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EFFECT OF DIFFERENT PRIMING AGENTS ON GERMINATION OF PURSLANE (*PORTULACA OLERACEA* L.) SEEDS UNDER LABORATORY CONDITIONS

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Abstract

Purslane (*Portulaca oleracea* L.) has gained in popularity as a food crop due to the presence of many biologically active compounds that are regarded to be helpful for human health and disease prevention. Unfavorable environmental conditions during sowing, such as high temperature and rigid seed structure can cause late, poor emergence and substantial seed mortality, resulting in low crop stand and yield. The only approach to tackle these challenges is to improve seed germination by using seed priming. Seed priming is a pre-sowing treatment that causes a physiological change in the seed, allowing it to germinate more quickly. The goal of this study was to observe the effect of different primings, such as temperature (hot water), methanol, NaCl, and KI, on germination under laboratory conditions at various concentrations and temperatures. The hot water-treated seed with temperatures of 30, 40, and 50°C for 10 minutes revealed 100% germination at 50°C under *In vitro* conditions. The effect of both salts (NaCl and KI) at concentrations of 15, 30, and 45% for 10 minutes showed that seed germination was inversely proportional to concentration. In comparison to NaCl, KI salt had a higher rate of purslane seed germination. Furthermore, the current study aimed to investigate the influence of various methanol concentrations on seed germination, > 90% germination was obtained at 20% concentration, followed by 10% and 30%. According to the present finding hot water was most effective to use as farm-priming of Purslane seeds. In fluctuating situations, seed priming techniques are a safe and simple strategy for promoting seed germination. They may help to manage early-season drought and avoid seed germination failure, which leads to crop failure.

Key words: Priming, Purslane, Germination, Drought, Salinity.

Introduction

Portulaca oleracea L. is an edible plant that has been used as a medicinal plant in over 40 countries across Asia, Europe, Africa, South America, and North America (Tang *et al.*, 2023; Kumar *et al.*, 2021). It is an herbaceous perennial plant that is commonly consumed in Italy, the United Kingdom, Spain, Greece, Turkey, Iran, Malaysia, the Philippines, China, North Africa, Australia, the United States, Brazil, and Mexico (Montoya-García *et al.*, 2023). *P. oleracea* is regarded as a "future power food" due to its human nutritional advantages, widespread availability, and ecological resilience, which includes the capacity to conduct both CAM and C4 photosynthesis under drought stress and other unfavorable circumstances (Moreno-Villena *et al.*, 2022; Tang *et al.*, 2023). *P. oleracea's* ethnomedical advantages have been acknowledged in a variety of cultural contexts, and the Chinese, Indian, French, Mexican, Spanish, and Venezuelan pharmacopeias all list applications for the plant (either aerial portions or the entire plant) (Sourani *et al.*, 2023). Traditional Chinese medicine frequently treats conditions including heat toxicity, blood dysentery, carbuncles, furuncles, eczema, erysipelas, snakebites, insect stings, hemafecia, hemorrhoids, and metrorrhagia using the fresh or dried aerial portions of *P. oleracea* (Anon., 2020).

Since it was discovered that Purslane contains linoleic acid (18:2ω6), α-linolenic acid (18:3ω3), and numerous antioxidant chemicals, it has become one of the crops that has drawn the greatest interest (Montoya-García *et al.*, 2023). Because of the stress brought on by its growing under unfavorable conditions, the plant produces a larger amount of nutraceutical chemicals, which have been found using a variety of chemical methods (Lombardi *et al.,* 2022). To better understand the biochemical alterations brought on by biotic and abiotic stress, metabolomics is a useful technique (Lombardi *et al.,* 2022; Montoya-García *et al.*, 2023).

