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Evaluating the Effect of Priming with Moringa Leaf Extract on Seed Germination and Seedling Growth of Bitter gourd *(Momordica charantia* L)

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ABSTRACT

The germination and field emergence in bitter gourd is always challenging one due to its thick and hard seed coat. Pre-sowing priming of bitter gourd seeds with moringa leaf extract (MLE) concentrations is proposed as a suitable, affordable, and cost-effective technique to overcome seed dormancy and enhance germination. Moringa leaf extract (MLE) is known to be rich in plant growth regulator hormones, such as auxin, gibberellin, and cytokinin, which can enhance the germination and early growth of bitter gourd. Therefore, the present pot study was conducted to explore the effect of MLE concentrations on bitter gourd seed germination and growth characteristics during the summer of 2023. A completely randomized design (CRD) was employed with three replications. The moringa leaf extracts were used as a seed priming agent in different concentrations, applied over a 12-hour period. The treatments included: untreated seeds (control), priming with tap water, and priming with MLE at concentrations of 1%, 3%, 5%, and 7%. The results showed that the 5% MLE concentration performed better than the 1%, 3%, and 7% concentrations. Moringa leave extract 5% showed better performance as compared to 1%, 3% and 7% of MLE concentration. The result exhibited that better gourd seeds primed with 5% MLE showed better germination % (89.95) germination index (5.00), plant height of 26.55 cm, number of leaves per plant of 10.36, fresh shoot biomass of 16.90 g, fresh root biomass of 0.75 g, root length of 17.51 cm, and chlorophyll content of 41.73. Based on the results of this study, it can be concluded that seed priming with 5% MLE for 12 hours significantly improves the germination and growth characteristics of bitter gourd.

Key words: Priming**,** bitter gourd, moringa leaf extract, germination, growth

INTRODUCTION

Bitter gourd (*Momordica charantia* L.) belongs to the Cucurbitaceae family is a delicious vegetable with high nutrient and medicinal value. It is generally grown as a summer vegetable crop in Pakistan. This vegetable is very famous in Asian countries; however, it is cultivated throughout the globe (Thriveni et al., 2015). Although it is more often cultivated as an annual crop, in milder climates and regions without frost, it may also thrive as a perennial. In the plain regions it is usually cultivated as a summer crop between the months of January and June (Singh & Grange, 2006). Hemal & Fonseka (2009) found that bitter gourd seeds germinate best at temperatures between 25 and 28 °C. In terms of nutrition and economy, bitter gourd is very important because the immature fruit of bitter gourd is abundant in Vitamins A and C. Patients with diabetes can greatly benefit from it because it is a wonderful source of blood cleanser (Yibchok et al., 2006). Bitter gourd is widely consumed in Pakistan, Africa, and South America and is known for its bitter taste and various health benefits. It is a rich source of vitamins and minerals, including vitamin C, folate, potassium, and iron. Bitter gourd is also known for its medicinal properties and has been used in traditional medicine to treat various elements, including diabetes, high blood pressure, and skin infections (Kumar et al., 2021). Several factors such as climatic conditions, fertility of soil, agronomic practices, occurrence of pests and diseases impact the yield and quality of Bitter gourd. These factors, if found unfavorable, inhibit the growth and productivity of the plant with poor quality, the recent agricultural technologies along with genetic improvements and modern crop management practices allows the enhancement of growth and productivity of crops (Silva et al., 2017). Abiotic stresses are those harsh conditions that decrease the crop yield and growth below favorable stage (Cramer et al., 2011). Abiotic stresses such as lack of water, increased quantity of

salinity, harsh temperatures, and mineral deficiencies or toxicities of metal lead to the reduced crop production. A great number of abiotic stresses are faced by agricultural production and these abiotic stresses inhibit the genetic potential of plants, that's the reason for decreased crop production, channeling to 50% reduction in yield of important food crops and destabilizing agricultural production. The physio-morphological and biochemical nature of the plants mutates the regular metabolism, making it the prime cause of losses in crop production (Saharan et al., 2022).

