94^{d}	67.86^{c}	76.933^{a}	69.82^{b}	

Table 2: Effect of Seed Priming Durations on Plant Height (cm) of Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	61.75	65.50	68.50	70.50	70.50	67.35^{b}
Kiran-95	90.16	95.63	100.01	100.93	99.75	97.69^{a}
Mean	75.95^{d}	80.56^{c}	84.24^{v}	86.71^{a}	85.12^{a}	

Table 3: Effect of Seed Priming Durations on Tillers m^{-2} of Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	301.00	317.50	328.50	352.25	340.50	327.95[a]
Kiran-95	267.89	282.57	292.36	313.50	303.05	291.88[b]
Mean	284.45[e]	300.04[d]	310.43[c]	332.88[a]	321.77[b]	

maximum plant height of 100.93 cm and the interaction of variety TD-1 × no seed priming (control) produced minimum plant height of 61.75 cm. It was observed that the effect of seed priming duration up to 12 hours on plant height was positive, but further increase in seed priming duration showed adverse impact on plant height of wheat.

Tillers m^{-2}

The tillers m^{-2} were significantly ($P<0.05$) influenced by varieties and seed priming duration; and their interactive effect (varieties × seed priming duration) on this trait was non-significant ($P>0.05$). It is evident from the results that wheat variety Kiran-95 produced more tillers of 327.95 m^{-2} than variety Kiran-95 (67.35). The effect of seed priming duration showed that seed soaked for 12 hours produced maximum tillers of 332.88 m^{-2}, followed by seed priming for 18 hours and 9 hours with 321.77 and 310.43 average tillers m^{-2}, respectively. However, the minimum number of tillers of 284.45 m^{-2} was observed in control (no seed priming). The interaction study showed that TD-1 × 12 hrs priming interaction resulted in maximum tillers m^{-2} (352.25) and Kiran-95 × Control (no seed priming) resulted in minimum tillers m^{-2} (267.89). It was noted that seed priming practice showed a marked impact on the tillering capacity of wheat and up to 12 hours seed priming, the tillers m^{-2} improved significantly; but increasing seed priming duration beyond 12 hours resulted a negative impact on tillering capacity.

Spike Length (cm)

The significant ($P<0.05$) impact of varieties and seed priming duration on spike length; and the spike length remained almost unaffected ($P>0.05$) due to varieties × seed priming duration interaction. The results showed that in varieties, TD-1 produced spikes of greater length (12.52 cm) than variety Kiran-95 producing spike length of 10.64 cm. In case of seed priming durations, the spike length of was highest (12.93 cm) under 12 hours seed priming practice, followed by 12.12 cm and 12.08 cm spike length observed under 18 hours and 9 hours seed priming practice, respectively. However, the minimum spike length of 9.40 cm was observed in control, where the seed was sown without priming. The interactive effect showed that variety TD-1×12 hours seed priming interaction produced maximum spike length of 13.98 cm and Kiran-95 × no seed priming (control) interaction produced minimum spike length of 8.364 cm. It was noted that seed priming for 12 hours produced excellent results to produce higher spike length; while further increase in seed priming duration up to 18 hours showed adverse impact on spike length.

Grains $Spike^{-1}$

The significant ($P<0.05$) effect of varieties and seed priming duration on grains $spike^{-1}$; while non-significant ($P>0.05$) effect of variety × seed priming duration interaction on grains $spike^{-1}$ was observed. It is apparent from the results (Table **5**) that TD-1 produced more grains $spike^{-1}$ (41.34) than variety Kiran-95 (35.14). In seed priming durations, the grains $spike^{-1}$ were highest (42.68) under 12 hour seed priming practice, followed by 40.00 and 39.89 grains $spike^{-1}$ observed under 18 hours and 9 hours seed priming practice, respectively. However, the lowest number of grains $spike^{-1}$ (31.04) was noted in control, where seed

Table 4: Effect of Seed Priming Durations on Spike Length (cm) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	10.17	12.31	13.07	13.98	13.10	12.52[a]
Kiran-95	8.364	10.47	11.10	11.88	11.14	10.64[b]
Mean	9.40[c]	11.39[c]	12.08[b]	12.93[a]	12.12[b]	

Table 5: Effect of Seed Priming Durations on Spike Length (cm) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	33.56	40.65	43.143	46.14	43.24	41.34[a]
Kiran-95	28.53	34.55	36.66	39.22	36.375	35.14[b]
Mean	31.04[d]	37.60[c]	39.89[b]	42.68[a]	40.00[b]	

was not soaked before sowing. The TD-1 × 12 hour seed priming interaction resulted in maximum grains spike^{-1} (46.14) and minimum grains spike^{-1} (28.53) were observed in Kiran-95 × Control interaction. These more grains spike^{-1} under 12 hour seed priming and in variety TD-1 were mainly associated with spike length. This showed that seed priming for 12 hours proved to be an optimum priming duration for this trait.

