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The implications of various seed priming treatments on seed yield in proso millet (*Panicum miliaceum*)

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ABSTRACT

The experiment was conducted during rainy (*kharif*) season of 2021 and winter (*rabi*) season of 2022 at Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu to identify suitable seed priming technique, soaking duration and priming agents for halo, osmo, and bio-priming in proso millet (*Panicum miliaceum* L.). To increase crop yield and sustainability in present-day agriculture, seed priming continues to be essential by utilizing scientific knowledge and technical breakthroughs. The experiment was laid out in factorial completely randomized design (FCRD) with three replications. The fresh seeds of proso millet cv. CO4 were imposed for halo, osmo, and bio priming treatments, viz. Agent for halo-priming: Control, hydropriming, KH_2PO_4 (1 and 2%), $ZnSO_4$ (1 and 2%), and $CaCl_2$ (1 and 2%); Agent for osmo-priming: Control, hydropriming, NaCl (1 and 2%), Mannitol (1 and 2%), and PEG (-10 and -15 Bar); Agent for bio-priming: Control, hydropriming, *Azospirillum* (15 and 20%), *P. fluorescens* (LF) (10 and 15%), *Prosophis* LE (5 and 10%), and soaked in equal volumes for 6 and 8 h. The results revealed that for halo priming, seeds soaked in 2% KH_2PO_4 for 8 h; for osmo priming seeds soaked in 2% mannitol for 8 h and for bio-priming seeds soaked in 15% *P. fluorescens* (LF) for 8 h outperformed other treatments. Field experiments were also conducted to determine the productivity of seed primed proso millet. The results showed that the crop performance was superior in seeds primed with 2% KH_2PO_4 for 8 h during *kharif* season than *rabi*.

Keywords: Proso millet, Seed priming, Seed enhancement, Saline soil, Seed yield

Proso millet (*Panicum miliaceum* L.) is an annual grass species with a shallow root system. It is a vital part in global food systems due to its nutritional content, versatility in growing environments, and several applications. To meet the nation's food security needs, superior quality seeds of all the minor millet crops must be made available to Indian farmers. In the absence of necessary technological skills, the long-term profitability and seed quality attributes are jeopardised. As a result, long-term sustainable seed technical recommendations sets the stage for improving seed production, quality, and distribution in a way that enhances crop performance, environmental sustainability, and equitable access of seeds for farmers worldwide.

Seed priming is a technique for improving seed quality in which seeds are partially hydrated until the germination process begins, but radicle emergence does not occur (Bradford 1986). The success of seed priming treatment is heavily influenced by priming agent concentration and soaking time. However, such studies are scarce in small millets (Sujatha *et al*. 2013). Pre-sowing seed treatment with inorganic salts (halo-priming) is simpler, less expensive, and has a lower risk of reducing salinity hazards in agricultural lands. The term osmo-priming has been used to describe the soaking of seeds in aerated low water potential osmoticants such as NaCl, mannitol and PEG, which involves exposing seeds to low water potentials that restrict germination but allow for pre-germinative physiological and biochemical changes (Khan 1992). Bio-priming is a biological seed treatment process that involves the combination of seed hydration (the physiological part of the disease control) and the inoculation (biological control factor) of seeds that have a beneficial immune system (Prasad *et al.* 2016). Seed priming increases the chances of successful establishment and yield in challenging growing conditions. With this foregoing in mind, studies were carried out in proso millet cv. CO4. The objectives of this study were to standardise the appropriate soaking duration and priming agent for proso millet in halo, osmo and bio-priming and to investigate the effect of different seed priming treatments on seed yield in proso millet.

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MATERIALS AND METHODS

The experiment was conducted during rainy (*kharif*) season of 2021 and winter (*rabi*) season of 2022 at Faculty of Agriculture, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu. Genetically pure seeds of proso millet cv. CO4 obtained from the Centre of Excellence in Millets (Tamil Nadu Agricultural University, Coimbatore), Athiyandal, Thiruvannamalai, Tamil Nadu.