Moringa (*Moringa olifera* L) is a common garden plant that may be found in several territories of Pakistan. The moringa plant is an evergreen plant and can grow to a height of twelve meters. Moringa has miniature, egg-shaped leaves that range in length from one to three centimeters and in width from four millimeters to one centimeter. (Isnan & Nurhaeidah, 2017). Moringa leaf extract (MLE) are rich in amino acids, potassium, calcium, iron, ascorbate, and growth regulating hormones such as cytokinin, gibberellin and auxin that enhance early and rapid growth of bitter gourd (Basra et al. 2011). Seed priming with moringa leaf extract (MLE) has been shown to improve seedling emergence, establishment, and overall crop growth, thereby increasing yields under both favorable and unfavorable environmental conditions (Basra et al., 2011). Pre-sowing seed priming is an affordable and effective technique to enhance seed germination, especially for resource-poor farmers working in low-input agricultural systems where yield potential is often limited by agronomic stress (Carrillo et al., 2018). Soaking bitter gourd seeds before planting is an excellent way to break dormancy and improve germination rates (Baig et al., 2020).

In case of bitter gourd (*Momordica charantia* L*)*, germination and field emergence are always problems because the bitter gourd seeds have a thick and hard seed coat. Usage of moringa leaf extracts via seed priming has been proven to enhance the emergence and establishment of seedlings and improve crop development and growth, leading to increased yields in unfavorable and normal environmental circumstances (Basra et al. 2011). Priming seeds with moringa leaf extracts promotes early crop growth, uniform seedlings and development which increase yields in both favorable and unfavorable climatic conditions (Khan et al., 2020).

MATERIALS AND METHODS

The pot experiment was conducted in the agro-ecological location of Tandojam, Sindh, with an average temperature ranging from 30 to 34°C. The aim of the study was to assess the impact of various doses of moringa leaf extracts on bitter gourd germination and growth characteristics using a completely randomized design (CRD) with three replications, each containing 10 seeds.

Moringa leaves extract preparation: A robust, mature, and disease-free fresh moringa leaves were collected from the Sindh Agriculture University Tandojam. The leaves were rinsed under running water and then stored in a deep freezer for the night. Juice was extracted from frozen leaves that had been left overnight using mortar and pestle equipment that had been built and constructed locally. The moringa leaf extracts were made at various quantities after sifting the extract applied to the seeds. Different concentrations of moringa leaf extract (MLE) were used for priming bitter gourd seeds, with the following treatments: T1: Untreated seeds (Control), T_2: Priming with tap water, T_3: Priming with 1% moringa leaf extract (MLE), T_4: Priming with 3% moringa leaf extract (MLE), T_5: Priming with 5% moringa leaf extract (MLE), T6: Priming with 7% moringa leaf extract (MLE). Each treatment involves priming the seeds for duration of 12 hours. The experiment was run for 45 days and the necessary cultural practices including irrigation, weeding etc were followed according to the plant requirements.

Data collection: The data were collected for seed germination, vegetative growth and physiological parameters.

Seed germination (%): Germination of the seeds was recorded up to 15 days. The germinated seeds were counted, and percentage was calculated by applying following formula (Larsen and Andreasen, 2004).

$$Seed\ germination\ (\%) = \frac{\sum n}{N}\ x100$$

Where n is number of germinated seeds at each counting and N is total seeds in each treatment.

Germination index: GI was calculated by the formula given by the Association of Official Seed Analysts (1983).

$$GI = \frac{\text{No. of germinated seeds}}{\text{Days of first count}} + \text{-------} + \text{-------} + \frac{\text{No. of germinated seeds}}{\text{Days of last count}}$$

Plant height (cm): The height of each plant was recorded, and the mean values were calculated and expressed in centimeters (cm). Plant height was measured with measuring tape from the soil surface or base of the plant to the growing tip of the plant.

Number of leaves plant^{-1}: The number of leaves plant^{-1} of random 50% plants from each treatment was counted visually and there by average was calculated.

Fresh root biomass (g): The fresh biomass of root was taken, and weight was measured by using analytical balance. The values were expressed as averages in grams.

