Forage Res., **51**(1) : pp. 47-51 (2025) **http://forageresearch.in**

SEED PRIMING AS A TOOL TO ENHANCE STOVER YIELD IN LATE-SOWN WHEAT

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(Received: 3 June 2025; Accepted: 29 June 2025)

SUMMARY

The experiment was carried out at CCS HAU, Regional Research Station, Bawal during *Rabi*, 2023-24 to study the effect of seed priming on wheat under late sown condition. The experiment was comprised of thirteen Seed priming (SP) treatments *viz.*, SP_1: Control, SP_2: Water @ 6hr (hours), SP_3: Water @ 9hr, SP_4: Water @ 12hr, SP_5: KH_2PO_4 @ 1% 6 hr, SP_6: KH_2PO_4 @ 1% 9 hr, SP_7: KH_2PO_4 @ 1% 12hr, SP_8: KNO_3 @ 1% 6 hr, SP_9: KNO_3 @ 1% 9hr, SP_{10}: KNO_3 @ 1% 12hr, SP_{11}: GA_3 @ 50 ppm 6hr, SP_{12}: GA_3 @ 50 ppm 9hr and SP_{13}: GA_3 @ 50 ppm 12hr. Among various treatments, seed priming of wheat with KH_2PO_4 @ 1% 12 hr took minimum number of days to emergence (6.03), anthesis (71.60), grain filling (85.69) and physiological maturity (120.89), while maximum days were taken by control treatment with respect to days to emergence (10.00), anthesis (75.90), grain filling (95.66) and physiological maturity (126.92). Maximum number of grain/spike (50.90), 1000 grain weight (41.61 g), grain yield (49.14 q/ha), straw yield (93.82 q/ha) and biological yield (142.96 q/ha) were obtained by seed priming of KH_2PO_4 @ 1% 12 hr followed by KNO_3 @ 1% 12 hr, while minimum no. of grain/spike (46.33), 1000 grain weight (36.30 g), grain yield (45.64 q/ha), straw yield (84.77 q/ha) and biological yield (130.41 q/ha) were recorded in control. highest gross returns, net returns and B:C ratio was recorded in case of KH_2PO_4 @ 1% 12 hr (Rs. 144,185/ha, Rs. 61,749/ha and 1.75, respectively). While, lowest gross return, net return and B:C ratio was recorded in control (Rs. 132,850/ha, Rs. 51,912/ha, and 1.64, respectively).

Key words: Environmental stresses, emergence, grain filling physiological maturity, wheat and yields

Crop production and quality are frequently challenged by environmental stresses, such as drought, heat, salinity and frost. With global climate change, both the magnitude and the frequency of severe weather events, such as extreme temperatures and reduced precipitation, are predicted to increase (Raza, *et al.* 2019). Such severe events affecting the productivity of various agricultural crops. Among various agricultural crops, wheat is one of the most important staple crops globally due to its nutritional value, economic significance and role in food security. It provides a major source of calories and nutrients for billions of people around the world as mentioned in Table 1.

Wheat is one of the most traded agricultural commodities in the world. Major producers like China, India, Russia and the U.S. contribute to its widespread availability and international trade. In India, it is grown all over from the sea level up to an elevation of 3500 m in the Himalaya. Agriculture is critical to India's economy. More over half of the population lives in villages, where agriculture and animal husbandry are the primary occupations. Animal husbandry and agriculture are inextricably linked in India. It is critical to the socioeconomic development of millions of rural households, consequently making a significant contribution to the national economy. The livestock sector employs 8.8% of the workforce and supports two-thirds of the rural community. The majority of women work in the cattle industry. Thus, improving the livestock industry implies accelerating rural India's economic development. India has the world's biggest cattle population (about 515 million) and the highest milk output (approximately 208 million tonnes), accounting for 22% of worldwide milk production (Singh, 2022). Additionally, this sector has emerged as a critical component in ensuring an equitable and sustainable agriculture system. Furthermore, when urbanization and economic levels rise, there is a parallel increase in demand for animal-sourced food (ASF)