This plant is useful in the treatment of urinary and intestinal issues, as well as cardiovascular ailments. Analgesic, anti-inflammatory, antifungal, wound healing, and hypoglycemia is only are a few of the pharmacological properties of *P. oleracea* (Ahmadi Moghadam *et al.,* 2014; Dighe *et al*., 2008). It is an herbaceous annual that grows in temperate and tropical climates and has succulent stems and leaves Desai *et al*., (2023). Purslane has been used in salads in various parts of the world for centuries, including the Mediterranean, Asia, Africa, and the Middle East (Yang *et al*., 2009). It contains several botanical ingredients that indicate its use in various cosmetics Mourelle *et al*., (2023). Purslane shoots are high in bio-protective elements such as omega-3 fatty acids, α-tocopherol, ascorbic acid, ß-carotene, and glutathione. As well as other antioxidants, vitamins, and vital amino acids and their wound healing and antibacterial activity, as well as their widespread use in the topical treatment of inflammatory diseases, make purslane valuable (Minh *et al*., 2019; Jaiswal, 2017; Yang *et al*., 2009). It has many medicinal properties, used to treat arthritis-related conditions such as concentration, liver, stomach, cough, shortness of breath, burns, headaches, and illnesses. Its use as a laxative, cardiac tonic, emollient, muscle relaxant, anti-inflammatory, and diuretic makes it an important source of potassium, magnesium, and calcium in herbal medicine. It is also used to treat diabetes and low blood pressure, and has tremendous nutritional properties, for potential future use (Petropoulos *et al*., 2015). All of these characteristics have heightened commercial interest in its cultivation (Cros *et al*., 2007).

Due to its strong resilience to varying climatic and severe circumstances, Purslane is a cosmopolitan weed that is extensively dispersed in many locations across the world (Pinto *et al.,* 2021). Cultivation can be done in a variety of methods, including soil and soilless systems. When compared to conventional soil cropping systems, floating and hydroponic systems are very promising for common purslane cultivation because they incorporate all of the benefits of soilless cultures such as higher plant density and yield, better nutritional management, faster crop production, cleaner final products (Petropoulos *et al*., 2016; Fussy & Papenbrock, 2022). Several environmental parameters, including light, temperature, salinity, pH, osmotic potential, and seed burial depth, have an impact on weed germination. Only a few weed species, such as *Rumex crispus* and *Rumex conglomeratus*, require light as a necessary condition for seed germination (Kaur *et al.,* 2021). Without any pretreatment, the dormant *P. oleracea* seeds only demonstrated a 27% germination rate (Sami *et al*., 2019; Kaur *et al.,* 2021). Seed priming is a pre-sowing technique that involves exposing dried seeds to a solution that allows for partial hydration but not complete germination (Abdelkader *et al.,* 2023; Lutts *et al*., 2016). Although germination occurs before seeding, the goal of priming is to start the metabolic processes that prepare seeds for radical protrusion (Passam & Kakouriotis, 1994). The seed priming can speed up and boost germination and early seedling growth, which is especially important during the typical drought stress conditions that occur at the start of the season (Souza *et al*., 2016). Various priming processes have been successfully developed, to improve seed germination speed (Gupta & Narzary, 2013), enhanced water absorption capacity, and ensured emergence (Matsushima & Sakagami, 2013).

Faster germination of the crops has resulted in better yields. Obtaining primers that promote metabolic activity in seed absorption before seeds are sown in the field is a straightforward and practical technique to increase yields (Qin *et al.,* 2023; Ashraf & Foolad, 2005). In developing countries, this method is known as farm priming, in which seeds are soaked before priming in the field (Carrillo-Reche *et al.,* 2018). This is a useful method in developing countries around the world to obtain higher yields from crops such as rice, chickpeas, and corn (Harris *et al*., 1999). It is mostly utilized for local production and consumption on a small scale. According to Safdar *et al*., (2019) around the world, salt has an impact on 50% of irrigated land. The production of crops across the world is threatened by both salt and drought. Salt stress, which combines the impacts of both components and causes osmotic pressure, certain ionic effects, and nutritional imbalances, often has a significant negative impact on plant development and output (Alam *et al.,* 2014). According to Karakas *et al*., (2021), *P. oleracea* can grow and withstand drought and salt stress. It has been classified as tolerant of moderate salinity. The nutritional quality of Purslane and high chloride ion resistance make this plant a promising halophyte for agriculture in areas where high concentrations of salt (mainly NaCl) are present in irrigation water Karkanis *et al*., (2022). Increases in salinity harmed the germination of the purslane (Franco *et al*., 2011). This elastic herbal plant requires relatively little water and soil nutrients and grows well in sunny climates it grows only in the hottest months of the year (June-September). Plants are sensitive to cold and are destroyed by cooling temperatures (Jaiswal, 2017).