Standardization of suitable priming agent and priming duration in proso millet: To standardize the optimum concentration of priming agent and duration of priming in various priming methods, the fresh seeds of proso millet cv. CO4 were imposed for following halo, osmo, and bio-priming treatments. The treatment for halo, osmo and bio-priming were, Agent for halo-priming: Control, hydropriming, KH_2PO_4 (1 and 2%), $ZnSO_4$ (1 and 2%), and $CaCl_2$ (1 and 2%); Agent for osmo-priming: Control, hydropriming, NaCl (1 and 2%), Mannitol (1 and 2%), PEG (-10 and -15 Bar); Agent for bio-priming: Control, hydropriming, *Azospirillum* (15 and 20%), *P. fluorescens* (LF) (10 and 15%), *Prosophis* LE (leaf extract) (5 and 10%). The seeds of proso millet were soaked in equal volumes of the above solutions for 6 and 8 h at ambient temperature. The seeds were rinsed in water after priming, shade dried at ambient temperature, and assessed for the seed quality parameters. As a control, unprimed seeds were used.

Effect of different seed priming treatments on field performance and seed yield in proso millet: The two best priming treatments from each priming experiments, viz. T_3, $CaCl_2$ @ 2% for 8 h; T_4, KH_2PO_4 @ 2% for 8 h; T_5, *Prosophis* leaf extract @10% for 8 h; T_6, *Pseudomonas fluorescens* (LF) @15% for 8 h; T_7, Mannitol @2% for 8 h; T_8, PEG @ -15 Bar for 8 h were forwarded to field experiment along with T_0, Control-Unprimed; T_1, Thiram @2 g/kg; and T_2, Hydropriming-Soaking in water for 8.

The above treated seeds of proso millet with three replications were evaluated for seed yield characteristics in the saline soil. The initial parameters of the experimental soil revealed that it was saline, with a *p*H of 8.43, EC of 4.61 dS/m and ESP of less than 15%. A factorial completely randomized design (FCRD) having 3 replications with a plot size of 4 m × 3 m and a spacing of 45 cm × 10 cm was employed.

Statistical analysis: Panse and Sukhatme (1985) procedure was used to statistically analyse the data from different experiments.

RESULTS AND DISCUSSION

Standardization of suitable priming agent and priming duration in proso millet

Agent for halo-priming: In the current study, the seeds were primed with two different concentrations (1 and 2%) of three different inorganic salts, namely $CaCl_2$, $ZnSO_4$, and KH_2PO_4, and hydro primed for 6 and 8 h using a standardised 1:1 (seed to solution ratio). In the halo-priming experiment, the KH_2PO_4 2% primed seeds for 8 h resulted in higher imbibition rate (20%), speed of germination (59), germination percentage (95%), seedling length (23.4 cm), dry matter production (42 mg) and vigour index (2223) in proso millet (Fig. 1). Pirmani *et al.* (2013) and Sathiya *et al.* (2019a) reported similar trend in sunflower and maize, respectively. Many studies have linked the increased germination caused by KH_2PO_4 priming to improvements in the structure of membranes in addition to greater protein and nucleic acid synthesis. This improvement in membrane integrity is essential for maintaining cell viability and facilitating processes such as water uptake during germination. Thus, the study found that seed priming with 2% KH_2PO_4 at 1:1 seed to solution ratio for proso millet for 8 hours improved seed germination and seedling vigour.

Agent for osmo-priming: The seeds of proso millet, were soaked in different osmoticants, namely NaCl, Mannitol, and PEG, in two different concentrations (1, 2% and -10, -15 bar) and hydro primed for 6 and 8 hours using a standardised of 1:1 (seed to solution ratio). In the osmo-priming study, mannitol 2% primed seeds for 8 h resulted in higher imbibition rate (20%), speed of germination (51.8), germination percentage (97%), seedling length (23.7 cm), dry matter production (43 mg) and vigour index (2299) in proso millet (Fig. 2). A similar finding was reported in maize by Dhakal and Subedi (2020). The final phase of pre-germination processes such as protein and membrane repair, DNA and mRNA synthesis, and induction of a variety of biochemical changes through activation of enzymes may be the reason for the