(Nagora *et al.,* 2022). Wheat was sown on approximately 31.83 million ha in India during 2023-24, yielding 113.30 million tonnes with an average productivity of 3559 kg/ha. Wheat was sown on approximately 2.40 million ha in Haryana during 2023-24, yielding 11.20 million tonnes with an average productivity of 4723 kg/ha (Anonymous, 2023). In Haryana, productivity of wheat is low, which needs improvement, the main causes of low productivity of wheat in south western Haryana is its delayed sowing in sizeable area after harvesting the cotton and early pigeon pea *etc*. One of the major obstacles to high yield and production of crop plants is the lack of synchronized crop establishment due to poor weather and soil conditions. On the other hand, seeds are occasionally sown in seedbeds having unfavorable moisture because of the lack of rainfall at sowing time which results in poor and unsynchronized seedling emergence. Due to limited land resources and high population density horizontal expansion of wheat area is not possible. Therefore, increasing production of wheat by vertical ways *i.e.* agronomic management practices may be most suitable, viable and practical approach under such circumstances. (Nagora *et al.*, 2023). Stress at germination stage influence the activity of key germinating enzymes such as á- amylase, protease, and lipase and reduce the capacity of seedling to healthy germination (Bose *et al.*, 2018). Various seed priming techniques have been developed which include hydro-priming, halo-priming, osmo-priming and hormonal priming. The priming technique can be an important method for the production of stress resistant plants. The priming method represents the process of seed hydration with solutions of different osmotic potentials that trigger certain metabolic processes (protein synthesis, repair, or synthesis of new mitochondria) that initiate germination but do not allow the emergence of a radicle (Masondo *et al.*, 2018). In addition, seed priming improves seedling rooting and growth, vigor index and ultimately crop yield (Ellouzi *et al.,* 2021). Water deficit during initial stage of crop results in delayed and erratic seedling emergence and stand establishment and in severe cases, complete inhibition of seedling emergence may also result. There is need to improve the yield of late sown in the existing systems. Seed priming has been shown to improve the performance of late-sown wheat by reducing the time between sowing and seedling emergence and promotes synchronized emergence, improve germination giving better crop stand and final yield. On-farm seed priming is a low-cost and low risk method in which seeds are soaked in water overnight, surface-dried and then sown on the same day while seeds are in a hydrated state (Farooq *et al.*, 2019). Seed priming provides a moisture level sufficient to start pre germination metabolic processes but prevents radical protrusion. Direct benefits due to seed priming includes, faster emergence, better and more uniform stands, more vigorous plants, great tolerance to environmental stress, reduced dormancy, earlier flowering and higher grain yield in many crops (Singh *et al.*, 2015). Considering the limitations of expanding cultivated areas, a remarkable rise in the wheat crop productivity will be needed to achieve this milestone (Reynolds *et al*., 2011). India has a surplus of food grains but a shortfall of feed and fodder. According to studies, high-quality seeds of enhanced fodder kinds are unavailable (Nagora *et al.,* 2022). New wheat varieties are being developed to withstand extreme weather under late sown conditions, like droughts and floods, which is crucial in the face of climate change. Hence choice of variety is also an import aspect in this context. Therefore, experiment has been conducted to assess the effect of seed priming on wheat under late sown condition.

MATERIALS AND METHODS

The experiment was carried out at CCS HAU, Regional Research Station, Bawal during *Rabi,* 2023-24 comprising of thirteen combinations of Seed priming (SP) *viz.,* SP_1: Control, SP_2: Water @ 6hr (hours), SP_3: Water @ 9hr, SP_4: Water @ 12hr, SP_5: KH_2PO_4 @ 1% 6 hr, SP_6: KH_2PO_4 @ 1% 9 hr, SP_7: KH_2PO_4 @ 1% 12hr, SP_8: KNO_3 @ 1% 6 hr, SP_9: KNO_3 @ 1% 9hr, SP_{10}: KNO_3 @ 1% 12hr, SP_{11}: GA_3 @ 50 ppm 6hr, SP_{12}: GA_3 @ 50 ppm 9hr and SP_{13}: GA_3 @ 50 ppm 12hr laid out in RBD design with replications. Seed priming was done by soaking of required quantity of seeds of wheat variety “WH 1124” in tap water. Then the primed seeds were dried in shade to maintain the seed moisture content approximately 12 or 13%. The crop was raised by using all recommended agronomical practices. Mature crop was harvested in the last week of April. The following field observations were recorded. Days taken to emergence, 50 % anthesis, grain filling stage, physiological maturity, Number of grains per spike, 1000 grain weight (g), Biological yield (q/ha), Grain yield (q/ha), Straw yield (q/ha) and economics.