Grain Weight Spike^{-1}

The grain weight spike^{-1} was significantly (P<0.05) affected by varieties and seed priming duration; while effect of variety × seed priming duration interaction was non-significant (P>0.05). It is clear from the results (Table **6**) that TD-1 produced higher grain weight spike^{-1} (4.13 g) than variety Kiran-95 (3.51 g). In case of seed priming durations, the grain weight spike^{-1} were highest (4.26 g) under 12 hour seed priming practice, followed by 4.00 g and 3.99 g grain weight spike^{-1} recorded under 18 hours and 9 hours seed priming practice, respectively. However, the lowest grain weight spike^{-1} (3.10 g) was recorded in control, where seed was not soaked before sowing. The TD-1 × 12 hour seed priming interaction resulted in highest grain weight spike^{-1} (4.60 g) and minimum grain weight spike^{-1} (2.85 g) was observed in Kiran-95 × no seed priming interaction. This higher grain weight spike^{-1} under 12 hour seed priming and in variety TD-1 was mainly associated with spike length and number of grains spike-1. It was observed that grain weight spike^{-1} improved with increasing seed priming upto 12 hours; and further increase in priming duration did not show positive impact on weight of grains spike^{-1}.

Biological Yield ha^{-1}

Biological yield was significantly (P<0.05) influenced by varieties and seed priming duration; while the interaction of variety × seed priming duration for this trait was non-significant (P>0.05). The data in Table **7** exhibited that variety Kiran-95 produced higher biological yield ha^{-1} (9169.50 kg) than variety TD-1 (8412.40 kg). The treatment effect indicated that the biological yield ha^{-1} were highest (9327.90 kg) under 18 hour seed priming practice, followed by 9281.70 and 8936.60 kg biological yield ha^{-1} recorded under 12 hours and 9 hours seed priming practice, respectively. However, the lowest biological yield ha^{-1} (7735.90 kg) was obtained in control, where un-soaked seed was sown. The interaction study showed that The Kiran-95 × 18 hour seed priming interaction resulted in highest biological yield ha^{-1} (9729.60 kg) and minimum biological yield ha^{-1} (7402.80 kg) was observed in TD-1 × Control (no seed priming) interaction. This higher biological yield ha^{-1} in variety Kiran-95 was mainly associated with increased plant height, because TD-1 is a dwarf variety and Kiran-95 produced plants of maximum height.

Grain Yield ha^{-1}

The grain yield was significantly (P<0.05) affected by varieties and seed priming durations; while the interactive effect of variety × seed priming duration for grain yield ha^{-1} was non-significant (P>0.05). The results in Table **8** showed that the grain yield ha^{-1} was significantly higher (4300.10 kg) in variety TD-1 than variety Kiran-95 which produced grain yield of 3784.20 kg ha^{-1}. Under seed priming treatments, the grain yield

Table 6: Effect of Seed Priming Durations on Grain Weight Spike^{-1} (g) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	3.35	4.06	4.31	4.60	4.32	4.13 a
Kiran-95	2.85	3.45	3.66	3.92	3.67	3.51 b
Mean	3.10 d	3.76 c	3.99 b	4.26 a	4.00 b	

Table 7: Effect of Seed Priming Durations on Biological Yield (kgha^{-1}) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	7402.80	8299.00	8551.80	8882.00	8926.30	8412.40^{b}
Kiran-95	8069.00	9045.90	9321.40	9681.40	9729.60	9169.50^{a}
Mean	7735.90^{d}	8672.50^{c}	8936.60^{b}	9281.70^{a}	9327.90^{a}	