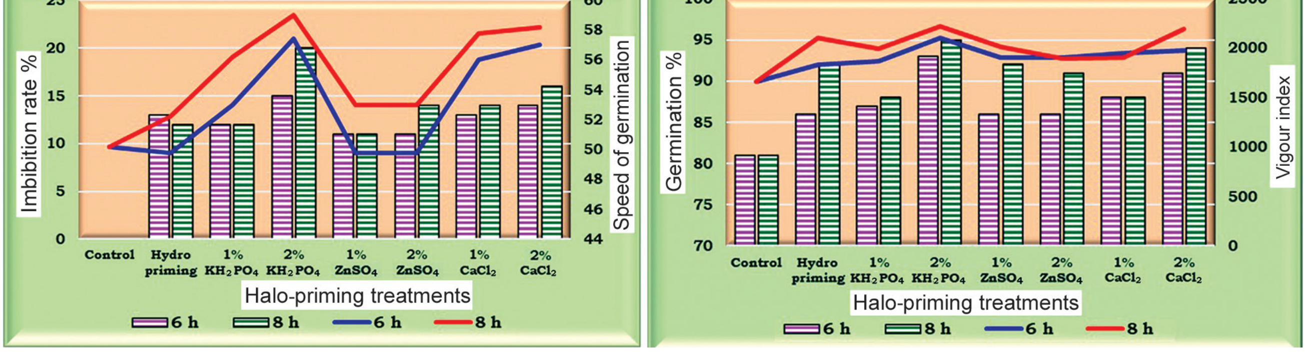

Fig. 1 Standardization of halo-priming treatment for proso millet cv. CO 4.

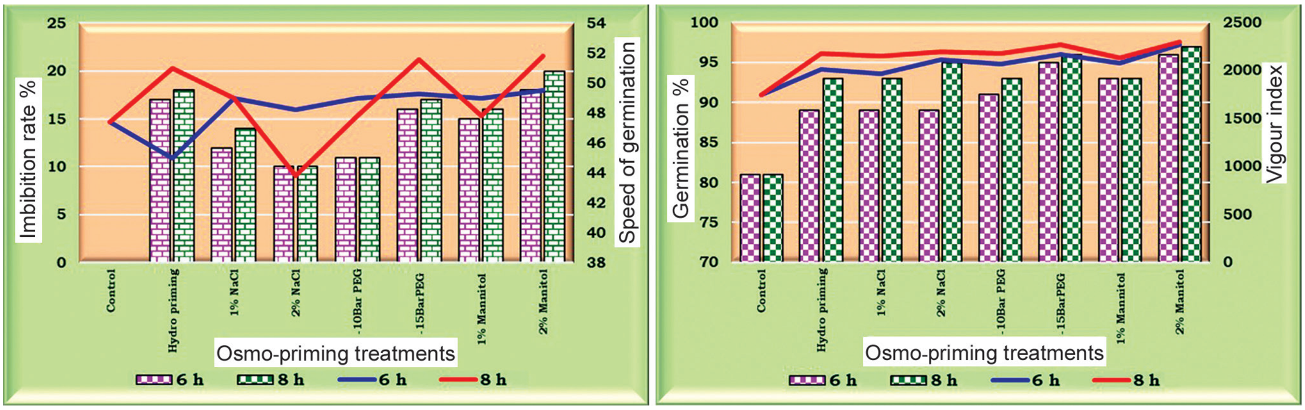

Fig. 2 Standardization of osmo-priming treatment for proso millet cv. CO4.

increase in percentage and uniformity of germination of the mannitol-primed seeds. This indicates that the seeds were soaked in the mannitol solution for a specified duration before germination, allowing them to absorb the solution and potentially benefit from its effects on cellular processes. Thus, the study found that seed priming with 2% mannitol with a 1:1 seed to solution ratio and an 8 h soaking time improved seed germination and seedling vigour.

Agents for bio-priming: In the bio-priming study, evaluation of biofertilizer, *Azospirillum* (15 and 20%), biocontrol agent the *P. fluorescens* liquid formulation (10 and 15%) and *Prosophis* leaf extract (5 and 10%) was done for seed invigoration with different durations (6 and 8 h) in proso millet by adopting 1:1 (seed to solution ratio). The 15% *P. fluorescens* for 8 h primed seeds produced higher imbibition rate (21%), speed of germination (56.3), germination percentage (97%), seedling length (24.6 cm), dry matter production (41.9 mg) and vigour index (2415) in proso millet (Fig. 3). Similar finding were reported by Mudi *et al.* (2021) in soyabean. This result was brought on by *Pseudomonas fluorescens* synthesizing more gibberellins, that would have increased the activity of certain enzymes that favoured early germination and enhanced the availability of starch absorption. This might also be due to the metabolic events like cell cycle related event, hydrolyses activities weakening the endosperm and the mobilization of stored proteins was also activated by the faster imbibition rate. These events could weaken the endosperm and facilitate the mobilization of stored nutrients, such as proteins, to support seedling growth. Thus, the study highlighted that 15% *P. fluorescens* primed seeds with 1:1 seed to solution ratio with the soaking duration of 8 h improved the seed germination and seedling vigour in proso millet.

