



## INFLUENCE OF POTASSIUM CHLORIDE SEED PRIMING ON THE GERMINATION TRAITS OF CANOLA UNDER DIFFERENT SALINITY LEVELS

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**Abstract** Soil salinity is a serious abiotic component that drastically lowers seed germination, especially in dry and semi-arid areas. In order to enhance germination performance under stressful circumstances, seed priming is thought to be an efficient pre-sowing method. This study aimed to assess how potassium chloride (KCl) seed priming affected canola (*Brassica napus* L.) germination characteristics at various salinity levels. The experiment was executed at the Carbon Sequestration and Sustainability Laboratory, Department of Agronomy, University of the Punjab, Lahore, Pakistan. Using three replications in a completely randomized design, seeds were halo-primed in a 30 mmol L<sup>-1</sup> KCl solution for five hours before germination under five NaCl salinity levels (0, 20, 30, 40, and 50 mmol L<sup>-1</sup>). The parameters that were recorded were mean germination time (MGT), germination percentage (GP), germination energy (GE), germination rate index (GRI), coefficient of velocity of germination (CVG), and fresh weight (FW). The findings showed that whereas MGT increased, indicating delayed and decreased germination under salt stress, rising salinity levels dramatically decreased FW, CVG, GP, GE, and GRI. Primed seeds under control conditions had the highest FW (0.4233 g), CVG (46.176), and GRI (5.4167), while unprimed seeds at 50 mmol L<sup>-1</sup> NaCl had the smallest values. When compared to unprimed seeds, seed priming with KCl greatly enhanced germination performance at all salinity levels, leading to a larger germination percentage and quicker germination. According to findings, KCl seed priming constructively mitigates the detrimental effects of salt on canola germination by improving the physiological mechanisms involved in germination. Consequently, seed priming can be considered to be an easy and affordable method to enhance crop establishment in a saline environment.

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### Introduction

Soil salinity significantly reduces agricultural productivity, predominantly in dry and semi-arid lands, which account for 110 million of the 270 million hectares of irrigated land (Smedema and Shiati, 2002). When certain alterations take place on the ground's surface, such as the development of salty patches in the soil and the emergence of white salt crust on bare ground, a soil can be identified as salt-affected. These changes can be either permanent or extended waterlogging following precipitation; road degradation and crumbling; deterioration of surface and ground water, making it unfit for human consumption and animals; and the presence of salt crystals, which are more common in extremely saline soils (Srivastava et al., 2019). Among the most important oilseed crops in the world is canola (*Brassica napus* L.) (Bybordi and Tabatabaei, 2009). A prime barrier to canola seed germination and seedling stand is soil salinity, which is a prevalent concern in irrigated environments (Bybordi and

Tabatabaei, 2009). Crop development and growth are negatively impacted by this problem, which results in low agricultural yield. One of the most important periods for a crop exposed to salinity is germination (Bybordi and Tabatabaei, 2009).

In the life cycle of terrestrial angiosperms, seed germination is a pivotal and delicate stage that influences plant growth and seedling establishment (Chakma et al., 2019). Salinity restrains germination in many vegetable crops' seeds, either due to adverse impacts of Na<sup>+</sup> and Cl<sup>-</sup> or due to osmotic imbalance outside the seed that stops water movement (Khajeh-Hosseini et al., 2003). Plants under salinity stress have three main difficulties: oxidative damage, imbalanced ion absorption, and rising osmotic pressure (Tahjib-Ul-Arif et al., 2018). All of these reasons make it difficult for the seed to germinate in a saline environment. "Priming" is a proven technique to improve seed quality. Priming boosts seed germination rates, causing more yield and opposition toward biotic and abiotic challenges (Paparella et al., 2015). As a pre-sowing procedure, seed priming

involves exposing seeds to a specific solution that permits restricted hydration without germination, then drying them back to their natural amount of moisture (Jiang et al., 2016). Halo-priming permits seeds to imbibe water, but doesn't allow the seed to germinate until sowing (Ali et al., 2012). The most common source of potassium (K) for crops is potassium chloride, and chloride (Cl) is thought to be a crucial micronutrient (Fixen, 1993). KCl is a commonly available nutrient salt among farmers; the purpose of the study is to check if the KCl helps in salt stress mitigation. According to earlier research, different seed priming techniques might lessen the detrimental and depressing impacts of salinity and water stress on germination. The intent of the current study is to discover how seed priming with KCl affects germination at various salinity levels.