Although in Gilgit-Baltistan Purslane is considered a weed and it affects the performance, of other main crops such as wheat, maize, potatoes, and other commercial green vegetables as discussed by (Chinnusamy *et al*., 2010). The majority of research focused on products, and there is limited data on how different priming techniques affect germination performance. The study aimed to test the effect of priming (soaking) in laboratory conditions that may have a positive effect on the germination and emergence, of seeds. It will help to develop a simple and economical method of seed priming for farmers to obtain a better yield and is recommended to farmers that use farm priming before sowing seeds for fast germination and better performance of crops, especially vegetables and fooders.

Materials and Methods

Research area (*In vitro*) and plant materials: The study was conducted between October 2019 to December 2019 at the laboratory of the Department of Agriculture and Food Technology, Karakorum International University Gilgit, Gilgit-Baltistan, Pakistan.

The Purslane seeds used in the study were obtained from the seed supplier in Gilgit-Baltistan. The collected seeds were washed and kept at room temperature in airtight containers until they were used in experiments. A thousand *P. oleracea* seeds weighed 1.40 g (Kaur *et al.,* 2021).

Germination experiment (treatments): Five specific primings were used to treat the seeds. The treatments were T1: seeds soaked in water, 30℃, 40℃, and 50℃ for 10 minutes. T2: seeds were treated in different concentrations of methanol such as 10%, 20%, and 30% for 10 minutes. T3: seeds were soaked for 10 minutes in 15%, 30%, and 45% sodium chloride (NaCl) concentrations. T4: seeds were soaked in 15%, 30%, and 45% Potassium Iodide (KI) solution for 10 minutes and tested the effect of these treatments on purslane seed germination. In C: seeds were soaked in normal tap water for 10 minutes and placed in the same media to test the germination difference between priming and control conditions. The seeds germinated through in-vitro propagation in laboratory conditions (Kaur *et al.,* 2021).

After these treatments, the seeds were put in germinating media to test their germination. The media was prepared by using cotton, water, and paper sheets in which moisturized cotton was placed in Petri dishes and two layers of a sheet were put over the wet cotton. The purpose of cotton is to supply water and to keep the sheet's surface moisturized as required for seed germination. Ten treated seeds were placed in each treatment of the Petri dish where each treatment has been divided into three replicates and tested their germination percentage in all treatments and replicates. The germination test was continued for 30 days, to determine the percentage of germination. 90 seeds were placed in different replicates of each treatment. Germination was counted in four days intervals and cumulative germination of 30 days has been determined as the final percentage of germination.

Statistical analysis: The germination was counted in four days intervals and cumulative germination of 30 days has been determined as the final percentage of germination. Data were statistically analyzed by using Statistix 8.1, table LSD, table CRD, and table ANOV at $p \leq 0.05$ using Fisher's Protected Least Significant Difference (LSD) test (Kaur *et al.*, 2021).

Results

Effect of temperature interval on germination: Purslane seed germination has been monitored by treating various temperature intervals such as 30℃, 40℃, and 50℃. The results shown in (Table 1) reveals that the germination observed at 50℃ was 100% while the germination was 96% at 30℃ and 40℃. This shows that the seeds are good to resist high temperatures and showed the highest germination at 50℃ as compared to 30℃ and 40℃. Similarly, the mean day-wise germination was recorded as 97.7% at the end of the experiment as shown in (Fig. 1) while the average germination at 30℃, 40℃, and 50℃ was observed as 81.8%, 77.5%, and 80.4% as shown in the Fig. 2. Therefore, the results reveal that when the temperature has been increased the germination of seeds also increased same as the seeds showing the lowest germination at low temperatures as shown in the table 1 as discussed by (Patanè & Gresta 2006).