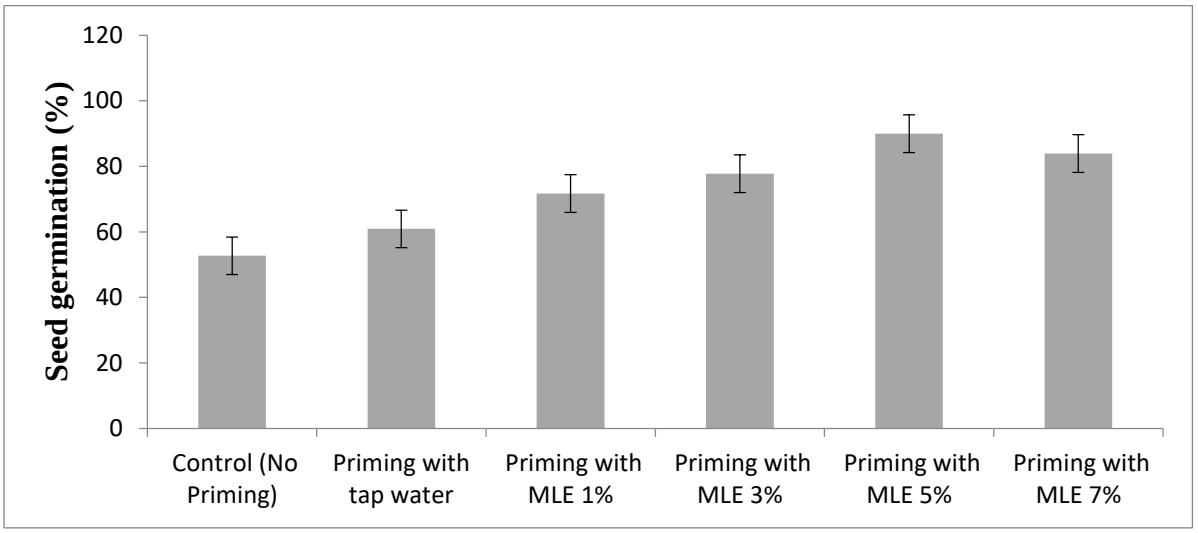
Fresh shoot biomass (g): The fresh biomass of shoot was taken, and weight was measured by using electronic balance. The values were expressed as averages in grams.

Root length (cm): Root length was measured from random samples from each treatment and length of roots was measured with measuring tape from root growing point to last root tip.

Chlorophyll content (SPAD): A SPAD (Soil Plant Analysis Development) meter was used to measure the chlorophyll concentration of leaves by analyzing the amount of light absorbs in the red and near-infrared regions.

RESULTS

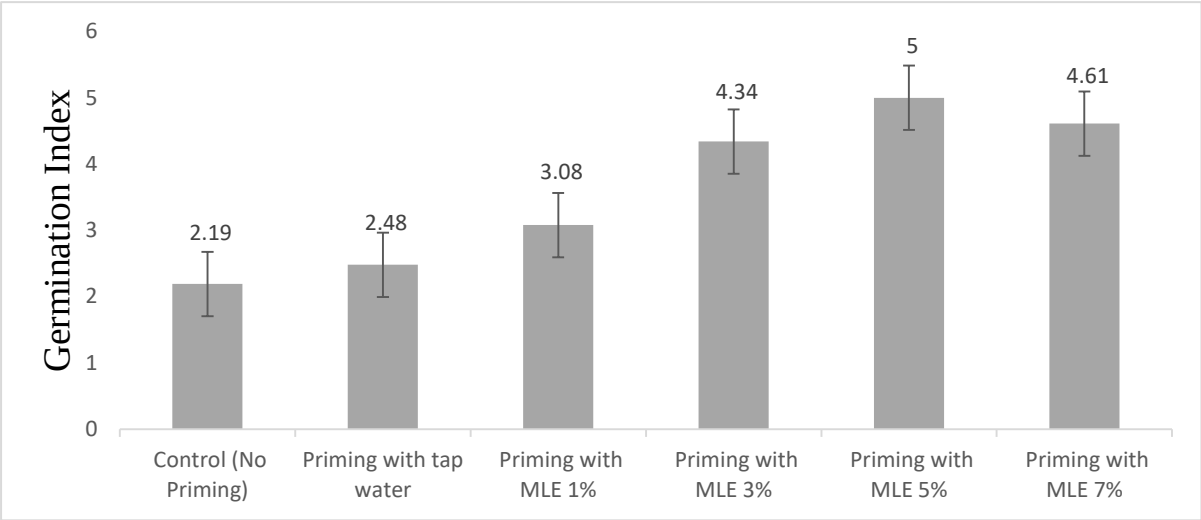
Seed germination (%): The seed germination percentage of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds primed with 5% (MLE) resulted in the highest seed germination rate of 89.95%. followed by 83.91% in 7% and 77.73% in 3% 71.70% in 1% and the seed primed in tap water resulted 60.91%, after 12 hours of priming While the lowest seed germination% was recorded in (Control) which is 52.69% (Figure.1).



