RESEARCH ARTICLE

Evaluation of Seed Priming and Priming Agents for Enhancing Seed Germination and Vigor of Cowpea Seedlings (*Vigna unguiculata*)

W. M. Shanika. S. Wijesooriya[1*], S. L. Ranamukhaarachchi[1], N. L. A. T. S. Nanayakkara[2]

[1]*Department of Agricultural Technology, Sri Lanka Technology Campus, Meepe, Sri Lanka.*
[2]*Central Seed Testing Laboratory, Gannoruwa, Sri Lanka.*

Submitted on: 2025.07.11 Revised on: 2025.10.25 Accepted on: 2026.01.07

Abstract: Cowpea is a leguminous crop grown in tropical regions, including Sri Lanka, where abiotic stress factors, such as drought and soil salinity, often limit its productivity. This study aimed to evaluate the effects of different seed priming agents and early seedling growth under controlled environmental conditions. Nine priming treatments were tested, including Sodium Chloride, Oral Rehydration Salts, Albert solution, Sodium bicarbonate, Potassium chloride, Trichoderma asperellum, Kody mix, Hydrogen peroxide, and Triple super phosphate. Seeds were primed and monitored over a ten-week period. Germination performance was assessed using parameters such as time to first germination, time to fifty percent germination, final germination percentage, shoot length, root length.

The results revealed that all priming agents improved germination and seedling growth to varying degrees compared to the unprimed control. Among the treatments, Potassium chloride, Trichoderma asperellum, Kody mix, and Hydrogen peroxide showed the most significant enhancement in germination rate, uniformity, and seedling vigor. These findings indicate that appropriate seed priming agents can be effectively utilized to enhance germination performance and early seedling establishment of cowpea, thereby improving its productivity under tropical conditions.

Keywords: Cowpea, Seed Priming, Germination, Vigor Index, Shoot Length, Root Length.

INTRODUCTION

Cowpea is a drought-tolerant legume that plays a crucial role in food and nutritional security as a rich protein source in tropical and sub-tropical regions, especially in sub-Saharan Africa and parts of Asia.

Globally, Africa accounts for nearly 90% of cowpea production [1]. In Sri Lanka, cowpea is cultivated in the dry and intermediate zones such as Anuradhapura, Polonnaruwa, and Monaragala districts [2].

Cowpea production faces considerable challenges due to abiotic stress. Such stress disrupts the physiological processes of seed germination and often results in delayed emergence, poor seedling establishment, and reduced crop yields. Seed priming has emerged as a pre-sowing technique to improve germination and early seedling vigor. Seed priming is a controlled hydration technique that improves seed performance by partially hydrating seeds to a point where germination-related metabolic processes begin, but radicle emergence is withheld. As a result, primed seeds exhibit enhanced germination speed, uniformity, and tolerance to abiotic stresses [3].

Different priming methods have been explored in recent studies. Chemical priming with hydrogen peroxide (H_2O_2) and potassium chloride (KCl). Strengthens the antioxidant defense system and reduces oxidative damage caused by reactive oxygen species [4].

**Corresponding author. E-mail address: shanikaswijes@gmail.com (W.M.Shanika.S. Wijesooriya)*

In addition to improving stress tolerance, advances in cowpea breeding and crop improvement have highlighted seed enhancement technologies as an important strategy for increasing productivity under diverse environmental conditions [5]. Several studies have further demonstrated that seed priming enhances germination, seedling establishment, and overall crop performance under both biotic and abiotic stress conditions [6]. Previous studies have specifically reported that hydrogen peroxide pre-treatment alleviates salinity stress and improves germination and early seedling development in cowpea [7]. Recent investigations on cowpea have also shown that seed priming positively influences several physiological parameters, leading to improved germination and seedling vigor under field and laboratory conditions [8].

In Sri Lanka, cowpea is mostly cultivated under rainfed conditions. The risk of germination failure and low vigor is high due to irregular rainfall and soil degradation. Seed priming is a practical solution that enhances crop establishment, reduces seedling mortality, and ultimately ensures higher yields [2]. Moreover, the use of priming agents could help reduce production costs and support sustainable farming practices. This study was conducted to determine suitable seed priming agents and their optimal concentrations to enhance seed germination, seedling vigor, and ultimately increase growth, development, and seed yields of cowpea.

