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Influence of Seed Priming Treatments on Plant Growth Parameters of Barley (*Hordeum vulgare* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The effects of different seed priming treatments, namelytap water, KNO_3 @ 2.5%, Thiourea @ 1000 ppm, $CaCl_2$ @ 2%, $Nacl_2$ @ 2%, $ZnSo_4$ @ 1%, KH_2PO_4 @ 1% and Salicylic acid @ 100 ppm solutions, on plant growthparameters of Barley cv. K-1055 and K-409 in Factorial Randomized

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Block Design with three replications were investigated during Rabi 2022-23 and 2023-24 at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. Analysis of variance revealed that the plant growth parameters were significantly affected by various seed priming treatments. Priming with Thiourea @ 1000 ppm significantlyincreased the plant growth parameters.

Keywords: Barley; priming; Thiourea; plant growth parameters.

1. INTRODUCTION

Barley (*Hordeum vulgare*L.) is a versatile cereal grain worldwide, ranking fourth in acreage and production after wheat, rice and maize [1]. Barley belongs to the grass family Poaceae, tribe *Triticeae* and genus *Hordeum*, comprising nearly 350 species. Out of which *Hordeum* consists of about 32 species, including wild and cultivated ones. Barley is a diploid with 2n=14 chromosomes.

The production of barley worldwide was estimated at around 142.22 million metric tons. Globally, the top barley-producing countries are Russia, Australia, Canada and the United Kingdom. Russia shares 13% of the world's total barley production, with an area 9 million hectares and a production of 19.03 million metric tons. Australia shares 8% of world's total barley production, with anarea of 3.2 million hectares and production of 11.5 million metric tons. Canada shares 6% of world's total barley production, with an area of 2.7 million hectares and production of 9.6 million metric tons [1]. Nowadays, barley accounts for 15 percent of world coarse grains in use. Approximately 70% of barley grown worldwide is utilized for animal feed, 20% for malting, and 5% for direct human food consumption [2]. Nearly all temperate regions of the world cultivate barley as an important industrial crop, including North Africa, Europe, South and North America, Asia and Australia. The area under barley cultivation in India is approximately 0.62 million hectares, with an annual production of 1.9 million metric tons [1]. Barley is mostly farmed in the northern plains of India, specifically in Uttar Pradesh, Rajasthan, Madhya Pradesh, Haryana and Punjab.

Barley grains have smothering and cooling properties that facilitate easy digestion. Barley is a healthy grain that has several advantages. It is an excellent source of minerals, vitamins, and dietary fiber. Barley, which is high in antioxidants, may help decrease cholesterol and promote heart health [3]. It is also appropriate for managing diabetes it has a lower glycemic index than certain other grains and provides important amino acids [4].

Strategies for improving the growth and development of crop species have been investigated for many years. Seed priming is a pre-sowing procedure that creates a physiological condition that is more favorable for successful seed germination. Before the radical protrudes, seed priming regulates hydration, which initiates the regular metabolic process during the early stages of germination [5].

One study by EL-Tayeb [6] investigated the effect of thiourea priming on barley seeds under high-temperature stress. The results indicated that thiourea priming significantly improved the germination percentage, seedling growth and physiological attributes of barley under high temperature conditions. Thiourea enhances growth in many plant species irrespective of the growth stage at which it is applied. Thiourea has long been known to break innate or environmentally imposed seed and bud dormancy [7].

2. MATERIALS AND METHODS

The experiment was carried out to determine the effect of various seed priming treatments on Barley yield attributes, seed yield and economic returns during the Rabi (winter) season in 2022-23 and 2023-24 at the Students Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, U.P. The experiment was comprised of two Barley cultivars *viz,* cv. K-409 (V_1) and K-1055(V_2) with seed rate 100 kg ha^{-1}. Both varieties were primed with control (T_0), tap water (T_1), KNO_3 @ 2.5% (T_2), Thiourea 1000 @ ppm(T_3), $CaCl_2$ @ 2% (T_4), $Nacl_2$ @ 2% (T_5), $ZnSo_4$ @ 1% (T_6), KH_2PO_4 @ 1% (T_7), Salicylic acid @ 100 ppm (T_8)solutions. The crop was sown in the second fortnight of November, 2022-23 and 2023-24. Full doses of P and K, along with one-third of N, were applied as a basal dose at the time of sowing using inorganic sources of nutrients, such as DAP, MOP and Urea respectively. The remaining two-thirds of N were applied in two equal splits doses. Individual data from the various plant growth parameters studied in the experiment were statistically analyzed. The

Table 1. Effect of priming treatments for 6 hours on plant Stand m^{-2} in barley varieties K-409 and K-1055