S.E.±	2.0772
LSD 0.05	4.5259
P-value	0.0000

Figure1. Seed germination (%) of bitter gourd Primed with different Concentrations of Moringa leaf Extract (MLE)

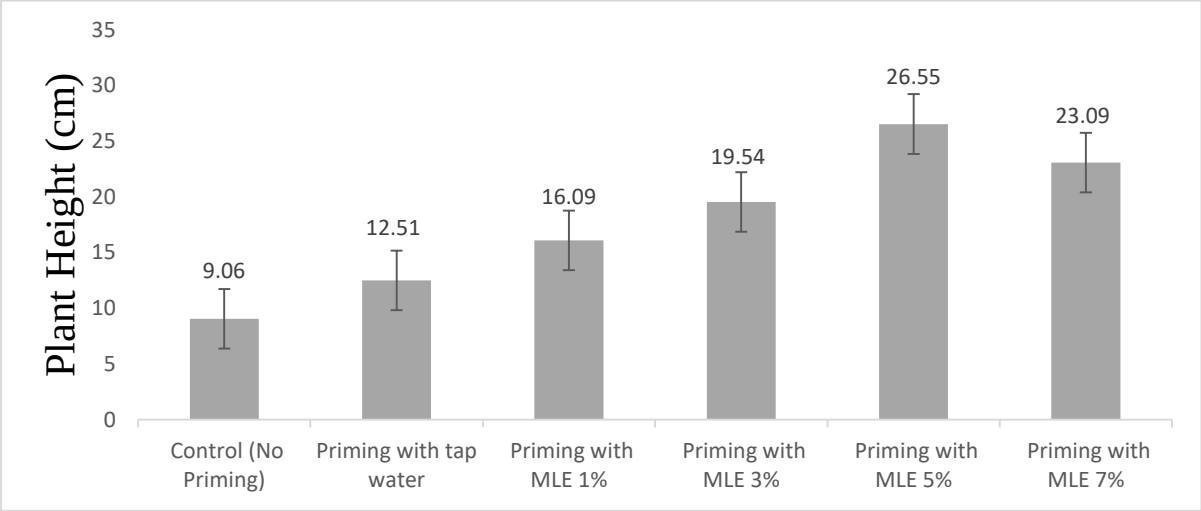
Germination index: The seed germination index of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% with (MLE) resulted in the highest germination index (5.00) followed by (4.61) in 7% and (4.34) in 3% and (3.08). in 1% and the seed primed in tap water resulted (2.48) after 12 hours of priming While the lowest seed germination index was recorded in (Control) which is (2.19) (Figure. 2).



S.E.±	0.0281
LSD 0.05	0.0612
P-value	0.0000

Figure 2.Germination index of bitter gourd primed with different Concentrations of Moringa leaf Extract (MLE)