METHODOLOGY

This experiment was conducted from April to August 2024 (Yala season) at the Central Seed Testing Laboratory of the Seed Certification & Plant Protection Centre, Gannoruwa, Kandy, Sri Lanka (7° 2′ N latitude, 80° 56′ E longitude, and at approximately 490 m above mean sea level). The location was in the Agro-Ecological Region Mid-Country Intermediate Zone. The area experiences a moderate climate with intermittent rainfall and an average daytime temperature ranging from 25 °C to 31 °C during the study period.

The experiment was arranged in a two-factor factorial design, where nine priming agents and their concentrations were tested. Priming solutions were prepared using Sodium chloride (NaCl), Potassium chloride (KCl), Oral Rehydration Salt, Albert Solution, Sodium bicarbonate ($NaHCO_3$), Hydrogen peroxide (H_2O_2), Triple Super Phosphate (TSP), Kody mix (a multiplication medium used for shoot proliferation in banana tissue culture), and *Trichoderma asperellum*. For each agent, five concentration levels (0.5%, 1%, 1.5%, 2%, and 2.5%) were prepared by dissolving the required mass or equivalent volumes in 100 ml of distilled water. Hydrogen peroxide dilutions were calculated using the dilution formula $C_1V_1 = C_2V_2$, with the initial concentration being 6%. For *Trichoderma asperellum*, a series of dilutions was prepared.

Cowpea seeds of the Waruni variety were obtained from the Seed and Planting Material Development Center, Department of Agriculture, Sri Lanka. Seeds were

manually cleaned to remove physical contaminants and sorted for uniformity. Each treatment consisted of 50 seeds. Seeds were soaked in the priming solutions for 2 hours at 25 °C in a controlled environment chamber. After soaking, the seeds were air-dried at room temperature for 23 hours to restore the initial moisture level and prevent early germination. Primed seeds were placed in germination boxes filled with filtered sand. Each box received 50 seeds per treatment per replicate.

The following observations were recorded during the study,

- Time to first germination,
- Time to 50% germination
- Mean Germination Time (MGT)
- Germination percentage (GP)
- Seedling Vigor Index (SVI)

Seedling Vigor Index (SVI) was calculated as described [4] using the following equation;

Seedling Vigor Index = Seedling length x Germination Percentage.

Where SVI is the Seedling vigor index, and seedling length and germination percentage were derived from germination data (shoot and root lengths (cm) were measured from 25 randomly selected cowpea seedlings per replicate)

Statistical Analysis

Analysis of Variance (ANOVA) was performed for data using SAS statistical software. Mean separation was performed using the Least Significant Difference (LSD) test at the 5% significance level. Means comparisons were made to determine the effect of different priming agents and concentrations on cowpea seed germination and vigor parameters.

RESULT AND DISCUSSION

The experimental treatments significantly influenced parameters. Except for the time to 50% germination showed a significant interaction between the priming agent and the concentrations. The results are shown in Figures 1 to 5. The observations made on time to seed germination and percent germination, shoot length, root length, and vigor index are discussed below.

Time for 50 % germination

The percentage of germination among different priming agents and their concentrations was significant at $p \leq 0.05$. The treatment with H_2O_2 at a 0.5% concentration significantly reduced the time required for 50% germination, indicating its strong potential to accelerate germination in cowpea seeds. Sodium bicarbonate ($NaHCO_3$) also promoted earlier germination at 0.5 %. However, higher concentrations of $NaHCO_3$ were detrimental. This adverse effect may be attributed to osmotic stress and elevated pH, which reduced water uptake and seedling abnormalities such as root and shoot intertwining. These results suggest that the use of H_2O_2 at low concentrations, such as 0.5 %, is optimal for promoting rapid and uniform germination.

Shoot length

The interaction between priming agents and concentrations gave the longest shots (19.04 cm) by Kody mix solution at 0.5 % (Figure 1). This may be attributed to its balanced nutrient content, which supplies essential macronutrients, including nitrogen, phosphorus, and potassium. Along with plant growth regulators which support robust shoot growth. Other priming agents, such as Oral Rehydration Salt and Albert solution, also showed moderate but stable improvement. H_2O_2 treatments promoted thick and strong shoots across a wide range of concentrations. *Trichoderma asperellum,* a biological priming agent, also enhanced the shoot growth.

Root length

Trichoderma asperellum and KCl significantly increased root length, and *Trichoderma* at 0.5 % concentration produced the longest roots. The beneficial effect of *Trichoderma* is likely due to its improvement of soil health, leading to enhanced nutrient and water uptake under abiotic stress conditions. KCl and Albert Solution supported root growth at lower concentrations but reduced effectiveness at higher concentrations. H_2O_2 consistently promoted root growth, possibly by modulating reactive oxygen species involved in stress tolerance and root development (Figure 2).