Treatments	2022-23			2023-24			Pooled		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_0	35.67	38.33	37.00	37.33	40.67	39.00	36.50	39.50	38.00
T_1	39.67	43.33	41.50	42.33	45.33	43.83	41.00	44.33	42.67
T_2	38.33	42.33	40.33	41.33	44.67	43.00	39.83	43.50	41.67
T_3	41.33	44.33	42.83	43.33	46.33	44.83	42.33	45.33	43.83
T_4	40.67	41.33	41.00	40.33	43.67	42.00	40.50	42.50	41.50
T_5	37.33	40.33	38.83	39.33	42.33	40.83	38.33	41.33	39.83
T_6	38.67	41.67	40.17	40.67	43.67	42.17	39.67	42.67	41.17
T_7	37.67	40.67	39.17	39.67	42.67	41.17	38.67	41.67	40.17
T_8	38.33	41.33	39.83	40.33	43.33	41.83	39.33	42.33	40.83
Mean	**38.63**	**41.51**	**40.07**	**40.51**	**43.63**	**42.07**	**39.57**	**42.57**	**41.07**
Factors	**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**	
V	**0.19**	**0.39**		**0.20**	**0.41**		**0.20**	**0.40**	
T	**0.41**	**0.84**		**0.43**	**0.88**		**0.42**	**0.86**	
V×T	**0.58**	**1.19**		**0.61**	**NS**		**0.60**	**NS**	
CV(%)	**4.18**			**4.06**			**4.12**		

Table 2. Effect of priming treatments for 6 hours on Plant height (cm) in Barley varieties K-409 and K-1055

Treatments	2022-23			2023-24			Pooled		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_0	93.42	96.19	94.81	94.38	97.05	95.72	93.90	96.62	95.26
T_1	94.38	97.31	95.84	95.66	98.17	96.91	95.02	97.74	96.38
T_2	101.35	106.45	103.90	102.64	107.52	105.08	101.99	106.99	104.49
T_3	104.46	108.55	106.50	105.71	108.94	107.32	105.08	108.74	106.91
T_4	100.29	104.36	102.33	101.78	105.18	103.48	101.04	104.77	102.90
T_5	98.54	101.41	99.97	100.36	102.47	101.42	99.45	101.94	100.69
T_6	100.85	105.47	103.16	102.36	106.16	104.26	101.61	105.82	103.71
T_7	99.19	103.27	101.23	100.42	104.35	102.39	99.81	103.81	101.81
T_8	95.68	99.28	97.48	96.86	99.62	98.24	96.27	99.45	97.86
Mean	**98.68**	**102.47**	**100.58**	**100.01**	**103.27**	**101.64**	**99.35**	**102.87**	**101.11**
Factors	**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**	
V	**0.038**	**0.078**		**0.11**	**0.23**		**0.07**	**0.15**	
T	**0.081**	**0.16**		**0.24**	**0.49**		**0.16**	**0.33**	
V×T	**0.11**	**0.23**		**0.34**	**0.70**		**0.23**	**0.47**	
CV(%)	**3.88**			**3.87**			**3.88**		

Table 3. Effect of priming treatments for 6 hours on number of tiller plant^{-1} in Barley varieties K-409 and K-1055

Treatments	2022-23			2023-24			Pooled		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_0	6.67	6.93	6.80	6.93	7.27	7.10	6.80	7.10	6.95
T_1	6.87	7.33	7.10	7.13	7.67	7.40	7.00	7.50	7.25
T_2	7.93	8.27	8.10	8.27	8.80	8.53	8.10	8.53	8.32
T_3	8.27	8.40	8.33	8.60	9.13	8.87	8.43	8.77	8.60
T_4	7.40	7.73	7.57	7.73	8.60	8.17	7.57	8.17	7.87
T_5	7.27	7.60	7.43	7.47	7.93	7.70	7.37	7.77	7.57
T_6	7.87	8.13	8.00	8.13	8.27	8.20	8.00	8.20	8.10
T_7	7.67	7.87	7.77	7.87	8.13	8.00	7.77	8.00	7.88
T_8	7.73	8.07	7.90	8.07	8.20	8.13	7.90	8.13	8.02
Mean	**7.52**	**7.81**	**7.67**	**7.80**	**8.22**	**8.01**	**7.66**	**8.02**	**7.84**
Factors	**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**	
V	**0.08**	**0.16**		**0.09**	**0.19**		**0.09**	**0.18**	
T	**0.17**	**0.34**		**0.20**	**0.41**		**0.19**	**0.38**	
V×T	**0.24**	**NS**		**0.29**	**NS**		**0.27**	**NS**	
CV(%)	**6.43**			**6.8**			**6.62**		

