

SHORT COMMUNICATION

Effects of Different Priming Treatments on The Germination and Growth of Okra (*Abelmoschus esculentus* L.)

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Abstract

The study was designed to overcome the low germination of okra seed and to assess the effects of different seed priming treatments on okra (*Abelmoschus esculentus*) seedlings, which were encompassed nine treatments: control, hydro-priming, SMP-sand matrix priming, H₂SO₄ - 40%, H₂O₂ - 2%, NaCl - 3%, KCl - 3%, CaCl₂ - 3%, and KI - 1%. A randomized complete block design was used with three replications. Germination percentages, germination speed index (GSI), seedling vigor index (SVI), and relative growth rate (RGR) were measured. The highest germination percentage (89.77%) and GSI (9.6) were observed with (H₂O₂ - 2%). T₃ (H₂SO₄ - 40%) exhibited the highest SVI (0.7), indicating robust seedling health. Additionally, H₂O₂ - 2% demonstrated the longest root and shoot length (11.7 cm and 14.2 cm, respectively) and highest seedling fresh weight (0.87 g). Treatment with H₂SO₄ - 40% displayed the highest dry weight (0.18 g). Notably, H₂O₂ - 2% treatment significantly enhanced germination and growth compared to the control. These findings underscore the potential of seed priming, particularly H₂O₂ - 2%, in enhancing okra seedling growth and development, offering valuable implications for crop productivity and establishment.

Keywords: dry weight, fresh weight, okra, soaking, vigor

Introduction

Okra, scientifically known as *Abelmoschus esculentus* (L.) Moench, is a significant vegetable

produced annually across humid and sub-tropical regions worldwide. In Bangladesh, it holds paramount importance as a highly nutritious vegetable crop cultivated throughout the year. However, the successful cultivation of okra faces challenges related to inadequate seedling emergence and vigor. These challenges are exacerbated by factors such as frost intolerance and a minimum germination temperature requirement of 20°C, which complicates early spring establishment of seedlings in this subtropic region (Pandita et al., 2010). Furthermore, the presence of hard seediness, intensifying as seeds mature and lose moisture content, poses a hurdle to successful germination (Felipe et al., 2010). The hardness of seeds not only affects germination but also impacts weed control, harvesting, and overall crop management practices (Villiers and Edgecumbe, 1975; Mohammadi et al., 2011; El-Balla et al., 2011).

Interestingly, the availability of vegetables in Bangladesh is primarily active during the winter, resulting in a scarcity of vegetables by the period of June to September, which coincides with the summer season (Firoz et al., 2007). Approximately 70% of vegetable production occurs during the rabi season in between November to February with the remaining 30% taking place during the kharif seasons which are rest of the months. Addressing this gap in vegetable supply during the rainy season requires innovative solutions, such as introducing new vegetables suitable for this period. Okra, being a summer/rainy season vegetable, has the potential to play a driving role in bridging this gap (Firoz et al., 2007). However, despite its potential contribution, the per capita consumption of vegetables in Bangladesh remains significantly below the recommended daily intake of 220 g per

person, with the current level being only 62 g per day per person (BBS, 2020). Therefore, successful okra cultivation becomes crucial to alleviating vegetable scarcity during the summer season.

Achieving uniform and rapid germination is pivotal for successful agriculture. Seed priming treatments had emerged as an operative technique to enhance seed performance, particularly in terms of germination rate and uniformity, leading to improved seedling establishment and better crop productivity (Badek et al., 2006). Priming involves controlled cycles of hydration and dehydration, activating essential metabolic processes necessary for germination before the actual germination process begins. This technique holds great promise for enhancing okra production by overcoming challenges related to germination and early seedling growth (Farooq et al., 2008).

Against this backdrop, the research's main inquiry centers around determining the most effective priming treatments to improve key germination parameters, including germination %, germination speed index (GSI), seedling vigor index (SVI), and relative growth rate (RGR) in okra seedlings. The study aims to evaluate various priming treatments' effectiveness in enhancing these germination and growth parameters. The specific objectives include assessing the impression of priming treatments on these limiting factors and identifying the most effective treatment(s) for enhancing okra seedling germination and growth.