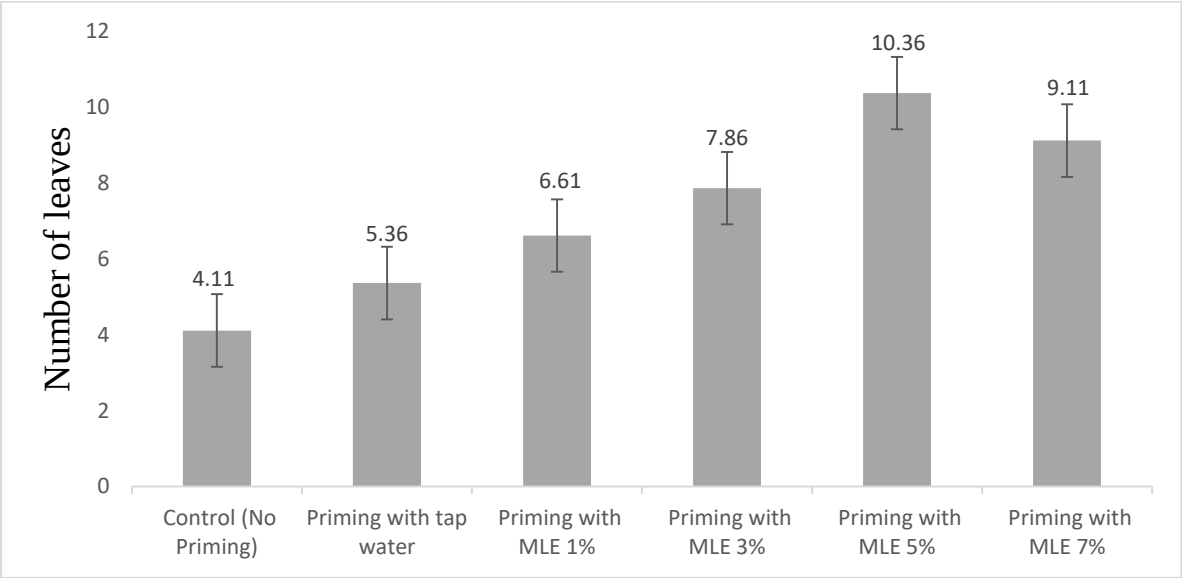
Plant height (cm): The plant height of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% with (MLE) showed the highest plant height of (26.55 cm) followed by (23.09 cm) in 7% and (19.54) cm in 3% and (16.09 cm in 1% and the seed primed in tap water resulted 12.51 cm. after 12 hours of priming While the lowest plant height was recorded in (Control) which is (9.06 cm) (Figure. 3)..



S.E.±	1.1912
LSD 0.05	2.5955
P-value	0.0000

Figure 3. Plant height (cm) of bitter gourd primed with different Concentrations of Moringa leaf Extract (MLE)

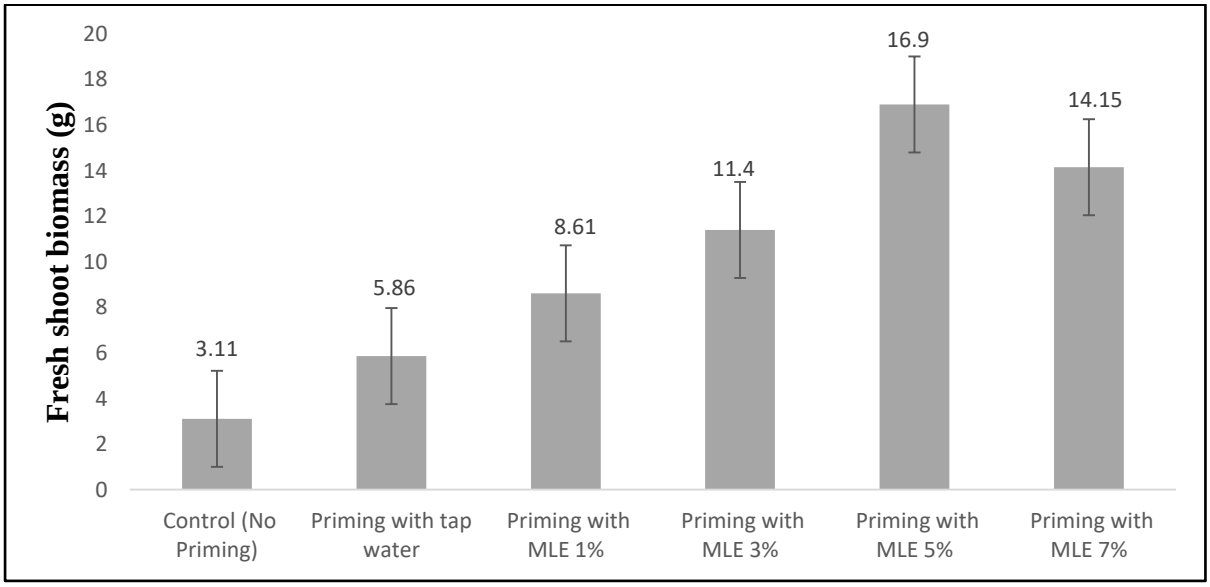
Number of leaves plant- 1: The number of leaves plant $^{-1}$ of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% with (MLE) showed the maximum number of leaves plant^{-1} (10.36) followed by (9.11) in 7% and (7.86) cm in 3% and (6.61) in 1% and the seed primed in tap water resulted (5.36) after 12 hours of priming While the lowest number of leaves plant $^{-1}$ was recorded in (Control) which is (4.11) (Figure. 4).