Effect of Methanol concentrations on germination: The results are shown below in (Table 2) reveals the highest germination (93.3%) at the concentration of 20%, and (86.6%) germination at 10% concentration, while the lowest germination (83.3%) was observed at a 30% concentration. The day-wise mean germination was recorded as 88.5% in the treatment of methanol as shown in Fig. 1, while the average germination was recorded as 71.4%, 79.9% 72.3% which indicates the concentration of methanol, and germination of seed has a negative correlation as shown in the Fig. 2. This difference in germination suggests that the concentration of methanol has a negative effect on germination, as discussed (Mahdavikia & Saharkhiz, 2015).

Effect of NaCl concentrations on germination: The effect of NaCl concentrations results is shown in (Table 3) which reveals that the germination percentage decreased as the salinity concentration increased. It shows that the salinity harms purslane seed and it reduced the germination percentage of purslane seed. Same as the fresh weight and dry mass of purslane slightly decreased when the concentration of salinity is increased as discussed by (Kiliç *et al.*, 2008; Fercha *et al.*, 2014; Bojović *et al.*, 2010), and the germination performance at different salinity concentrations results in the below table also reveals as the concentration has increased the germination is decreased. Where the lowest concentration (15%) showed 100% germination, 30% NaCl concentration showed 86.6% germination, while as the concentration increased up to 45% the germination decreased to 76.6% this showed a negative linear relationship between salinity and purslane seed germination as shown in Table 3. While figure 1 shows 87.7% mean day-wise germination at NaCl treatment, similarly the average germination at 15% concentration of NaCl was 66.6%, 58% at 30% concentration, and at 45% of NaCl concentration the germination was recorded as 51.8% as mentioned in (Fig. 2). These results revealed the negative linear correlation between salinity and seed germination.

Effect of KI concentrations on germination: As already discussed above and discussed by (Kiliç, *et al.*, 2008) that salinity has a negative impact on purslane seed germination and our results are proving and show the below (Table 4) that the germination decreased as KI concentrations increased. Total germination was observed at 15% and 30% which showed 80%. While marginal germination was observed at a concentration of 45% in which purslane showed 76%. Where the mean day-wise germination was recorded as 78.8% and represented in figure 1. While the average germination at different concentrations of potassium iodide is shown in figure 2, like 61.9%, 57.6%, and 55.1% at 15%, 30%, and 45% of KI concentration, which indicates the germination percentage decreases as the concentration of KI increases as discussed by (da Silva *et al.*, 2017).

Germination of seeds on control treatment: The results revealed the average germination which was 78% as shown in figure 2, the average germination of three replicates on control treatment, while figure 1 represents the mean day-wise germination of the replicates, where seeds were soaked in normal water at room temperature and the results were recorded as 80%, and 77.1%. The findings show at low temperatures and cold water, germination was low as compared to "hot water" and "methanol" as shown above in results. Although the pre-soaking increases the germination ratio, similarly, the hot water and other priming stimulate the germination as the findings of the study revealed and other studies have proven findings (Tadros *et al.*, 2011; Patanè & Gresta 2006; Azad *et al.*, 2011).

Table 1. Effect of different temperature intervals on germination of Purslane seed.

Temperature Interval	48Hrs	14Hrs	240Hrs	336Hrs	432Hrs	528Hrs	624Hrs
30℃	0	9.00 ± 1.09A	9.66 ± 0.72A	9.66 ± 0.72A	9.66 ± 0.44A	9.66 ± 0.44A	9.66 ± 0.44A
40℃	0	7.33 ± 0.57B	9.00 ± 1A	9.00 ± 1.0A	9.66 ± 0.57A	9.66 ± 0.57A	9.66 ± 0.57A
50℃	0	7.00 ± 0B	9.66 ± 0.57A	9.67 ± 0.57A	10.00 ± 0A	10.00 ± 0A	10.00 ± 0A
S. Er. C	0	0.54	0.61	0.60	0.38	0.38	0.39
CVC	0	1.33	1.48	1.48	0.94	0.94	0.94
Mean	0	7.77	9.44	9.44	9.77	9.77	9.77
CV	M	14.05	7.69	7.69	4.50	4.50	4.50
Kurtosis	M	-0.19	-0.50	-0.50	-0.21	-0.21	-0.21
Skew	M	1.06	-0.83	-0.83	-1.33	-1.33	-1.33

The values represent means of three replications and ± SD; the means with different letters/ letter is statistically significant at $p<0.05$

Table 2. Effect of different concentrations of Methanol on germination of Purslane seed.