Materials and Methods

The research was directed under the supervision of the Department of Horticulture during the period from March-April of 2023 to study the outcome of primer on germination and seedling excellence of okra. The experiment included nine different priming treatments: T_0 (Control), T_1 (hydro priming), T_2 (sand metrix

priming, SMP)), T_3 (H_2SO_4 - 40%), T_4 (H_2O_2 - 2%), T_5 (NaCl-3%), T_6 (KCl-3%), T_7 ($CaCl_2$ - 3%), and T_8 (KI-1%). Three replications of the randomized complete block design experimental design were used. Ahead of priming, seed of hybrid okra variety "Mukut" were collected prior to the experiment from BRAC seed center, a non-government organization. The seeds had 12% moisture, garish in color and 62 g of 1000 seed weight with 80% germination rate. Untreated okra seeds were taken as a control or non-priming behavior (T_0), hydro-priming was done by using only distilled water (T_1), for (SMP) Sand Metrix Priming (T_2) at 60% water holding capacity was maintained and kept soaked overnight. In the case of priming with 40% H_2SO_4 solution (T_3), the seeds were soaked into the acid solution for only 5 minutes and bathed with purified water to remove the solution. Priming with 2% H_2O_2 (T_4), 3% NaCl (T_5), 3% KCl (T_6), 3% $CaCl_2$ (T_7), and 1% KI (T_8) was done by soaking the seed in the prepared solution for 24 hours. Formerly, the seed was indifferent from the solution and cleaned with distilled water. Following, the seeds other than the control, were dried in the oven at 25 °C for 24 hours in the oven close to the typical moistness as described by (Khan et al., 2009).

From the experimentation, the subsequent facts were calculated: 1. germination %, 2. germination speed index (GSI), 3. seedling vigor index (SVI), 4. relative growth rate (RGR)-(a) root length, (b) shoot length, (c) fresh weight of seedling, (d) dry weight of seedling.

Thirty seeds were chosen anonymously from individual treatments, and they were homogeneously positioned on the media. Seed were placed on the seed tray filled with prepared medium in a normal temperature and light condition. Emergence from the medium was considered as the germination of seed and it was ready to count from the 6th day after sowing (DAS) till the 14th DAS. The germination % was evaluated based on the next formula:

$$\text{Germination Percentage} = \frac{\text{Number of total germinated seeds}}{\text{Total number of seeds}} \times 100\%$$

According to Association of Official Seed Analysts (AOSA) (AOSA, 1983), the Germination speed index (GSI) was computed using the formula below:

$$GIS = \frac{\text{Number of total germinated seeds}}{\text{Days of final count}} + \dots + \dots + \frac{\text{Number of total germinated seeds}}{\text{Days of final count}}$$

The Seedling Vigor Index (SVI) was determined using a modified version of the equation from (Abdul-Baki and Anderson, 1973):

$$SVI = \frac{\text{Seedling length (cm)}}{100} \times \text{Germination percentage}$$

Relative growth rate is an important measure of plant growth because it can be used to compare the growth rates of different plants or the growth rates of the same plant under different conditions. RGR is used to compare the growth rates of seedlings grown in different priming treatments. In this study, for evaluating the RGR, 30-days-old seedlings were uprooted, root and shoot were detached, fresh and dry masses, and shoot and root lengths were measured (Al-Maskri et al., 2002). For measuring the parameters, 20 days old seedling (DAS) were chosen from the seed tray to examine.

Utilizing the Statistix-10 statistical bundle program, statistical analysis of the measurement data was performed. The mean for each treatment was computed, and the F (variance ratio) test was used to analyze the variance for each character. According to Gomez and Gomez (1984), LSD was used at a 5% level of significance to determine differences between treatment means.

Results and Discussion

Seed Germination (%)

Significant variation was observed in seed germination at 7 days after sowing (DAS) among different seed priming treatments (Table-1) The highest germination percentage of 89.77% was recorded in treatment T₄: H₂O₂ - 2%, indicating its effectiveness as the most successful treatment in promoting seed germination. Iqbal et al. (2001) reported comparable outcomes in their investigation involving okra, while Rahman et al. (1997) achieved similar results in their study focused on groundnuts. Following closely, treatment T₂: SMP-Sand Metrix Priming exhibited a germination percentage of 83.4%, demonstrating its significant positive influence on seed germination. On the other hand, the control treatment T₀: No priming had the lowest germination percentage of 72.2%, implying reduced germination in the absence of any priming treatment. The rest of the ungerminated seeds were found fresh and hard. Treating okra seeds with hydrogen peroxide can enhance germination for several reasons. Hydrogen peroxide may break seed dormancy, release oxygen, control pathogens, improve water uptake, induce a stress response, activate enzymes, and reduce seedborne pathogens. The specific benefits depend on factors such as concentration and treatment duration, and careful experimentation is necessary to optimize conditions.