Table 8: Effect of Seed Priming Durations on Grain Yield (kgha^{-1}) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	3556.00	4009.80	4432.30	4951.50	4551.50	4300.0^{a}
Kiran-95	3129.30	3528.60	3900.40	43571.30	4005.30	3784.2^{b}
Mean	3342.60^{d}	3769.20^{c}	4166.30^{b}	4654.40^{a}	4278.40^{b}	

ha^{-1} was highest (4654.40 kg) under 18 hour seed priming practice, followed by 4278.40 and 4166.30 kg grain yield ha^{-1} recorded less than 18 hours and 9 hours seed priming practice, respectively. However, the minimum grain yield ha^{-1} (3342.60 kg) was obtained in control, where seed was sown without priming. The interactive effect indicated that TD-1 × 12 hour seed priming produced highest grain yield ha^{-1} (4951 kg) and minimum grain yield ha^{-1} (3129.30 kg) was obtained in TD-1 × Control (no seed priming) interaction. This higher grain yield ha^{-1} in variety TD-1 under 12 hour seed priming treatment was mainly associated increased with germination, plant tallness, tillering, spike length, grains and grain weight spike^{-1} and seed index.

Seed Index (g)

The seed index value was significantly (P<0.05) influenced by varieties and seed priming duration; while the interactive effect of variety × seed priming duration on seed index was non-significant (P>0.05). It is obvious from the results in Table **9** that the seed index was markedly higher (40.06 g) for wheat variety TD-1 as compared to 37.28 g seed index in variety Kiran-95. In seed priming duration, the seed index was highest (40.71 g) under 12 hour seed priming practice, followed by average seed index of 39.16 g and 38.90 g seed index recorded under 18 hours and 9 hours seed priming, respectively. However, the lowest seed index (36.29 g) was noted in control, where seed was not soaked before sowing. The interaction of TD-1 × 12 hour seed priming resulted in highest seed index (42.18 g) and minimum seed index (34.98 g) was observed in Kiran-95 × no seed priming interaction. This higher seed index under 12 hour seed priming and in variety TD-1 was mainly associated with weight of grains spike^{-1}. The results suggested that the impact of seed priming duration on the seed index value was considerable. However, seed priming beyond 12 hours adversely affected this trait. Hence, 12 hour seed priming treatment, regardless the wheat variety was an optimum seed priming duration. Bolder grains were also reported by [12-14] who found that seedlings emerged from soaked seed resulted in healthy crop and heavier and bolder seeds.

Harvest Index (g)

The harvest index was significantly (P<0.05) affected by varieties and seed priming duration; while non-significant (P>0.05) for variety × seed priming

Table 9: Effect of Seed Priming Durations on Seed Index (g) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	37.61	39.62	40.31	42.18	40.58	40.08^{a}
Kiran-95	34.98	36.84	37.49	39.23	37.74	37.26^{b}
Mean	36.29^{d}	38.23^{c}	38.90^{b}	40.71^{a}	39.16^{b}	

Table 10: Effect of Seed Priming Durations on Harvest Index (%) Wheat Varieties

Varieties	Seed Priming Durations					
	Control	6 hrs	9 hrs	12 hrs	18 hrs	Mean
$T.D_1$	48.07	48.31	51.83	55.74	50.99	50.99[a]
Kiran-95	38.81	39.30	41.84	45.00	41.17	41.16[b]
Mean	43.44[c]	43.66[c]	46.83[b]	50.37[a]	46.08[b]	

duration interaction. The harvest index was markedly higher (50.99%) for wheat variety TD-1 as compared to 41.16% in variety Kiran-95. In seed priming duration, the harvest index was highest (50.37%) under 12 hour seed priming practice, followed by 46.83 and 46.08% harvest index under 9 hours and 18 hours seed priming, respectively. However, the lowest harvest index (43.44%) was noted in control, where seed was not soaked before sowing. The interaction of TD-1 × 12 hour seed priming resulted in highest harvest index (55.74%) and minimum harvest index (38.81%) was observed in Kiran-95 × Control. The results suggested that the impact of seed priming duration on the harvest index was well established. However, seed priming for 18 hours adversely affected this character. Hence, 12 hour seed priming treatment was an optimum seed priming duration.

CONCLUSIONS

It was concluded that seed priming practice has proved to be highly beneficial for all the studied traits and the seed soaked for 12 hours showed better results with higher grain yield of 4654 kg ha^{-1} and 50.37% harvest index as compared to rest of seed priming durations and control; while increasing seed priming duration up to 18 hours affected the crop traits adversely. In varieties, the dwarf variety TD-1 showed remarkably higher grain yield of 4300.10 kg ha^{-1} than Kiran-95 (3705.30 kg ha^{-1}).

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