S.E.±	0.0464
LSD 0.05	0.1012
P-value	0.0000

Figure 4. Number of leaves plant^{-1} of bitter gourd Primed with different Concentrations of Moringa leaf Extract (MLE)

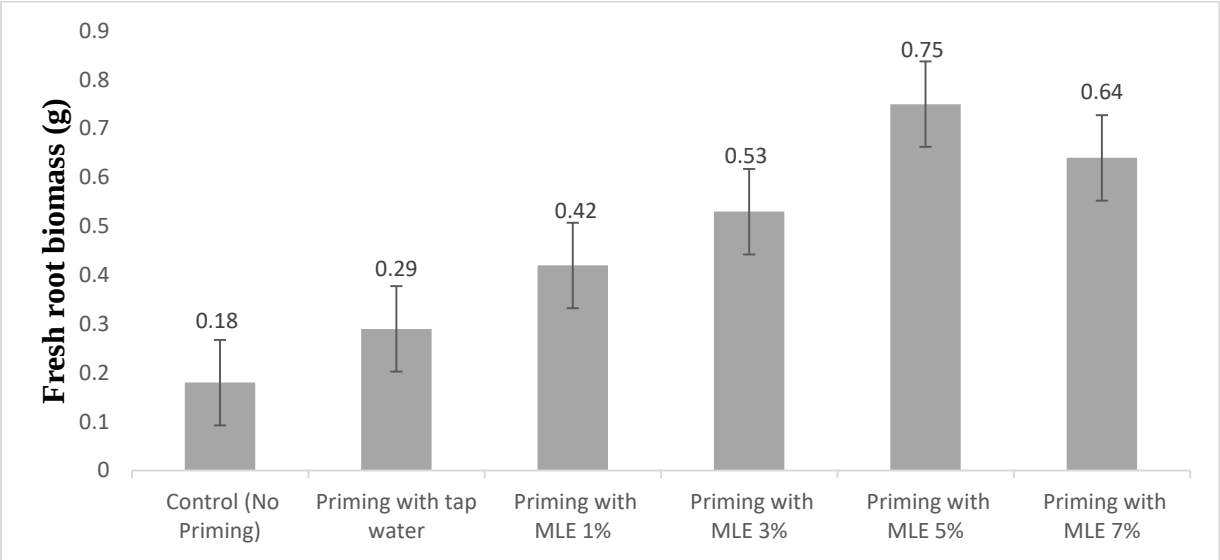
Fresh shoot biomass (g): Fresh shoot biomass of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% (MLE) showed the maximum Fresh shoot biomass (16.90 g). followed by (14.15 g) in 7% and (11.40 g) in 3% and (8.61 g) in 1% and the seed primed in tap water resulted (5.86 g) after 12 hours of priming While the lowest Fresh shoot biomass was recorded in (Control) which is (3.11 g) (Figure. 5).



S.E.±	0.0287
LSD 0.05	0.0626
P-value	0.0000

Figure 5. Fresh shoot biomass (g) of bitter gourd primed with different Concentrations of Moringa leaf Extract (MLE)