RESULTS AND DISCUSSIONS

Phenological Studies: Data presented in Table 2 showed that seed priming of wheat with KH_2PO_4 @ 1% 12 hr took minimum number of days to emergence (6.03), anthesis (71.60), grain filling (85.69) and physiological maturity (120.89), while maximum days were taken by control treatment with respect to days to emergence (10.00), anthesis (75.90), grain filling (95.66) and physiological maturity (126.92). These findings were supported by Singh *et al.*, 2017 who documented that priming may help seed production under rain fed condition by ensuring fast; improve germination vigorously.

Yield and yield attributes

Among various treatments, maximum no. of grain/spike (50.90), 1000 grain weight (41.61 g), grain yield (49.14 q/ha), straw yield (93.82 q/ha) and biological yield (142.96 q/ha) were obtained by seed priming of KH_2PO_4 @ 1% 12 hr followed by KNO_3 @ 1% 12 hr, while minimum no. of grain/spike (46.33), 1000 grain weight (36.30 g), grain yield (45.64 q/ha), straw yield (84.77 q/ha) and biological yield (130.41 q/ha) were recorded in control. Seed priming is a controlled hydration process followed by re drying that allows seeds to imbibe water and begin internal biological processes necessary for

TABLE 1
Effect of seed priming on phenological stages of wheat under late sown condition

Treatment	Days to emergence	Days to anthesis	Days to grain filling	Days to physiological maturity
Control	10.00	75.90	95.66	126.92
Water @ 6 hr	10.00	75.68	94.87	126.57
Water @ 9 hr	9.00	75.67	93.64	125.80
Water @ 12 hr	9.00	74.67	93.57	125.06
KH_2PO_4 @ 1% 6 hr	8.97	73.25	93.17	124.00
KH_2PO_4 @ 1% 9 hr	7.00	72.30	91.59	119.04
KH_2PO_4 @ 1% 12 hr	6.03	71.60	85.69	120.89
KNO_3 @ 1% 6 hr	8.03	73.25	92.67	122.64
KNO_3 @ 1% 9 hr	7.00	72.36	92.63	122.07
KNO_3 @ 1% 12 hr	7.97	72.10	89.67	121.89
GA_3 @ 50 ppm 6 hr	9.00	74.50	93.45	124.78
GA_3 @ 50 ppm 9 hr	9.03	74.29	93.30	124.69
GA_3 @ 50 ppm 12 hr	8.00	73.56	93.22	124.67
C.D. (p=0.05)	0.34	2.76	2.60	4.06

TABLE 2
Effect of seed priming on yield and yield attributes of wheat under late sown condition

Treatment	No. of grains/ spike	1000 grain weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)
Control	46.33	36.30	45.64	84.77	130.41
Water @ 6 hr	47.69	36.47	45.97	88.22	134.19
Water @ 9 hr	47.94	37.16	46.30	89.23	135.53
Water @ 12 hr	47.99	37.83	47.00	89.66	136.66
KH_2PO_4 @ 1% 6 hr	49.00	38.60	47.75	91.87	139.62
KH_2PO_4 @ 1% 9 hr	50.51	39.28	48.51	93.26	141.77
KH_2PO_4 @ 1% 12 hr	50.90	41.61	49.14	93.82	142.96
KNO_3 @ 1% 6 hr	49.76	38.78	48.00	92.45	140.45
KNO_3 @ 1% 9 hr	49.87	38.90	48.37	93.19	141.56
KNO_3 @ 1% 12 hr	50.75	40.04	48.89	93.67	142.56
GA_3 @ 50 ppm 6 hr	48.44	37.83	47.35	90.24	137.59
GA_3 @ 50 ppm 9 hr	48.97	38.00	47.57	91.26	138.83
GA_3 @ 50 ppm 12 hr	49.00	38.10	47.75	91.84	139.59
C.D. (p=0.05)	2.42	1.68	2.07	2.99	3.84