Concentration	48Hrs	240Hrs	336Hrs	432Hrs	528Hrs	624Hrs
10%	0	8.33 ± 0.84A	8.66 ± 0.62A	8.66 ± 0.62A	8.66 ± 0.62A	8.66 ± 0.62A
20%	0	9.33 ± 0.52A	9.33 ± 0.52A	9.33 ± 0.52A	9.33 ± 0.52A	9.33 ± 0.52A
30%	0	8.33 ± 0.5A	8.33 ± 0.5A	8.33 ± 0.5A	8.33 ± 0.5A	8.33 ± 0.5A
S.Er.C	0	0.66	0.47	0.48	0.47	0.47
CVC	0	1.63	1.15	1.15	1.15	1.15
Mean	0	8.74	8.85	8.85	8.85	8.85
CV	M	9.65	7.03	7.03	7.03	7.03
Kurtosis	M	0.35	-0.36	-0.36	-0.36	-0.36
Skew	M	-0.79	0.13	0.13	0.13	0.13

The values represent means of three replications and ± SD; The means with different letters/ letter is statistically significant at $p<0.05$

Table 3. Effect of different concentrations of NaCl on germination of Purslane seed.

Concentration	48Hrs	144Hrs	240Hrs	336Hrs	432Hrs	52 Hrs	624Hrs
15%	0	0	8.00 ± 1.48A	8.66 ± 1.126A	10.00 ± 1.20A	10.00 ± 1.20A	10.00 ± 1.20A
30%	0	0	6.33 ± 1.15A	8.33 ± 1.52A	8.66 ± 1.15AB	8.66 ± 1.15AB	8.66 ± 1.15AB
45%	0	0	6.00 ± 2.0A	7.33 ± 1.15A	7.66 ± 0.57B	7.66 ± 0.57B	7.66 ± 0.57B
S. Er. C	0	0	1.08	1.05	0.6086	0.6086	0.6086
CVC	0	0	2.6639	2.5793	1.4891	1.4891	1.4891
Mean	0	0	6.77	8.11	8.77	8.77	8.77
CV	M	M	21.85	15.64	13.69	13.69	13.69
Kurtosis	M	M	-0.69	-0.46	-1.62	-1.62	-1.62
Skew	M	M	-0.82	0.17	-0.015	-0.015	-0.015

The values represent means of three replications and ± SD; The means with different letters/ letter is statistically significant at $p<0.05$

Table 4. Effect of different concentrations of KI on germination of Purslane seed.

Concentration	48Hrs	144Hrs	240Hrs	336Hrs	432Hrs	528Hrs	624Hrs
15%	0	5.00 ± 1.90A	6.33 ± 1.412A	8.00 ± 1.26A	8.00 ± 1.26A	8.00 ± 1.26A	8.00 ± 1.26A
30%	0	1.33 ± 1.15B	7.00 ± 1.73A	8.00 ± 1.73A	8.00 ± 1.73A	8.00 ± 1.73A	8.00 ± 1.73A
45%	0	2.33 ± 1.15B	5.66 ± 1.15A	7.66 ± 1.15A	7.66 ± 1.15A	7.66 ± 1.15A	7.66 ± 1.15A
S. Er. C	0	0.9027	1.2172	1.1863	1.1863	1.1863	1.1863
CVC	0	2.2088	2.9783	2.9029	2.9029	2.9029	2.9029
Mean	0	2.88	6.33	7.88	7.88	7.88	7.88
CV	M	65.77	22.33	16.09	16.09	16.09	16.09
Kurtosis	M	-0.85	-0.60	-1.25	-1.25	-1.25	-1.25
Skew	M	0.16	0.78	-0.56	-0.56	-0.56	-0.56