Seedling Length

Lower concentrations of priming solutions (0.5 % and 1%) generally produced longer seedlings compared to

the higher concentrations tested. KCl, Trichoderma, and Kody mix maintained stable seedling lengths across all priming solutions. However, higher concentrations of $NaHCO_3$ and TSP reduced seedling growth (Figure 3).

Vigor Index

The highest and most stable vigor index was found with KCl and *Trichoderma* treatments. KCl reached a peak vigor index of 4111.66 at 1 %, reflecting its strong positive effect on seedling health and growth. *Trichoderma* also showed high vigor indices at lower concentrations, though a decline was observed at higher levels. H_2O_2 was effective at both low (0.5%) and high (2.5%) concentrations (Figure 4).

Germination Percentage

NaCl, KCl, and H_2O_2 treatments enabled up to 100 % germination of cowpea seeds. In contrast, $NaHCO_3$ inhibited germination when used as a priming agent. Moderate concentrations (0.5 %- 1 %) consistently gave the best results, while higher concentrations used decreased germination rates (Figure 5).

CONCLUSION

Seed priming with Hydrogen peroxide (H_2O_2), Potassium chloride (KCl), and *Trichoderma asperellum* at moderate concentration (0.5 % - 1 %) significantly improved cowpea germination, seedling vigor, and early growth. H_2O_2 at 0.5 % effectively reduced the time required for 50 % germination by enhancing enzyme activity and braking dormancy. KCl and *Trichoderma asperellum* promoted superior root and shoot development. Higher concentrations of sodium bicarbonate ($NaHCO_3$) negatively affected seed performance. Therefore, priming H_2O_2, KCl, and *Trichoderma asperellum* at 0.5 % -1 % is recommended for improving cowpea seed germination and establishment under stress conditions.

Table 1: Effects of priming agents and their concentration on germination and seedling growth parameters in cowpea

Treatment Priming Agent and Concentration	Time for 50 % germination days a
Priming agent	
NaCl	3.20a
Oral Rehydration Salt	3.00b
Albert Solution	3.00b
KCl	3.20a
Kody Mix Solution	3.13a
$NaHCO_3$	2.53c
H_2O_2	2.40d
TSP	3.00b
Trichoderma asperellum	3.00b
LSD (p≥0.05)	0.12
Concentration	0.24
0.5 %	3.03b
1 %	3.03b
1.5 %	3.22a
2 %	2.55d
2.5 %	2.85c
LSD (p≥0.05)	0.24

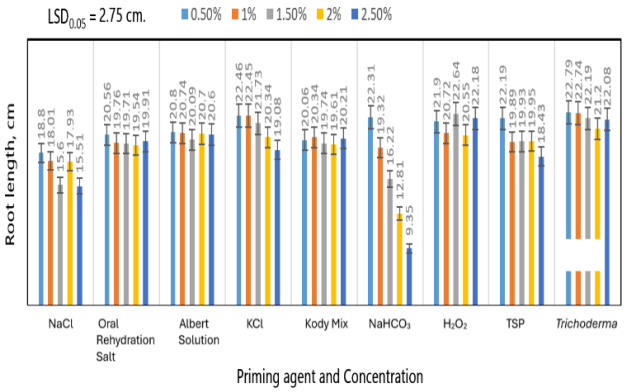

Figure 1: Effect of the priming agent and its concentration on the mean shoot length of cowpea seedlings

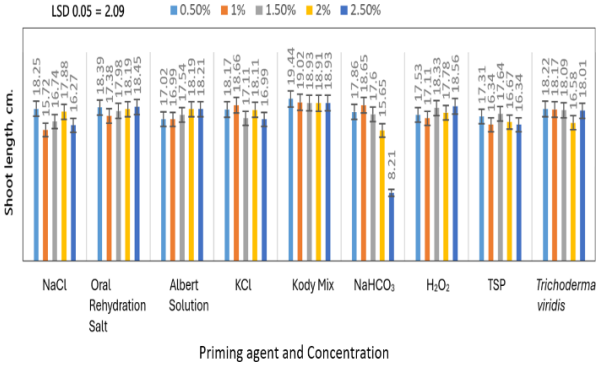

Figure 2: Effect of the priming agent and its concentration on the mean root length of cowpea seedlings.