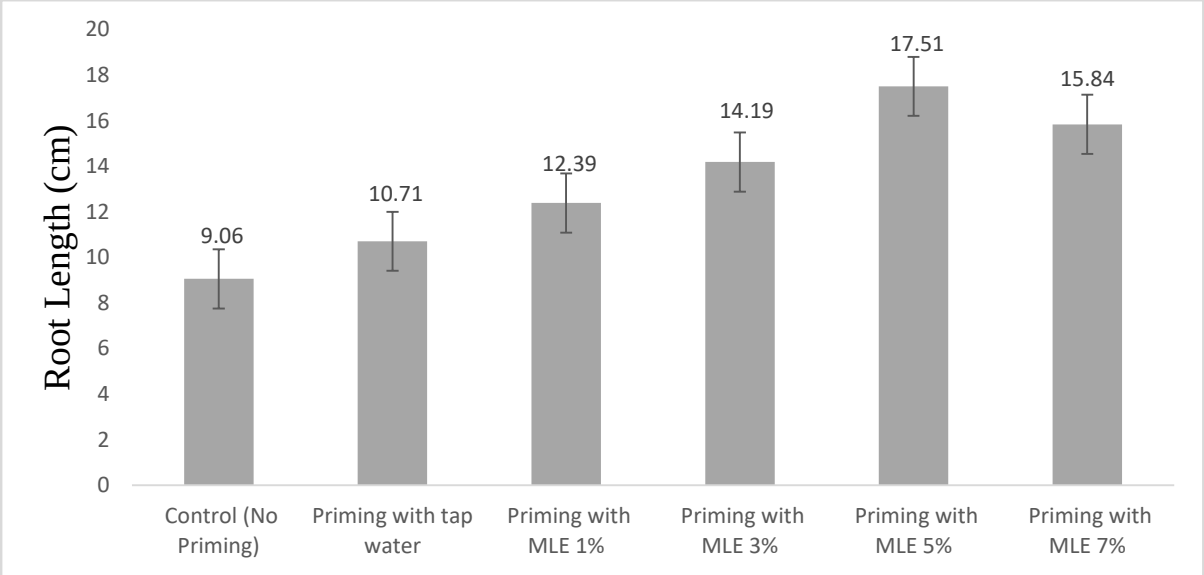
Fresh root biomass (g): Fresh root biomass of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% (MLE) showed the maximum Fresh root biomass (0.75 g). followed by (0.64 g) in 7% and (0.53 g) in 3% and (0.42 g) in 1% and the seed primed in tap water resulted (0.29 g) after 12 hours of priming While the lowest Fresh root biomass was recorded in (Control) which is (0.18 g) (Figure.6).



S.E.±	0.0261
LSD 0.05	0.0569
P-value	0.0000

Figure 6. Fresh root biomass (g) of bitter primed with different Concentrations of Moringa leaf Extract (MLE)

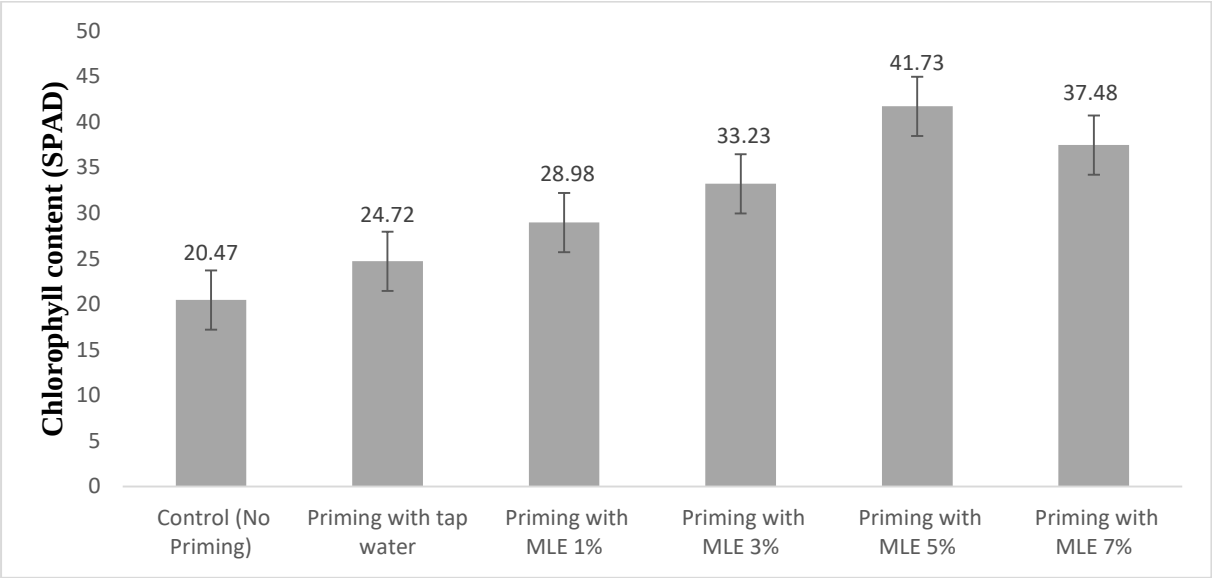
Root length (cm): Root length of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% (MLE) resulted in the longest roots of (17.51 cm. followed by (15.84 cm) in 7% and (14.19 cm) in 3% and (12.39 cm) in 1% and the seed primed in tap water resulted (10.71 cm) after 12 hours of priming. While the shortest roots were recorded in (Control) which is (9.06 cm) (Figure7).