TABLE 3

Effect of seed priming on economics of wheat under late sown condition

Treatment	Cost of Cultivation (Rs./ha)	Gross Returns (Rs./ha)	Net Returns (Rs./ha)	B:C
Control	80,938	132,850	51,912	1.64
Water @ 6 hr	81,567	135,087	53,520	1.66
Water @ 9 hr	81,567	136,226	54,659	1.67
Water @ 12 hr	81,567	137,872	56,305	1.69
KH_2PO_4 @ 1% 6 hr	82,436	140,423	57,987	1.70
KH_2PO_4 @ 1% 9 hr	82,436	142,625	60,189	1.73
KH_2PO_4 @ 1% 12 hr	82,436	144,185	61,749	1.75
KNO_3 @ 1% 6 hr	83,210	141,203	57,993	1.70
KNO_3 @ 1% 9 hr	83,210	142,303	59,093	1.71
KNO_3 @ 1% 12 hr	83,210	143,598	60,388	1.73
GA_3 @ 50 ppm 6 hr	84,191	138,859	54,668	1.65
GA_3 @ 50 ppm 9 hr	84,191	139,775	55,584	1.66
GA_3 @ 50 ppm 12 hr	84,191	140,409	56,218	1.67

germination, but which does not allow the seed to actually germinate. A robust seedling establishment enhances competitiveness against weeds, improves tolerance to environmental stresses and maximizes biological and grain yields (Hosseein *et al.* 2011). Ramamurthy *et al*. (2015) reported that seed priming in wheat led to significantly higher grain yield (17%) over non-primed. (Patra 2019) reported that seed priming with potassium salt improve growth and yield under rain-fed conditions. Several other studies on wheat crop by using different chemical compound suggested that seed priming significantly improves the wheat crop yield under moisture stress condition. Recent study suggested that priming seed remember the memory of earlier drought and transfer to next generation which provide the tolerance to next generations (Tabassum *et al*., 2017). Therefore, from the data of yield and yield attributes parameters, it can be assumed that seed priming improves the seed yield by improving earlier reproductive growth and more allocation of assimilates toward the developing grains. Singhal *et al*., 2019. These results are in accordance with the finding of Hamidi *et al.* (2013), Tian *et al.* (2014).

ECONOMICS

After critical study of data, it is found that among various seed priming treatments, highest gross returns, net returns and B:C ratio was recorded in case of KH_2PO_4 @ 1% 12 hr (Rs. 144,185/ha, Rs. 61,749/ha and 1.75, respectively). While, lowest gross return, net return and B:C ratio was recorded in control (Rs. 132,850/ha, Rs. 51,912/ha and 1.64, respectively). Since cost of cultivation increases with increase in input but advantage in grain yield overpower the cost of cultivation (Satyajeet *et al.,* 2006) and KH_2PO_4 @ 1% 12 hr gave maximum gross returns, net returns and B:C ratio followed by KNO_3 @ 1% 12 hr. these findings were supported by Mickky, 2022 who reported that economics of wheat seemed to be the most enhanced by seed priming.

CONCLUSION

On the basis of study, it can be concluded that Potassium hydro phosphates (KH_2PO_4), have been found to enhance no. of grain/spike (50.90), 1000 grain weight (41.61 g), grain yield (49.14 q/ha), straw yield (93.82 q/ha) and biological yield (142.96 q/ha) and net return (Rs. 51,912/ha) of wheat. Overall, it can be concluded that seed priming in wheat crops can lead to increased economic returns and benefit-cost ratio by improving yield and stand establishment by enhancing the ability of wheat plants to withstand environmental stresses.

ACKNOWLEDGEMENT

The authors wish to express their appreciation to Regional Research Station, Bawal, CCS Haryana Agricultural University for providing the essential facilities for the successful completion of the experiment.

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