Table 4. Effect of priming treatments for 6 hours on number of ears m^{-2} in barley varieties K-409 and K-1055

Treatments	2022-23			2023-24			Pooled		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_0	219.33	221.67	220.50	221.67	223.67	222.67	220.50	222.67	221.58
T_1	223.33	226.33	224.83	227.33	229.33	228.33	225.33	227.83	226.58
T_2	246.33	250.67	248.50	251.33	255.33	253.33	248.83	253.00	250.92
T_3	250.33	257.67	254.00	258.33	262.67	260.50	254.33	260.17	257.25
T_4	229.67	233.67	231.67	234.33	236.67	235.50	232.00	235.17	233.58
T_5	225.33	228.67	227.00	229.67	231.33	230.50	227.50	230.00	228.75
T_6	247.33	252.33	249.83	246.33	249.67	248.00	246.83	251.00	248.92
T_7	230.67	232.67	231.67	233.67	236.33	235.00	232.17	234.50	233.33
T_8	242.33	245.33	243.83	242.67	245.33	244.00	242.50	245.33	243.92
Mean	**234.96**	**238.78**	**236.87**	**238.37**	**241.15**	**239.76**	**236.67**	**239.96**	**238.31**
Factors	**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**		**SE(d)**	**CD 5%**	
V	**0.12**	**0.24**		**0.14**	**0.28**		**0.13**	**0.26**	
T	**0.25**	**0.52**		**0.31**	**0.61**		**0.28**	**0.57**	
V×T	**0.36**	**0.74**		**0.42**	**0.86**		**0.39**	**0.80**	
CV(%)	**5.19**			**5.21**			**5.20**		

standard error of the mean, a critical difference (C.D.) at 5% level of probability and coefficient of variance were calculated using standard procedures. The soil of the experimental plot was analyzed for its various physical and chemical characteristics in the Soil Testing Laboratory of the C. S. Azad University of Agriculture and Technology, Kanpur, in accordance with the accepted.

3. RESULTS AND DISCUSSION

The data presented in Table 1 to Table 4 revealed that both varieties of Barley when treated with various seed priming treatments, showed significant effects on plant growth parameters. The variety K-1055 scored more number of plant stands m^{-2} (42.57), plant height (102.87cm), number of tiller $plant^{-1}$ (8.02) number of ears m^{-2} (239.97) as compared to the variety K-409 which may be due to differential response of variety and their genotype. Similar results have been reported by Kaczmarek et al. [8], Tahira Tabassum et al. [9] and Kurubar et al. [10] in Barley.

Pooled data of priming treatments also presented in Table 1 to Table 4 revealed that the among the priming treatments, priming with thiourea @ 1000 ppm (T_3) was significantly superior in terms of number of plant stands m^{-2} (43.83) followed by hydropriming (T_2) and in terms of plant height (106.91cm), number of tiller $plant^{-1}$ (8.60) and number of ears m^{-2} (257.25) followed by priming with KNO_3 @ 2.5 % (T_2) while all the plant growth parameters were minimum in control (T_0).These results are in conformity withJalal et al. [11] and Dhiman et al. [12] in barley, Subedi et al. [13] in rice.The interaction effect of varieties and treatments was presented in Table 1 to Table 4. Table revealed that the variety K-1055 and priming with Thiourea @ 1000 ppm ($V_2 \times T_3$) showed significant increased in plant height (108.74 cm), number of ears m^{-2} (260.17), followed by variety K-1055 priming with KNO_3 @ 2.5% (T_2) ($V_2 \times T_2$). The interaction effect of varieties and treatments showed non significant effect on number of plant stands m^{-2} and number of tiller $plant^{-1}$ however maximum number of plant stands m^{-2} (43.83) and number of tiller $plant^{-1}$ (8.60) were observed in variety K-1055 priming with Thiourea @ 1000 ppm ($V_2 \times T_3$). The minimum plant stands m^{-2}, plant height, number of tiller $plant^{-1}$ number of ears m^{-2} were observed in variety K-409 in control ($V_1 \times T_0$). These results are in conformity withPatra et al. [14] in wheat, Jalal et al. [11] and Dhiman et al. [12] in barley, Subedi et al. [13] in rice.

4. CONCLUSION

Based on the results of this study, it was determined that seed priming with 1000 ppm of Thiourea for six hours considerably improved the plant development characteristics of barley. Variety K-1055 outperformed the other varieties evaluated, suggesting that it may have use at the farmer level.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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