The values represent means of three replications and ±SD; The means with different letters/ letter is statistically significant at $p<0.05$

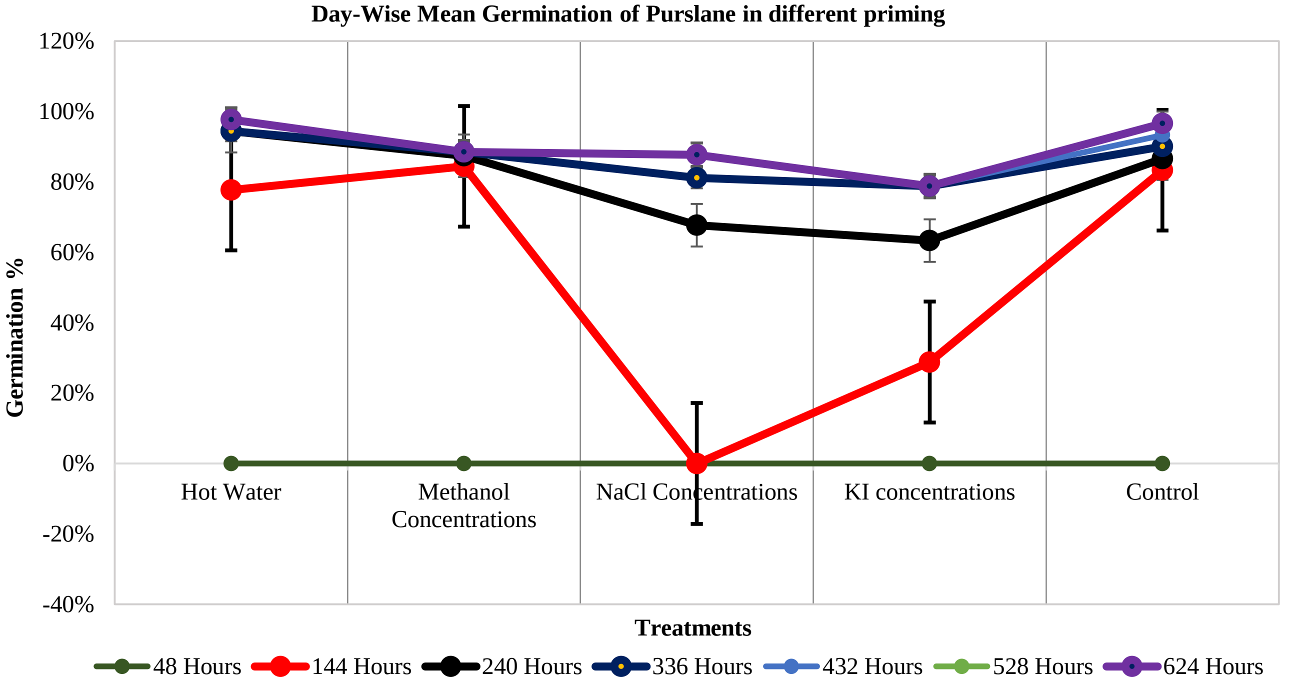

Fig. 1. Day-wise means germination of Purslane seed in different priming.