S.E.±	0.0343
LSD 0.05	0.0747
P-value	0.0000

Figure 8. Root length (cm) of bitter primed with different Concentrations of Moringa leaf Extract (MLE)

Chlorophyll content (SPAD): Chlorophyll content of bitter gourd was significantly affected by various concentration of Moringa leaf extract. The seeds Primed with 5% (MLE) showed in the highest chlorophyll content (41.73) followed by (37.48) in 7% and (33.23) in 3% and ((28.98)) in 1% and the seed primed in tap water resulted (24.72.) after 12 hours of priming While the lowest chlorophyll content was recorded in (Control) which is (20.47) (Figure.8).



S.E.±	1.6364
LSD 0.05	3.5654
P-value	0.0000

Figure 8. Chlorophyll content (SPAD) of bitter gourd primed with different Concentrations of Moringa leaf Extract (MLE)

DISCUSSION

Seed priming is a key strategy to enhance seed emergence and establish uniform crop growth. In bitter gourd (*Momordica charantia* L.), germination and field emergence are challenging due to the thick, hard seed coat, which delays growth and seed emergence. Recognizing the importance of priming, especially the role of moringa leaf extract (MLE) in improving seed germination and growth, the present study aimed to evaluate the effects of different concentrations of MLE on bitter gourd's germination and vegetative growth. The results of this research indicated that bitter gourd seeds primed with 5% MLE for twelve hours showed the highest performance. Specifically, seeds treated with 5% MLE (T5) achieved a germination rate of 89.95%, a germination index of 5.00, plant height of 26.55 cm, 10.36 leaves per plant, 16.90 g of fresh shoot biomass, 0.75 g of fresh root biomass, 17.51 cm root length, and 41.73 chlorophyll content. Ali et al. (2011) also demonstrated significant effects of MLE on plant growth parameters, such as plant height, shoot length, and fresh and dry shoot weights. While statistically insignificant effects were observed in root length and fresh/dry root weights, positive impacts were still noted. The highest plant height (222.7 cm), shoot length (187 cm), fresh shoot weight (386 g), and dry shoot weight (189 g) were recorded in treatments where MLE was sprayed two weeks after seedling emergence and biweekly thereafter. Carrillo et al. (2018) reported that water scarcity negatively impacted growth metrics such as fresh and dry biomass and shoot and root lengths in bitter gourd seedlings. However, seedlings primed with MLEs performed better in both control and water-stressed environments, aligning with the current study's findings (Khan et al., 2017).

The results of this study are consistent with previous research (Abbas et al., 2013; Chattha et al., 2015), which also demonstrated that MLE application enhances plant height, leaf number, shoot and root lengths, and fresh and dry weights of bitter gourd plants. Foidle (2001) suggested that spraying MLE on various field crops promotes vegetative growth and increases shoot and root weights. The conclusion drawn from this data suggests that priming bitter gourd seeds with MLE improves germination and growth rates. MLE appears to assist in distributing essential minerals to the embryo, facilitating better seedling emergence and subsequent plant development. This technique could be particularly beneficial for resource-poor farmers in low-input agricultural systems (Khan et al., 2017; Sarwar et al., 2020).

Salsinha et al. (2021) further supported these findings, reporting that MLE priming increased bitter gourd plant height, fresh biomass by 68.1%, dry biomass by 51.5%, photosynthetic pigments, photosynthetic rate, photosynthetic rate, photosynthetic rate, stomatal conductance, total soluble protein, ascorbic acid content, and phytohormones.

CONCLUSIONS

From the present study it is concluded that the seed priming with moringa leaf extract MLE had a significant effect on the seed germination and growth attributes of bitter gourd. The moringa leaf extract of 5% resulted in the highest germination %, germination index, plant height, number of leaf plant$^{-1,}$ fresh shoot biomass, fresh root biomass, root length and chlorophyll content of bitter gourd.

CONFLICT OF INTEREST

All authors have read the manuscript and declared that they have no conflict of interest

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