### Material methods

The experiment was conducted in the Carbon Sequestration and Sustainability Lab, Department of Agronomy, Faculty of Agriculture, University of the Punjab, at an elevation of 220 meters in Lahore, Pakistan, at 31.49° N, 74.3° E. Three hundred *Brassica napus L.* cultivar Super seeds were surface-sterilized for fifteen minutes with 1% sodium hypochlorite. After that, distilled water was utilized to wash the seeds three times. For halopriming, seeds were arranged in a 250 mL beaker along with a solution that contained 30 mmol L<sup>-1</sup> KCl. The seeds were surface dried using tissue paper after five hours in the solution, and they were then left to air dry for three hours. Ten seeds were arranged on filter paper in Petri plates (11 cm in diameter) in triplicate. For creating saline conditions, NaCl solution was added at 0, 20, 30, 40, and 50 mmol L<sup>-1</sup> concentrations. For germination, Petri dishes were covered and kept at 25°C in the dark. The number of germinated seeds was counted to check the following parameters.

### Mean germination time (MGT)

Mean germination time is calculated by (Ellis and Roberts, 1981) equation;  $MGT = \frac{\sum(n * D)}{\sum D}$   
n = no of germinated seeds; D = no of days from start of germination

### Germination percentage (GP)

For statistical analysis, the observed germination % was arcsin converted, as suggested by (Dezfuli et al., 2008)

### Germination Rate Index (GRI)

The germination rate index is calculated by the method suggested (Czabator, 1962).

$$GRI = \frac{G_1}{D_1} + \frac{G_2}{D_2} + \frac{G_3}{D_3} + \dots + \frac{G_n}{D_n}$$

### Germination energy (GE)

Using the methods outlined in the International Rules for Seed Testing (ISTA, 2022), germination energy (GE) was determined as the percentage of sprouted seeds at the first count.

$$GE = \frac{Ng}{Nt} * 100$$

Ng is the quantity of seeds that sprouted on the first count (early germination day); Nt is the total number of seeds examined.

### Coefficient Of Velocity Of Germination (CVG)

Coefficient of Velocity of germination is calculated as

$$CVG = \frac{\sum N}{\sum N * T} \text{ (Czabator, 1962)}$$

N is the number of seeds that sprout each day; T is the number of days since germination started.  $\sum N$  is the total number of seeds that sprouted;  $\sum(N * T)$  is the total germinated seeds  $\times$  matching day.

### Fresh weight

The fresh weight of germinated seeds was calculated on the seventh day, and the mean of each replicate was calculated for analysis. The LSD test (Gomez and Gomez, 1984) was used to compare means after data were statistically evaluated based on two variation factors (NaCl dosages and priming treatments).