Effect of different seed priming treatments on field performance and seed yield in proso millet: This study was designed to assess the effect of different seed priming treatments on seed yield in proso millet. Fresh seeds of proso millet cv. CO4, were treated with various seed priming treatments i.e. halo priming with KH_2PO_4 @2%, $CaCl_2$ @2%, osmo-priming with mannitol @2%, PEG @ -15 Bars, and bio-priming with *Pseudomonas fluorescens* (LF) @15 and *Prosophis* leaf extract @10% with seed to solution ratio of 1:1 for the soaking duration of 8 h. Then treated seeds were dried adequately and evaluated for their production potential in field conditions during *kharif* and *rabi* seasons along with unprimed, Thiram @2 g/kg and hydro-primed seeds.

It was found that seeds primed with 2% KH_2PO_4 for 8 h had greater results for field emergence percentage, plant height at 45 days after sowing (DAS), short duration to flowering, NAR at 30–60 DAS and leaf area, which were 94%, 123.15 cm, 39.1 days, 0.42 mg/cm^2/day and 931.22 cm^2 for proso millet, respectively with the above-

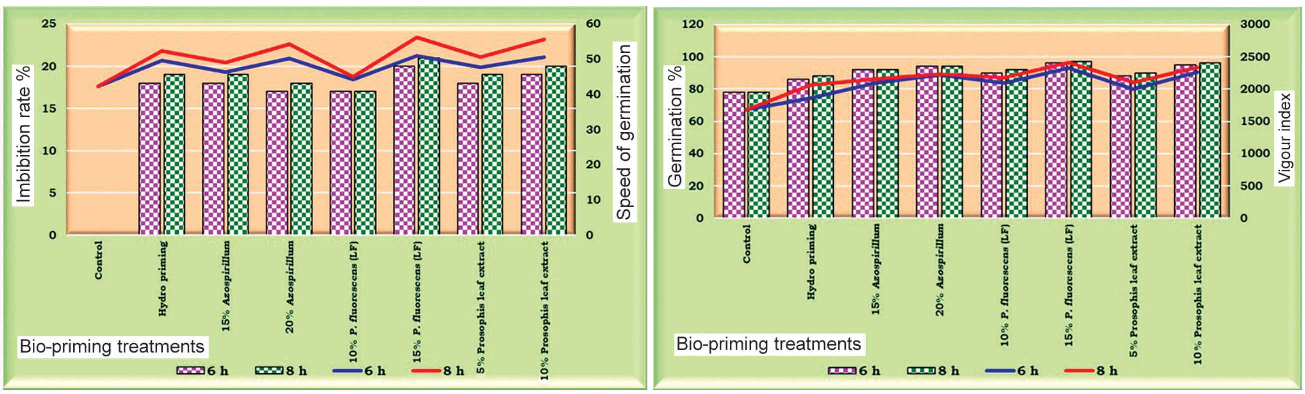

Fig. 3 Standardization of bio-priming treatment for proso millet cv. CO4.

Table 1 Effect of various seed priming treatments on field emergence, plant height, days to first flowering, net assimilation rate and leaf area in proso millet cv. Co 4