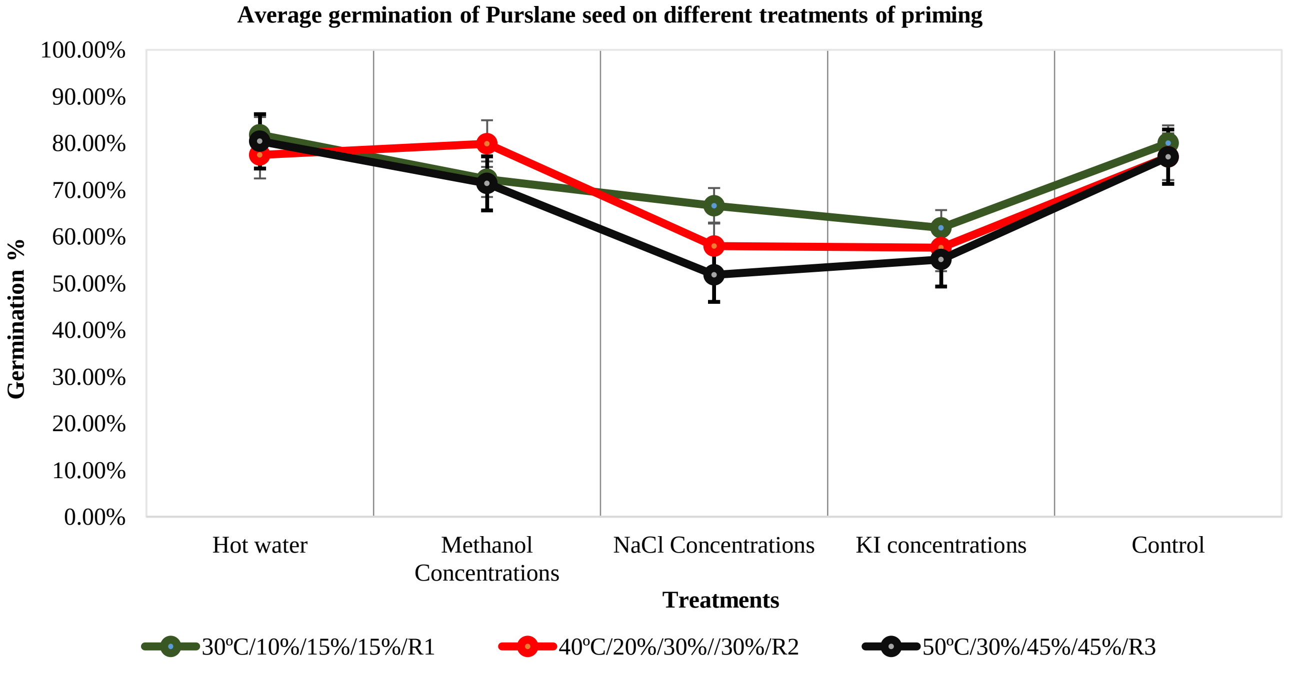

Fig. 2. Average germination of Purslane seeds in different seed priming in different concentrations.

Discussion

Seed germination is a crucial event for seedling establishment and plant growth in the following generation, and it is a complex physiological process that is tightly controlled by endogenous and external stimuli (Yu *et al*., 2021). Plants exhibit a wide range of tolerances for soil salinity, temperature, and chemical concentrations. The ability of seeds to complete germination and seedlings to develop successfully under unfavorable conditions is crucial for species dispersion and survival (Sangeetha *et al.*, 2020). Seeds in their dormant state have a low moisture content and are consequently relatively inactive. Moisture, on the other hand, initiates germination by activating enzymes, causing breakdown, translocation, and the utilization of reserve storage material; hence, data revealed that hydro-priming durations increased seedling emergence percentage and decreased emerging time. Better seed emergence from hydro-priming shows that a longer priming period can help to establish more quickly in the field. Rapid seedling emergence could result in the creation of strong plants (Dembélé *et al*., 2021) *P. oleracea* has the ability to tolerate harsh environmental conditions, including salinity, pH, salinity stress, high temperature, and moisture stress. This plant uses the CAM metabolism during drought and the C4 metabolism when there is enough water available to support its photosynthetic functions (Kaur *et al.*, 2021).

Effect of temperature interval on germination: Purslane seed germination has been observed by treating three different temperature ranges of hot water where the temperature intervals were 30°C, 40°C, and 50°C. The results showed that germination observed at 50°C was 100% while the germination was 96% at 30°C and 40°C. This shows that the seeds are good to resist high temperatures and showed the highest germination at 50°C as compared to 30°C and 40°C (Egley, 1990) conducted a similar study. A similar method was used to analyze the effect of temperature, light, salinity, drought stress, and seeding depth on germination (Asif *et al*., 2012; Patanè & Gresta, 2006; Kaur *et al.*, 2021). It may be due to a very hard seed coat in which at low temperatures the seed coat may not have fully absorbed water in 10 minutes and the seed coat may not be softened. Table 1, Figs 1, and 2 show the results of day-wise germination, mean day-wise germination, and average germination at different temperature intervals of 30 days of germination of seeds, and our results are supporting some previous studies as mentioned in results and discussions.