### Results

As salinity levels increased, fresh weight decreased (Figure 1). Primed seeds at 0 mM NaCl had the maximum FW (0.4233 g), whereas unprimed seeds at 50 mM NaCl had the lowest FW (0.1367 g). Primed seeds produced more fresh weight than unprimed seeds at all salinity levels, suggesting that seed priming enhanced seedling vigor and biomass accumulation under salt stress. As the concentration of NaCl increased, the coefficient of germination velocity dropped. Primed seeds under control conditions showed the highest CVG (46.176), while primed seeds at 50 mM NaCl showed the lowest CVG (24.022). Primed seeds generally maintained comparatively higher CVG values than unprimed seeds, indicating that priming accelerated germination even in saline environments. In both primed and unprimed seeds, germination energy remained high (100%) at lower salt levels (0–20 mM). But the GE dropped at increasing salinity levels, especially in unprimed seeds. Primed seeds maintained increased germination energy even at increasing salt concentrations, while unprimed seeds had the lowest GE (53.33%) at 50 mM NaCl. The germination percentage trended similarly to GE. Significant decreases happened at greater salt concentrations, and maximum GP values were observed under control and lower salinity levels. While primed seeds maintained comparatively greater germination levels, unprimed seeds displayed a rapid fall in GP at 40 and 50 mM NaCl. As salinity increased, the germination rate index gradually decreased. Primed seeds at 0 mM NaCl had the highest GRI (5.4167), whereas unprimed seeds at 50 mM NaCl had the lowest GRI (1.7556). When compared to unprimed seeds, seed priming significantly increased GRI, indicating quicker and more consistent germination.

Slower germination under saline circumstances is indicated by an increase in mean germination time with increasing salinity stress. Primed seeds under controlled circumstances had the lowest MGT (2.1667 days), whereas primed seeds under 50 mM

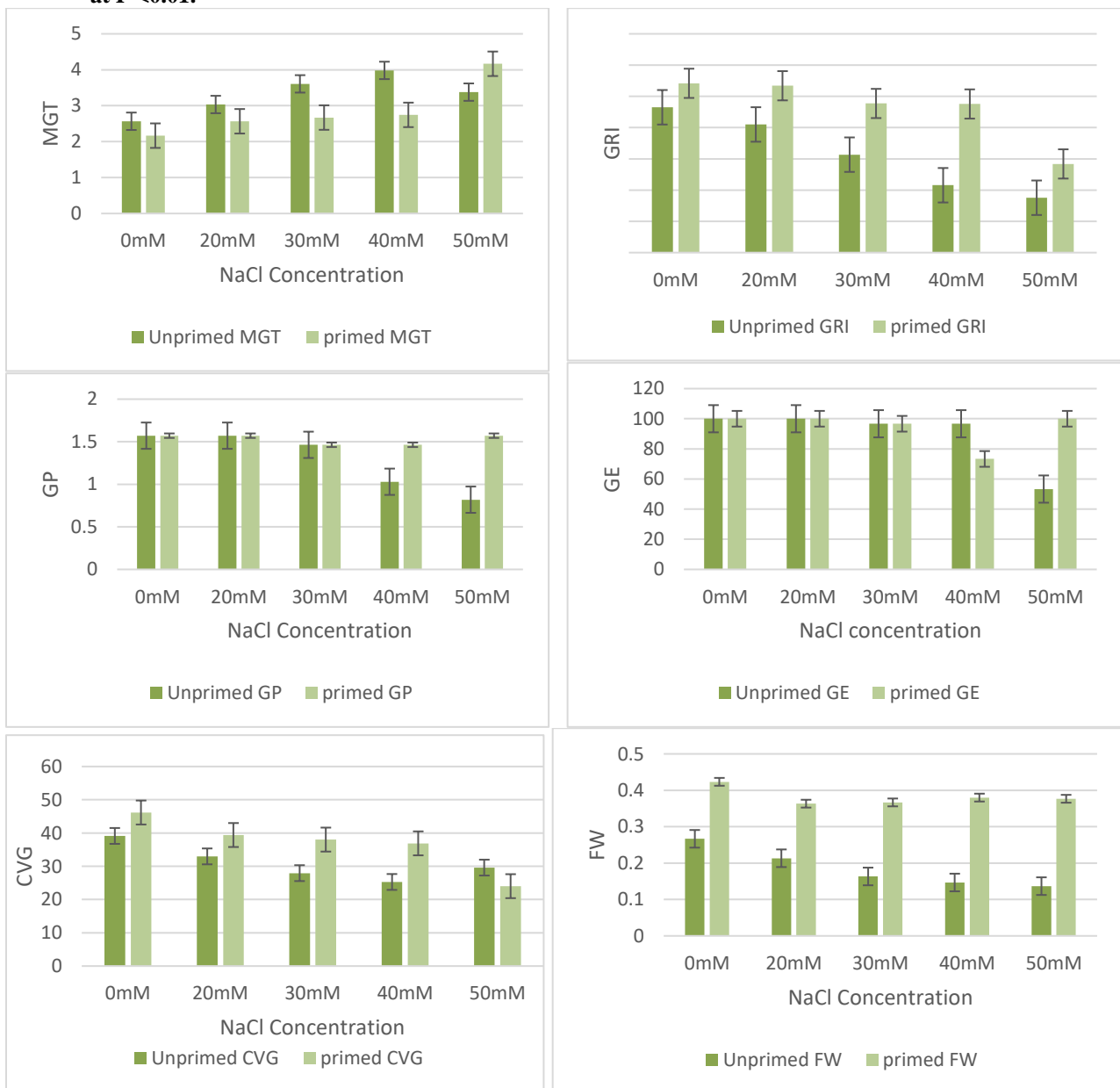
NaCl had the highest MGT (4.1667 days). In general, priming shortened the time it took for seeds to