Treatment	Field emergence (%) (Arc sine)			Plant height (cm) 45 DAS			Days to first flowering			Net assimilation rate (mg/cm^2/day) 30–60 DAS			Leaf area (cm^2)		
	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction
T_0	84 (66.52)	83 (65.74)	84 (66.13)	110.20	108.40	109.30	42.1	44.2	43.2	0.32	0.29	0.31	721.11	692.72	706.92
T_1	89 (70.75)	89 (70.75)	89 (70.75)	113.60	115.20	114.40	40.6	42.6	41.6	0.35	0.35	0.35	849.72	795.11	822.42
T_2	85 (67.32)	85 (67.32)	85 (67.32)	120.10	113.40	116.75	41.2	43.2	42.2	0.37	0.32	0.36	746.54	732.62	739.58
T_3	87 (69.05)	87 (69.05)	87 (69.05)	115.70	111.60	113.65	40.1	43.1	41.6	0.34	0.33	0.34	811.12	721.76	766.44
T_4	95 (77.57)	93 (74.93)	94 (76.25)	124.70	121.60	123.15	38.1	40.1	39.1	0.43	0.40	0.42	953.21	909.23	931.22
T_5	91 (73.07)	84 (66.60)	88 (69.83)	112.80	119.30	116.05	41.7	43.7	42.7	0.39	0.36	0.38	764.53	751.62	758.08
T_6	92 (73.07)	88 (69.95)	90 (71.87)	121.60	120.10	120.85	39.4	40.9	40.2	0.40	0.38	0.39	868.54	833.11	850.83
T_7	88 (69.90)	85 (67.32)	87 (68.61)	117.60	110.70	114.15	41.8	41.9	41.9	0.33	0.30	0.32	778.11	790.62	784.37
T_8	90 (71.87)	84 (66.60)	87 (68.61)	119.10	118.70	118.90	41.2	41.2	41.2	0.39	0.37	0.38	832.22	802.23	817.23
Mean	89 (71.11)	87 (69.27)	88 (70.19)	117.27	115.44	116.36	40.69	42.32	41.5	0.37	0.34	0.36	813.90	781.00	797.45
Level of significance	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	S_1	S_2	Interaction	S_1	S_2	Interaction
S	1.158 (1.043)		2.354 (2.120)	1.532		3.116	0.551		1.119	SEd		CD (P=0.05)	SEd		CD (P=0.05)
T	2.456 (2.212)		4.994 (4.497)	3.251		6.610	1.168		2.375	0.005		0.010	10.410		21.165
S × T	3.474 (3.128)		7.063 (6.360)	4.597		9.347	1.652		3.359	0.010		0.020	22.082		44.898

T_0, Unprimed (Control); T_1, Thiram @2 g/kg; T_2, Soaking in water; T_3, $CaCl_2$ @2%; T_4, KH_2PO_4 @2%; T_5, *Prosophis* leaf extract @10%; T_6, *Pseudomonas fluorescens* (LF) @15%; T_7, Mannitol @2%; T_8, PEG @-15Bar. DAS, Days after sowing.

Table 2 Effect of various seed priming treatments on physiological parameters in proso millet cv. Co4

Treatment	Chlorophyll content (mg/g of fresh leaf) 45 DAS			Chlorophyll content (mg/g of fresh leaf) 60 DAS			Photosynthetic rate Pn - (mg CO_2/ m/S)			Transpiration rate Tr- (mg H_2O CO_2/m/S)			Stomatal conductance CS - (mol/mol/S)		
	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction	S_1	S_2	Interaction
T_0	1.328	1.311	1.319	0.851	0.816	0.834	35.44	33.17	34.31	12.12	10.82	11.47	1.05	0.93	0.99
T_1	1.389	1.376	1.383	0.931	0.881	0.906	38.34	35.91	37.13	13.52	12.43	12.98	1.52	1.37	1.45
T_2	1.429	1.332	1.381	0.911	0.851	0.881	37.14	37.11	37.13	12.81	10.91	11.86	1.37	1.07	1.22
T_3	1.377	1.352	1.365	0.883	0.823	0.853	37.71	36.53	37.12	13.32	11.21	12.27	1.42	1.24	1.33
T_4	1.493	1.454	1.474	0.991	0.967	0.979	42.92	40.61	41.77	15.95	14.11	15.03	1.93	1.71	1.82
T_5	1.353	1.343	1.348	0.891	0.870	0.881	36.14	34.54	35.34	12.55	11.52	12.04	1.30	1.11	1.21
T_6	1.461	1.431	1.446	0.962	0.927	0.945	40.17	38.11	39.14	14.89	13.23	14.06	1.72	1.53	1.63
T_7	1.371	1.381	1.376	0.943	0.863	0.905	36.84	34.78	35.81	13.13	12.51	12.82	1.21	1.31	1.26
T_8	1.411	1.407	1.409	0.912	0.903	0.908	39.12	36.63	37.88	14.13	12.91	13.52	1.63	1.41	1.52
Mean	1.401	1.376	1.389	0.919	0.878	0.898	38.20	36.38	37.29	13.60	12.18	12.89	1.46	1.30	1.38
Level of significance	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)
S	0.0182		0.0370	0.0118		0.0240	0.488		0.991	0.168		0.342	0.018		0.037
T	0.0386		0.0786	0.0250		0.0508	1.034		2.103	0.357		0.726	0.038		0.078
S × T	0.0546		0.1111	0.0354		0.0719	1.462		2.974	0.505		1.027	0.054		0.110