Germination Speed Index (GSI)

The outcomes revealed significant variations in the

germination speed index (GSI) among the different seed priming treatments (Table-1). Treatment T₄: H₂O₂ - 2% achieved the highest GSI of 9.6, indicating its effectiveness in promoting faster germination. The findings of Iqbal et al. (2001) also agreed with the results. This treatment outperformed the others in terms of germination speed. Conversely, treatments T₈: KI - 1% and T₀: Control showed the lowest GSIs of 6.2 and 6.3 individually, with no noteworthy variance between them. These treatments exhibited slower germination compared to the other treatments. The compound's capacity to induce a stress response, break seed dormancy, control pathogens on the seed surface, improve water uptake, release oxygen, and activate enzymes involved in germination processes can be the reason for the higher Germination Speed Index (GSI) seen in hydrogen peroxide-treated seeds. Hydrogen peroxide treatment is a potentially useful technique for increasing seed germination efficiency because of these combined effects, which work to accelerate the rate of germination overall.

Seedling Vigor Index (SVI)

The highest seedling vigor index (SVI) value of 0.7, was calculated from treatment T3: H₂SO₄ - 40%, indicating its effectiveness in enhancing seedling growth (Table-1). Close behind were treatments T₇: CaCl₂ - 3% and T₈: KI - 1% with an SVI value of 0.6, demonstrating their ability to foster strong seedling development. Similarly, treatments T₆: KCl - 3% and T₄: H₂O₂ - 2% exhibited a respectable SVI value of 0.55, signifying their positive impact on seedling vigor, although they were not significantly different from each other. The observed enhancement in seedling vigor after sulfuric acid treatment may be explained by multiple possible mechanisms. To break seed coat dormancy and speed up water absorption, sulfuric acid may be used as a scarification agent. This will ultimately encourage stronger and faster germination. Additionally, by acidifying the surrounding media and increasing the accessibility of critical minerals for the budding seedlings, the acid treatment may improve nutrient availability. Additionally, sulfuric acid may have sterilizing qualities that lower the likelihood of pathogenic infections in the early stages of seedling growth. Sulfuric acid treatment may, all things considered, foster better seedling vigor and a robust start to plant growth.

Root Length (cm)

Within the treatments, Treatment T₄: H₂O₂ - 2% emerged as the frontrunner, displaying the longest root length of 11.7 cm, indicating its effectiveness in promoting robust root growth (Figure. 1). Iqbal et al. (2001) identified congruent findings in their exploration

Table 1. Effect of seed priming on okra germination %, speed of germination and seedling vigor.

Treatments	Germination %	Germination speed	Seedling vigor
Control	72.20 i	6.30 e	0.33 g
Hydro priming	76.80 f	7.20 d	0.39 f
Sand-matrix priming	83.40 c	8.20 b	0.45 e
H ₂ SO ₄ - 40%	81.20 d	7.10 d	0.70 a
H ₂ O ₂ - 2%	89.70 a	9.60 a	0.56 c
NaCl-3%	74.30 h	7.10 d	0.53 d
KCl-3%	85.40 b	7.70 c	0.55 c
CaCl ₂ - 3%	79.30 e	7.00 d	0.60 b
KI-1%	74.80 g	6.20 e	0.55 c

Note: Means with the same letter (s) within a column are not significantly different by LSD at 5% level of significance. T₀: (Control), T₁: (Hydro- Priming), T₂: (SMP-Sand Matrix Priming), T₃: (H₂SO₄ - 40%), T₄: (H₂O₂ - 2%), T₅: (NaCl-3%), T₆: (KCl-3%), T₇: (CaCl₂ - 3%), T₈: (KI-1%).