Effect of methanol concentrations on germination: The results revealed the highest germination (93%) at the concentration of 20%, (86%) germination at 10% concentration, while the lowest germination (83%) was observed at a 30% concentration as shown in table 2 while the mean germination and average germination in different concentrations of methanol are showing in Figs. 1 and 2. This difference in germination suggests that as the concentration of methanol increases the percentage of germination decreases, which was already discussed by (Mahdavikia & Saharkhiz, 2015). The average and day-wise germinations are presented below figures, the lowest germination results may be due to the high concentration of methanol, which may damage the seed cotyledons, and affect the germination value of the seed while when the concentration of methanol decreases germination also increased these results are showing a negative linear correlation between methanol concentration and seed germination.

Effect of NaCl concentrations on germination: Results showed that the germination percentage decreased as the salinity concentration increased. Similar justification and findings of the salinity effects on Purslane seeds were mentioned by (Franco *et al*., 2011, Xing *et al*., 2019, Borsai *et al*., 2018, Naik & Karadge, 2017) and a similar method was used to analyze the effect of temperature, light, salinity, drought stress and seeding depth on germination by (Asif *et al*., 2012; Karkanis *et al.,* 2022).). The seeds may not be tolerant to high salinity concentration, or it may damage the seed germination ability, maybe it damages the seed cotyledons, and affect germination. As purslane seeds are to some extent resistant to salinity but when it is increased the germination decreased as shown in table 3 and figures 1 and 2 in which the highest concentration of NaCl showed the lowest germination. Our results are supported by (Parvaneh *et al*., 2012; Tanveer *et al*., 2013; Naik & Karadge, 2017; Kaur *et al.,* 2021; Karakas *et al.,* 2021).

Effect of KI concentrations on germination: The below figures 1, 2, and (Table 4) reveal that germination decreased as KI concentrations increased. Mean germination was observed at 15% and 30%. While marginal germination was observed at a concentration of 45% which the below-average and day-wise germination. Figures show that at 15% and 30% concentrations while if it's increased to 45% the germination is decreased to 76% which means the salinity harms germination a similar method was used to analyze the effect of temperature, light, salinity, drought stress, and seeding depth on germination by (Asif *et al*., 2012). It may be due to the seed cotyledons being damaged at high concentrations, their seed coat has been damaged at a high concentration of KI. It showed that the seeds were salinity sensitive and their output on high salt concentration was poor as already discussed by (Normov *et al*., 2019; Eifediyi *et al*., 2021; Karakas *et al.,* 2021; Kaur *et al.,* 2021).

Germination of seeds on control treatment: The result revealed the average germination, which was 78.1%. As shown in, figure 2, the average germination in 3 replicates of the control treatment, and the mean day-wise germination of replicates are shown in Fig. 1. Because of low temperature and cold water, germination was low compared to "hot water" and "methanol". Maybe the seeds absorbed cold water gradually and it may slowly activate the cotyledons and germination. The findings show at low temperatures and cold water, germination was low as compared to "hot water" and "methanol" as shown above in results. Although the pre-soaking increases the germination ratio, similarly, the hot water and other priming stimulate the germination as the findings of the study revealed and other studies have proven findings (Tadros *et al*., 2011; Patanè & Gresta 2006; Azad *et al*., 2011; Kaur *et al.,* 2021).

Conclusion

The simple and practical treatment method known as priming can be used effectively to accelerate seed germination by soaking before sowing. The results indicate that the different priming treatments at different intervals and concentrations have improved the germination percentages, which may lead to high productivity and better yield production. The economic tool used for enhancing the emergence and establishment of benefits for low-income farmers. Farm priming is economical for low-income and small landholding farmers, which enhances germination in less time, will help them to save time, and enhance germination. As the results revealed that temperature interval or hot water treatments are best for enhancement of seed germination, it is economical so farmers can easily use this technique before sowing seed. It may lead single cropping areas to double cropping zone by emerging germination.

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