T_0, Unprimed (Control); T_1, Thiram @2 g/kg; T_2, Soaking in water; T_3, $CaCl_2$ @2%; T_4, KH_2PO_4 @2%; T_5, *Prosophis* leaf extract @10%; T_6, *Pseudomonas fluorescens* (LF) @15%; T_7, Mannitol @2%; T_8, PEG @-15Bar. DAS, Days after sowing.

mentioned characters followed by the 15% *Pseudomonas fluorescens* (LF) for 8 h (Table 1). In contrast, the control had the lowest. Among the interactions, the *kharif* season, 2% KH_2PO_4 for 8 h primed seeds resulted in higher values for the above-mentioned traits of the proso millet studied. Mosqueda-Vazquez and Avila-Resendiz (1985) observed that seed priming with KH_2PO_4 promoted ethylene biosynthesis in plants. This suggests that KH_2PO_4 priming treatment enhances the activity of enzymes involved in ethylene synthesis, such as ACC synthase, or facilitates the availability of precursors required for ethylene production. The phosphorus in KH_2PO_4 increased flowering and metabolism in plant buds. This P promotes the absorption of Mg, an element that is essential in floral formation, and promotes the synthesis of nucleic acids. According to Marschner (2002), when there is a P deficiency, the number of flowers formed decreases. Furthermore, the K fraction in KH_2PO_4 may increase photosynthesis and photo assimilates transport, among other things, which is important for flower development. High NAR and leaf area are positive manifestations of the plant's rapid and continuing growth effects. The findings agreed with Rupa *et al.* (2020) in mustard and Prajapat *et al.* (2022) in lentil. The KH_2PO_4 primed crops grew more vigorously, flowered early, had a higher leaf area index and accumulated more dry matter.

The physiological parameters such as chlorophyll content, photosynthetic rate, transpiration, and stomatal conductance were all higher in *kharif* than in *rabi* seasons. In proso millet, the 2% KH_2PO_4 for 8 h primed seed treatment had higher values of chlorophyll content @45 and 60 DAS, photosynthetic rate, transpiration rate, and stomatal conductance, which were 1.474 mg and 0.979 mg, 22, 31 and 84% higher than the control (Table 2). Among the interactions, the *kharif* season, 2% KH_2PO_4 for 8 h primed seeds resulted in higher chlorophyll content, photosynthetic rate, transpiration rate, and stomatal conductance for the proso millet studied. The finding agreed with Priyamvada *et al.* (2016) in sorghum. KH_2PO_4 priming causes a variety of biochemical changes in the seed that are required to initiate the germination process, such as dormancy breaking, inhibitor hydrolysis or metabolism, imbibition and enzyme activation (Ajouri *et al.* 2004). Previous research has indicated that some or all the processes that occur prior to germination are triggered by KH_2PO_4 priming and persist after the seed is re-desiccated. At all stages of the experiment, the effect of KH_2PO_4 priming was more pronounced and produced a significant effect on chlorophyll content. The chlorophyllase enzyme, which is responsible for degrading chlorophyll, may have been suppressed by this priming treatment. This increase in chlorophyll content influences photosynthesis rate, which in turn influences growth and development. These results led to greater stomatal opening, allowing for increased carbon dioxide uptake and transpiration, which in turn promotes photosynthesis and nutrient absorption. The findings agreed with Sathiya *et al.* (2019b) in maize and Prajapat *et al.* (2022) in lentil, reported a beneficial effect of nutrients in improving germination.

The *kharif* season had higher yield attributing characters in the current study than the *rabi* season. The 2% KH_2PO_4 for 8 h primed seeds had higher values for yield attributing characters such as panicle weight/plant, panicle to seed recovery percent, seed yield/plant, seed yield/plot, and 1000-seed weight which were 30.74 g, 56.13%, 17.50 g, 2833 g, and 6.45 g for proso millet, respectively (Table 3). The findings agreed with Rupa *et al.* (2020) in mustard and Prajapat *et al.* (2022) in lentil. The current study found that the growth and yield parameters were higher in the *kharif* season than in the *rabi* season. KH_2PO_4 priming may enhance chlorophyll content, photosynthetic rate, and other physiological processes related to photosynthesis. This leads to increased carbon assimilation, better energy production, and improved seed filling, all of which contribute to higher seed yield. There was a substantial impact on growth and yield attributes due to season, which was supported by Sumathi (2010), who revealed that yield varies with season of location due to soil fertility status and environmental factors favourable for seed growth and development. The better increase in growth attributes during the *kharif* season could be attributed to the ideal environmental circumstances offered throughout the crop development stage. Favourable conditions allow for efficient portioning, which leads to increased emergence and early growth. Approximately 75% of biomass of seed is used for germination, with the remaining 25% used for future crop development (White and Reynolds 2003). In the *kharif* season, crops can receive the required photoperiod, trapping more solar energy to produce more food materials, resulting in the formation of more leaves, which play an important role in determining the morphological framework relating to productivity.