of okra, mirroring the parallel results obtained by Rahman et al. (1997) in their investigation involving two distinct varieties of groundnuts. Following closely, Treatment T₂: SMP-Sand Matrix Priming exhibited a notable root length of 10.5 cm, showcasing its substantial impact on root development. In contrast, the control treatment, T₀, exhibited the shortest root of 5.8 cm, signifying limited root growth without any priming treatment. Hydrogen peroxide, known for its role in stress signaling, might induce a positive stress response in plants, prompting the development of a more extensive root system as a adaptive mechanism. The treatment could also enhance the availability of oxygen in the root zone through the decomposition of hydrogen peroxide, promoting aerobic respiration and stimulating root growth. Additionally, hydrogen peroxide has the potential to mitigate the impact of soil-borne pathogens, creating a healthier root environment that allows for greater root elongation.

Shoot Length (cm)

Among the treatments, Treatment T₄: H₂O₂-2% emerged as the standout performer, displaying the longest shoot length of 14.2 cm, indicating its effectiveness in promoting robust shoot development (Figure. 1). In their study on okra, Iqbal et al. (2001) discovered results like those obtained by Rahman et al. (1997), who found the same outcome in their research involving two varieties of groundnuts. Following closely, Treatment T₂: SMP-Sand Matrix Priming exhibited a notable shoot length of 13.5 cm, showcasing its substantial impact on shoot growth. In contrast, the control treatment, T₀, showed the shortest shoot length of 7.4 cm, indicating limited shoot growth in the absence of any priming treatment. To promote overall shoot growth, hydrogen peroxide may accelerate cell elongation and division. Furthermore, the chemical may stimulate physiological reactions

that improve shoot development because of its function as a signaling molecule in response to stress. Moreover, treatment with hydrogen peroxide may help activate antioxidant systems, which may lessen oxidative stress and enable more effective metabolic activities that are essential for the elongation of shoots.

Seedling Fresh Weight (g)

Significant variations in fresh weight were observed among the different seed priming treatments, highlighting the impact of priming on overall plant biomass (Figure. 2). Treatment T₃: H₂SO₄ - 40% displayed the highest fresh weight of 0.87 g, indicating its positive influence on promoting robust plant growth and biomass accumulation. Following closely, treatments T₇: CaCl₂ - 3% and T₈: KI - 1% exhibited fresh weights of 0.76 g and 0.74 g, respectively, demonstrating substantial effects on increasing plant weight. In contrast, the control treatment T₀ exhibited the lowest fresh weight of 0.47 g, suggesting limited biomass accumulation in the absence of any priming treatment. By disrupting seed coat dormancy and accelerating more uniform and quick germination, sulfuric acid can function as a scarification agent. This improved germination may result in more seedlings that are healthier. Additionally, the acid treatment may improve the pH of the surrounding environment, enhancing the uptake of nutrients and metabolic activities, and ultimately causing the treated seedlings to accumulate more biomass.

Seedling Dry Weight (g)

Treatment T₃: H₂SO₄ - 40% exhibited the highest dry weight of 0.18 g, signifying its positive impact on promoting robust biomass production (Figure. 2). Conversely, treatments T₂: SMP-Sand Matrix