germinate when compared to unprimed seeds at most salinity levels.

**Table 1. Mean comparison of priming effects On Canola Germination traits under saline stress.**

NaCl Stress (mM)	Priming	FW	CVG	GE	GP (%)	GRI	MGT
0	Primed	0.4233 A	46.176 A	100.00 A	1.5708 A	5.4167 A	2.1667 F
	Unprimed	0.2667 C	39.127 B	100.00 A	1.5708 A	4.6500 BC	2.5667 EF
20	Primed	0.3633 B	39.402 B	100.00 A	1.5708 A	5.3389 A	2.5667 EF
	Unprimed	0.2133 D	32.975 CD	100.00 A	1.5708 A	4.1000 C	3.0333 DE
30	Primed	0.3667 B	38.028 BC	96.67 A	1.4635 A	4.7722 B	2.6704 E
	Unprimed	0.1633 E	27.937 DE	96.67 A	1.4635 A	3.1341 D	3.6074 BC
40	Primed	0.3800 AB	36.891 BC	96.67 A	1.4635 A	4.7556 B	2.7444 E
	Unprimed	0.1467 E	25.286 E	73.33 B	1.0298 B	2.1556 E	3.9821 AB
50	Primed	0.3767 B	24.022 E	100.00 A	1.5708 A	2.8373 D	4.1667 A
	Unprimed	0.1367 E	29.608 DE	53.33 C	0.8190 B	1.7556 E	3.3778 CD

- **Note: The LSD test shows that having the same letter is not significantly different from one another at P <0.01.**