Based on the findings of this study, it is evident that different seed priming treatments significantly influenced seed yield in proso millet. The results revealed that for halo priming, seeds soaked in 2% KH_2PO_4 for 8 h; for osmo priming seeds soaked in 2% mannitol for 8 h and for bio priming seeds soaked in 15% *P. fluorescens* (LF) for 8 h showed promising results compared to other treatments. When comparing the effects of various seed priming treatments on seed yield in proso millet, it was found that halo-priming with 2% KH_2PO_4 for 8 h primed seeds recorded the highest seed yield in the studied proso millet. The significance of choosing a suitable seed priming technique to maximize seed yield in proso millet production is shown by these findings. The efficiency of bio-priming, osmo-priming and halo-priming demonstrates the wide range of methods that may be used to improve seed yield and performance. Further research could explore the underlying mechanisms behind the observed effects and investigate the long-term impacts of these priming treatments on crop performance and sustainability. In conclusion, the study suggests that halo priming with 2% KH_2PO_4 solution for 8 h holds significant potential for

Table 3 Effect of various seed priming treatments on yield parameters in proso millet cv. Co4

Treatment	Panicle weight/Plant (g)			Panicle to seed recovery (%)			Seed yield/Plant (g)			Seed yield/Plot (g)			1000-seed weight (g)		
	S_1	S_2	Interac -tion	S_1	S_2	Interac -tion	S_1	S_2	Interac-tion	S_1	S_2	Interac-tion	S_1	S_2	Interac-tion
T_0	26.90	23.51	25.21	50.11	47.33	48.72	14.07	12.11	13.09	2313	2032	2173	6.10	5.43	5.77
T_1	27.87	25.71	26.79	52.76	51.07	51.92	16.12	13.71	14.92	2579	2363	2471	6.31	5.98	6.15
T_2	28.73	25.12	26.93	51.62	51.54	51.58	15.71	13.70	14.71	2511	2310	2411	6.30	5.77	6.04
T_3	26.32	24.24	25.28	50.72	49.62	50.17	17.11	14.12	15.62	2773	2413	2593	6.40	6.13	6.27
T_4	31.76	29.71	30.74	59.07	53.19	56.13	19.12	15.88	17.50	2970	2696	2833	6.52	6.37	6.45
T_5	28.11	23.91	26.01	52.54	48.12	50.33	15.12	13.51	14.32	2467	2247	2357	6.27	5.70	5.99
T_6	30.18	28.55	29.52	55.24	51.72	53.48	17.79	14.51	16.15	2820	2511	2666	6.47	6.24	6.36
T_7	27.11	27.63	27.37	54.31	47.91	51.11	16.65	14.30	15.34	2645	2391	2518	6.35	6.11	6.23
T_8	29.28	26.12	27.70	53.12	50.12	51.62	14.82	12.98	13.90	2392	2212	2302	6.21	5.63	5.92
Mean	28.51	26.06	27.28	53.28	50.07	51.67	16.28	13.84	15.06	2608	2353	2480.27	6.33	5.93	6.13
Level of significance	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)	SEd		CD (P=0.05)
S	0.357		0.726	0.678		1.378	0.0197		0.401	32.466		66.009	0.081		0.164
T	0.757		1.539	1.437		2.922	0.419		0.851	68.870		140.027	0.171		0.347
S × T	1.071		2.177	2.033		4.133	0.592		1.204	97.397		198.028	0.242		0.491

T_0, Unprimed (Control); T_1, Thiram @2 g/kg; T_2, Soaking in water; T_3, $CaCl_2$ @2%; T_4, KH_2PO_4 @2%; T_5, *Prosophis* leaf extract @10%; T_6, *Pseudomonas fluorescens* (LF) @15%; T_7, Mannitol @2%; T_8, PEG @-15Bar.

improving seed yield in proso millet, offering valuable insights for agricultural practices aimed at enhancing crop productivity and food security.

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