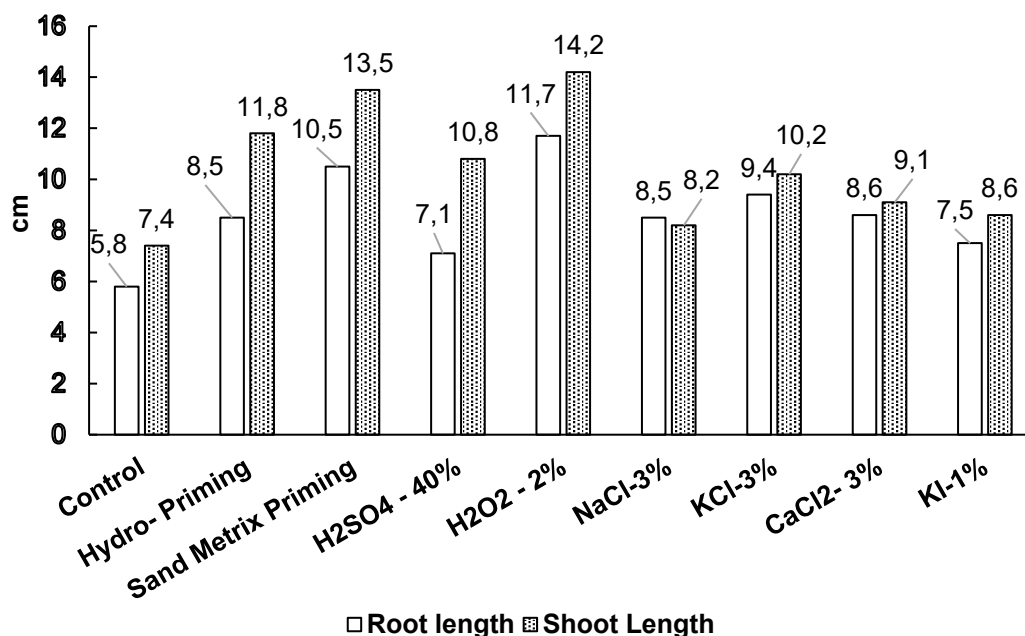


Figure 1. Seedling root length and shoot length.

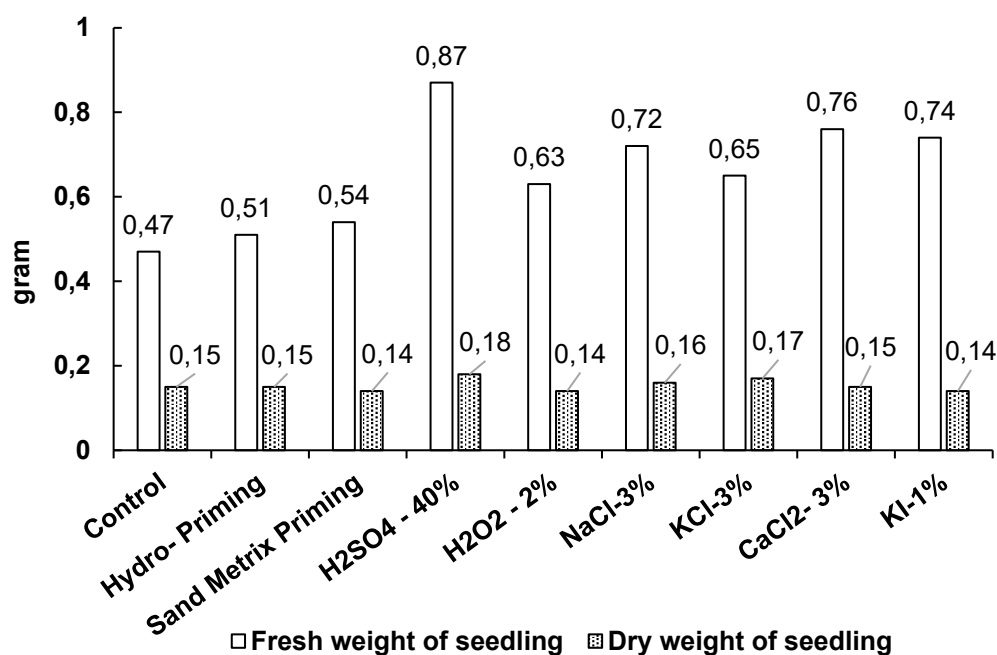


Figure 2. Okra seedling fresh weight and dry weight.

Priming, T₄: H₂O₂ - 2%, and T₈: KI - 1% displayed the lowest dry weights of 0.14 g, suggesting limited biomass accumulation in these treatments. The remaining treatments demonstrated intermediate dry weights. The control treatment T₀ displayed a dry weight of 0.15 g, while treatments T₁: Hydro-Priming, T₅: NaCl - 3%, T₆: KCl - 3%, and T₇: CaCl₂ - 3% exhibited dry weights of 0.15 g, 0.16 g, 0.17 g, and 0.15 g, respectively. These findings emphasize the importance of specific seed priming treatments in influencing biomass production. Treatment T₃: H₂SO₄ - 40% stands out as particularly effective in promoting

dry weight accumulation. The seedling fresh weight accumulation was accelerated by the acid, it could be the similar pattern that help the seedling to accumulate higher dry matter.