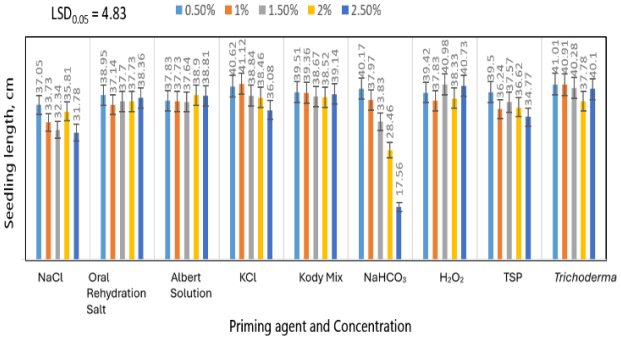

Figure 3: Effect of priming agent and concentration on the mean seedling length of cowpea seedlings.

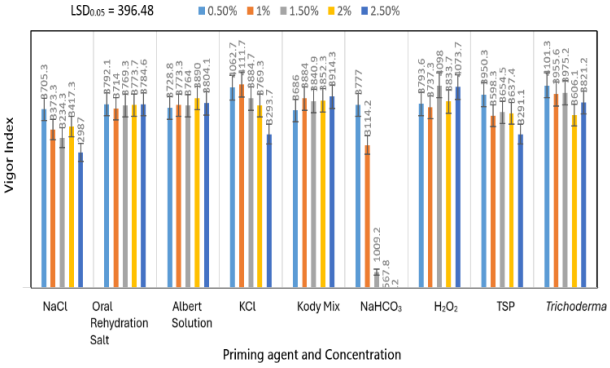

Figure 4: Effect of priming agent and their concentration on the vigor index of cowpea seedlings.

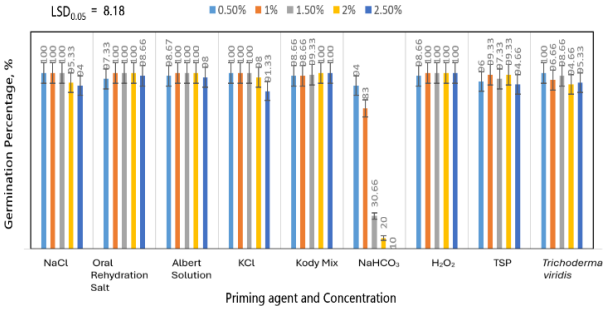

Figure 5: Effect of priming agent and concentration on mean germination percentage of cowpea seeds

ACKNOWLEDGMENT

This research was financially supported by the personnel at the Central Seed Testing Laboratory, Department of Agriculture, Gannoruwa, Peradeniya, providing facilities and assisting the primary author in experimenting on their premises.

REFERENCES

[1] T. O. Fabunmi,B. K. Gbadamosi,and S. O. Adigbo," Seed hydro-priming and early moisture stress impact on biomass production and grain yeild of cowpea, "*International Journal of Applied*, Vol.2, no10,2012.

[2] S. H. N. S. B. Dharmarathna,S. Sutharsana, and S. Srikrishnah, "Application of Hydrangea macrophylla flower extract on growth and yield of Vigna unguiculata L, "*Journal of Agriculture and Value Addition* vol, no,pp.10-19,2019.

[3] M. Hasanuzzaman and V. Fotopoulos, Priming and pretreatment of seeds and seedlings. Singapore: Springer Singapore, 2019, p.20203172603.

[4] Anon, Chapter 1-19, International rules for seed testing, *International Seed Testing Association*,2024.

[5] O. L. Chambliss and B. Sharma, "Recent advance in cowpea breeding," in Advance in Cowpea Research, Ibadan, Nigeria: *International Institute of Agriculture (IITA) and Japan International Research Center for Agricultural Science (JIRCAS),*1997.

[6] H. S. B. Mustafa, T. Mahmood, A, Ullah, A. Shah, A. N. Bhatti, M. Naeem,and R. Ali,"Role of seed priming enhance growth and development of crop plants against biotic and abiotic stresses," *Bulletin of Biological and Allied Science Research*, vol.2017, no.1, pp.8-8,2017.

[7] A. H. Naim, "Influence of pre-sowing treatment with hydrogen peroxide on alleviation salinity stress impacts on cowpea germination and early seedling development," *Asain J. plantScie*., vol.5, pp.62-67,2015.

[8] N. pradhan, R. L. Moharana, N. Ranasingh, K, A, Biswal, and S. K. Bordolui," Effect of seed priming on different physiological parameters of cowpea (Vina unguuiculata L. Walp) seeds collected fromWestern Odisha," *Thepharma innovation Journal*, vol.11, no.6, pp.2338-2343,2022.