**Figure 1. Influence of KCl priming on Germination of canola in salinity**

## Discussion

Salinity stress is a very serious abiotic stress limiting seed germination. The current study discovered that fresh weight, germination rate index (GRI), germination percentage, and coefficient of velocity of germination (CVG) all considerably decreased while mean germination time (MGT) increase as NaCl concentration increased. These findings show that germination performance is adversely affected by salinity. Osmotic stress and ionic toxicity brought on by a large amount of Na<sup>+</sup> and Cl<sup>-</sup> ions may be the reason for the decrease in germination under salinity stress. During germination, these ions interfere with metabolic processes and decrease the seeds' absorption of water. As a result, in saline environments, seedling development and germination rates decrease. Increasing saline levels dramatically decreased germination percentage, germination rate, and seedling growth features in several crops, according to similar findings from multiple studies (Feghhenabi et al., 2020). Germination percentage (GP) and germination rate (GR) have an inverse relation with saline stress. As the concentration of NaCl increased in the current experiment, the fresh weight of the seedlings gradually dropped. While the lowest values were found at greater salt levels, the highest fresh weight was reported under control conditions. Inhibited cell division, decreased water absorption, and compromised metabolic activity during early seedling growth are the main causes of lower fresh weight under salt stress. Increasing saline levels dramatically decreased seedling biomass and development characteristics in wheat and tomatoes, according to similar findings reported by (El-Saifi et al., 2010). As saline levels rose, the germination rate index (GRI) and coefficient of velocity of germination (CVG) both declined, indicating slower germination under salt stress. Salinity slows down the rate of enzymatic processes that mobilize seed stores, delaying germination and the establishment of seedlings. Due to the osmotic limitation of seeds' ability to absorb water, prior research has also shown (Akram et al., 2024) that germination rate and germination index drop as saline levels rise. Higher saline levels resulted in an increase in mean germination time (MGT), which suggests delayed germination. Increased salt concentrations cause osmotic stress, which delays the start of metabolic pathways needed for germination and hinders imbibition (Akram et al., 2024). In this experiment, seed priming greatly enhanced germination characteristics and somewhat tolerated the detrimental impacts of salinity. Across all salt levels, primed seeds outperformed unprimed seeds in terms of fresh weight, CVG, germination %, and germination rate index. Initially in germination, seed priming speeds up enzyme activation, increases metabolic activity, and speeds up the mobilization of stored food stores. As a result, even in stressful situations, primed seeds germinate more quickly and

consistently. Present outcomes are in accordance with previous work demonstrating that seed priming enhances germination rate and germination percentage in saline environments (Mirza, 2021).

## Conclusion

The current investigation demonstrated that increasing salt levels significantly reduced seed germination. At greater NaCl concentrations, fresh weight, germination percentage (GP), germination energy (GE), germination rate index (GRI), and coefficient of velocity of germination (CVG) all decreased while mean germination time (MGT) increased. These findings suggest that osmotic stress and ionic toxicity, which restrict water absorption and interfere with metabolic processes during germination, cause salinity stress to delay germination. It has been demonstrated that seed priming is a beneficial method to improve germination performance in saline settings. Across all salinity levels, primed seeds consistently displayed reduced MGT and higher fresh weight, CVG, GP, GE, and GRI than unprimed seeds. This improvement implies that priming improves physiological and biochemical processes that allow seeds to germinate more quickly and evenly, even under salt stress. These processes include enzyme activation, quicker mobilization of stored food reserves, and enhanced water uptake. Overall, the results indicate that seed priming can magnify seed germination by limiting the negative influence of salinity. Therefore, seed priming is a simple, practical, and economical method of enhancing crop establishment in saline environments. To confirm the potency of priming methods to elevate crop performance in salt-affected soils, more field research is advised.

## References

- Akram, M., Manzoor, N., Hassan, M.W., Farooq, A.B.U., 2024. On-farm seed priming to alleviate the effect of saline stress during germination of pearl millet (*Pennisetum glaucum* L.). *Bangladesh Journal of Botany*, **53**, 973–980. <https://doi.org/10.3329/bjb.v53i4.78651>
- Ali, A., Hyder, S.I., Arshadullah, M., Bhatti, S.U., 2012. Potassium chloride as a nutrient seed primer to enhance salt-tolerance in maize. *Pesquisa Agropecuária Brasileira*. **47**, 1181–1184. <https://doi.org/10.1590/S0100-204X2012000800020>
- Bybordi, A., Tabatabaei, J., 2009. Effect of salinity stress on germination and seedling properties in canola cultivars (*Brassica napus* L.). *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* **37**, 71–76. [notulaeobotanicae.ro/article/view/3299](http://notulaeobotanicae.ro/article/view/3299)
- Chakma, P., Hossain, M.M., Rabbani, M.G., 2019. Effects of salinity stress on seed germination and seedling growth of tomato: Salinity stress on seed germination and seedling growth. *Journal of Bangladesh Agricultural University*, **17**, 490–499.