Conclusion

The outcomes of this study demonstrated that seed priming has substantial effects on germination, speed of germination, vigor, fresh weight, dry weight, shoot length, and root length. H₂O₂-2% demonstrated the

highest results in relations of germination percentage, speed of germination, root length, and shoot length. These outcomes suggest that treatment with a 2% concentration of hydrogen peroxide could be particularly beneficial for enhancing the germination process and promoting the growth of roots and shoots in okra seeds. Treatment with H_2SO_4 -40% furthermore, showed the highest result for seedling vigor, fresh weight, and dry weight of the seedling. This indicates that the use of 40% sulfuric acid could be effective in improving the overall vigor of okra seedlings and increasing their biomass.

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References

- Abdul-Baki, A.A., and Anderson, J.D. (1973). Vigor determinations in soybean seed multiple criteria. *Crop Science* **13**, 630-633.
- Al-Maskri, A., Khan, M.M., Al-Manthery, O., and Al-Habsi, K. (2002). Effect of accelerated aging on lipid peroxidation, leakage, and seedling vigor in cucumber (*Cucumis sativus* L.) seeds. *Pakistan Journal of Agricultural Science* **39**, 330-337.
- AOSA. (1983). "Seed Vigour Testing Handbook". Association of Official Seed Analysts. Lincoln, NE, USA.
- Badek, B., van Duijn, B., and Grzesik, M. (2006). Effects of water supply methods and seed moisture content on germination of China aster (*Callistephus chinensis*) and tomato (*Lycopersicon esculentum* Mill.) seeds. *European Journal of Agronomy* **24**, 45-51.
- BBS. (2020). "Annual Survey Report". Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.
- El-Balla, M.M.A., Saidahmed, A.I., and Makkawi, M. (2011). Drought stress effects on growth and yield of okra (*Abelmoschus esculentus* L.). *Journal of Plant Physiology* **13**, 173-174.
- Farooq, M., Basra, S.M.A., Rehman H., and Saleem, B.A. (2008). Seed priming enhances the performance of late sown okra by improving chilling tolerance. *Journal of Agronomy and Crop Science* **194**, 55-60.
- Felipe, V.P., Antonio, A.L., and Francisco, A.P. (2010). Improvement of okra (*Abelmoschus esculentus* L.) hard seed by using microelements fertilizer. *Hort Bras* **28**, 232-235.
- Firoz, Z.A., Islam, M.A., Mohiuddin, M., and Rahman, M.M. (2007). Yield and yield attributes of okra as influenced by planting time and plant spacing in hill slope condition. *Progressive Agriculture* **18**, 67-73.
- Gomez, K.A., and Gomez, A.A. (1984). "Statistical Procedure for Agricultural Research (2nd ed.)". pp. 139-240. International Rice Research Institute. John Wiley and Sons.
- Iqbal, T.M.T., Bahadur, M.M., Kabir, M.A., Hasan M.A., and Majumder, D.A.N., (2001). Improvement of okra seed quality by pre-soaking in H_2O_2 solution. *Pakistan Journal of Biological Sciences* **4**, 639-641.
- Khan, H.A., Ayub, C.M., Pervez, M.A., Bilal, R.M., Shahid, M.A., and Ziaf, K. (2009). Effect of seed priming with NaCl on salinity tolerance of hot pepper (*Capsicum annuum* L.) at seedling stage. *Soil and Environment* **28**, 81-87.
- Mohammadi, G., Ebrahim M., Khah, and Aval, M.B. (2011). Effect of priming of seed on growth and yield of okra. *Horticultural Science and Biology* **3**, 117-122.
- Pandita, V.K., Anand, A., Nagarajan, S., Seth, R., and Sinha, S.N. (2010). Solid matrix priming improves seed emergence and crop performance in okra. *Seed Science and Technology* **38**, 665-674.
- Rahman, M.M., Rahman M.M, and Islam M.N. (1997). Effects of H_2O_2 pre-soaking on germination and early growth of ground nut seeds. *Bangladesh Journal of Seed Science and Technology* **1**, 63-68.
- Villiers, T.A., and Edgecumbe, D.I. (1975). On the cause of seed deterioration in dry storage. *Seed Science and Technology* **3**, 761-774.