- Czabator, F.J., 1962. Germination value: an index combining speed and completeness of pine seed germination. *Forest Science*, **8**, 386–396. <https://doi.org/10.1093/forestscience/8.4.386>
- Dezfuli, P.M., Sharif-Zadeh, F., Janmohammadi, M., 2008. Influence of priming techniques on seed germination behavior of maize inbred lines (*Zea mays* L.). *ARPN Journal of Agricultural and Biological Science*, **3**, 22–25.
- Ellis, R., Roberts, E., 1981. The quantification of ageing and survival in orthodox seeds. *Seed Sci. Technol. Neth.* **9**.
- El-Saifi, S., Ahmed, H., Hasan, S.M., Morsi, M., El-Shatoury, R.S., 2010. Seed priming influences seed germination and seedling growth of tomato under different salinity levels. *Journal of Plant Production*, **1**, 159–170. <https://doi.org/10.21608/jpp.2010.86334>
- Feghhenabi, F., Hadi, H., Khodaverdiloo, H., Van Genuchten, M.T., 2020. Seed priming alleviated salinity stress during germination and emergence of wheat (*Triticum aestivum* L.). *Agricultural Water Management*, **231**, 106022. <https://doi.org/10.1016/j.agwat.2020.106022>
- Fixen, P.E., 1993. Crop responses to chloride. *Advances in Agronomy*, **50**, 107–150. [https://doi.org/10.1016/S0065-2113\(08\)60383-2](https://doi.org/10.1016/S0065-2113(08)60383-2)
- Gomez, K.A., Gomez, A.A., 1984. Statistical procedures for agricultural research. John Wiley & sons.
- Jiang, X., Li, H., Song, X., 2016. Seed priming with melatonin effects on seed germination and seedling growth in maize under salinity stress. *Pakistan Journal of Botany*, **48**, 1345–1352.
- Khajeh-Hosseini, M., Powell, A., Bingham, I., 2003. The interaction between salinity stress and seed vigour during germination of soyabean seeds. *Seed Science and Technology*, **31**, 715–725. <https://doi.org/10.15258/sst.2003.31.3.20>
- Mirza, S.R., 2021. 23. Seed priming enhanced seed germination traits of Wheat under water, salt and heat stress. *Pure and Applied Biology, PAB* **4**, 650–658. <https://doi.org/10.19045/bspab.2021.100068>
- Paparella, S., Araújo, S.S., Rossi, G., Wijayasinghe, M., Carbonera, D., Balestrazzi, A., 2015. Seed priming: state of the art and new perspectives. *Plant Cell Reports*, **34**, 1281–1293. <https://doi.org/10.1007/s00299-015-1784-y>
- Smedema, L.K., Shiati, K., 2002. Irrigation and Salinity: a Perspective Review of the Salinity Hazards of Irrigation Development in the Arid Zone. *Irrigation and Drainage Systems*, **16**, 161–174. <https://doi.org/10.1023/A:1016008417327>
- Srivastava, P., Wu, Q.-S., Giri, B., 2019. Salinity: an overview. *Microorganisms in Saline Environments: Strategies and Functions*, 3–18. [https://doi.org/10.1007/978-981-13-8335-9\\_1](https://doi.org/10.1007/978-981-13-8335-9_1)
- Tahjib-Ul-Arif, Md., Roy, P.R., Al Mamun Sohag, A., Afrin, S., Rady, M.M., Hossain, M.A., 2018. Exogenous Calcium Supplementation Improves Salinity Tolerance in BRR1 Dhan 28; a Salt-Susceptible High-Yielding *Oryza Sativa* Cultivar. *Journal of Crop Science and Biotechnology*, **21**, 383–394. <https://doi.org/10.1007/s12892-018-0098-0>

### Statements and Declarations

#### Data Availability statement

All relevant data are within the manuscript file.

#### Author's Contribution Statement

JA, MN, SHUHS, and AS conceived the study, collected and analyzed data, wrote the manuscript. AH supervised, provided resources. MN and HA critically reviewed, edited, and provided resources. All authors have read the final manuscript and approve its submission.

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#### Ethical Statement

Not applicable

#### Conflict of interest

No conflict of interest.



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