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Research Article

Priming with Moringa Leaf Extract Improves the Germination and Growth of Bottle Gourd (*Lagenaria siceraria* L.)

Asadullah Noor, Niaz Ahmed Wahocho*, Nasir Haider, Muzamil Farooque Jamali, Afifa Talpur, Maria Abro, Safdar Ali Wahocho

Department of Horticulture, Sindh Agriculture University Tandojam, Pakistan.
**Corresponding author*: nawahocho@gmail.com

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ABSTRACT

Several biotic and abiotic stresses negatively influence the germination of vegetable crop seeds, which ultimately lead to the poor seedling establishment. Among vegetables, cucurbits are a largely demanded group but most of the vegetables of this group have hard seed coat which hinders the resilient seed germination. Similarly, the seeds of bottle gourd encounter disrupted germination. However, research methods have been moved towards the quick approaches that can enhance seed germination under varying environmental stresses, seed priming is one such quick method to enhance seeds tendency to uniform germination. Therefore, a pot experiment was conducted at Horticulture Garden, Sindh Agriculture University Tandojam during summer 2023 for investigating the germination and growth response of Bottle gourd to priming with moringa leaf extract (MLE) concentrations. The experiment was conducted via three replicates using Completely Randomized Design (CRD). The methodically structured treatments were: T_1 = Control, T_2 = Tap water, T_3 = priming with 1% MLE, T_4 = priming with 3% MLE, T_5 = priming with 5% MLE and T_6 = priming with 7% MLE. The findings of the study revealed that the bottle gourd seeds primed with 7% moringa leaf extract (MLE) resulted in maximum seed germination, germination index, seedling vigor index, plant height, number of leaves plant^{-1}, fresh shoot biomass, fresh root biomass, root length and chlorophyll content. However, the minimum result of all the parameters was found under control. Based on the findings of the present study, it can be concluded that priming with 7% moringa leaf extract (MLE) significantly enhanced the germination and growth performance of bottle gourd.

Keywords: Bottle gourd, Growth, Moringa leaf extract, Priming, Seed germination

Introduction

The Cucurbitaceae family represents the largest group of vegetables crops, which provide the substantial contribution for economically valuable domesticated species and are produced for consumption purpose (Chen et al., 2024). Among all plants of the Cucurbitaceae family, bottle gourd (*Lagenaria siceraria*) is one of the most popular cucurbits that are currently facing hindrances regarding its cultivation. Looking ahead, it is anticipated that these challenges will intensify due to the cumulative effects of growing demand, climate change, loss of natural habitat and genetic diversity (Henkhaus et al., 2020).

However, the possible prime cause of low production of bottle gourd may be that agricultural fields have insufficient water causing low germination and seedling growth (Lima, 2017). Therefore, it's necessary to use pre-sowing seed treatment technique as substitute strategy to mitigate the negative effects of abiotic stresses on agricultural production, primarily due to their low cost and minimal risk (Khan et al., 2016). The most efficient treatment prior to sowing is priming that has been shown to improve seed vigor more effectively than traditional soaking methods. This technique involves controlling seed hydration in a solution containing organic or inorganic components, with subsequent re-drying, which facilitates metabolic processes before germination, deterring radical emergence (Khalil et al., 2015). Seed priming enhances seed vigor by safeguarding the plasma membrane structure, preventing damage during stressful environmental conditions (Shah et al., 2017).

However, the current environmental hazards intensify the focus on organic crop production. Therefore, scientists and researchers are concentrating on environmentally friendly seed enhancement methods to boost germination and ensure consistent crop establishment. The significant role of seed priming in enhancing crop tolerance to biotic and abiotic stresses have been strongly advocated, in relation to the specific mechanisms involved (Jatana et al., 2024).

Among different natural sources used, moringa (*Moringa oleifera* L.) is gaining ground as a potential source of priming. Moringa leaf extract is reported to Enhance the growth and phytohormones, in addition to the osmoprotectants and antioxidant enzymes of salinity affected wheat plants (Sadak et al., 2024).

. The application of moringa leaf extracts as seed priming agent has been shown to improve seedling emergence and establishment, enhance crop development and growth, and ultimately boost yields, even in challenging and substandard environmental conditions (Khan et al., 2017).

Keeping in mind the above facts, we conducted this research to evaluate the effects of seed priming with moringa leaf extract on the germination and growth of bottle gourd.

Materials and Methods

Experimental Setup: The experiment was conducted at the Horticulture Garden, Sindh Agriculture University, Tandojam, following a controlled condition completely randomized design with three repeats.

Seed Treatment and sowing: Seeds were primed with the moringa leaf extract, as per treatment plan, following established protocols. Thereafter, the seeds were dried under shade for six hours and planted in earthen pots.

Moringa Leaf Extraction: Fresh moringa leaves were collected, washed thoroughly, and air-dried in a shaded area to remove surface moisture. The leaves were then ground to obtain a fine paste using a blender. This paste was then mixed with distilled water at a 1:10 (w/v) ratio to extract the bioactive compounds. The mixture was stirred well and filtered through muslin cloth to obtain a clear moringa leaf extract solution.

Treatments: Six priming treatments were used, namely: T_1 = Control, T_2 = Tap water, T_3 = Priming with moringa leaf extract (MLE) at 1%, T_4 = Priming with MLE at 3%, T_5 = Priming with MLE at 5%, and T_6 = Priming with MLE at 7%.

Observation recorded: The data was recorded on the parameters including germination percentage, seed germination index, seedling vigor index, plant height (cm), leaves per plant, shoot and root biomass (g), root length (cm), and chlorophyll content (SPAD).

Statistical analysis: The data were statistically analyzed using Statistix ver. 8.1. The treatment means were compared using the least significant difference test at alpha 0.05.

Results

Seed germination (%): Maximum seed germination (87.1%) was recorded with the treatment involving priming with MLE at 7% followed by MLE at 5% and 3% with seed germination of 80.7% and 74.3%, respectively (Table 1). A significant reduction in seed germination was observed with priming using MLE at 1%, which resulted in 67.9%. The lowest seed germination (61.9%) was noted when seeds were primed without MLE. The minimum seed germination (55.5%) was observed in the control (Table 1).

Germination Index: The analysis of variance showed that germination index was substantially varied under different concentrations of moringa leaf extracts (Table 1). Highest germination index (4.47) was noted under MLE at 7% followed by MLE at 5% and MLE at 3%, had an average germination index of 3.98 and 3.49, respectively. While MLE at 1% had the lowest results 3.00, after tap water which showed (2.52) germination index. Finally, the minimum germination index (2.22) was observed in the control.

Seedling vigor index: In respect of seedling vigor index, highly significant results were observed in each treatment (Table 1). The maximum seedling vigor index (1896.46) was achieved with MLE at 7%. Following this, priming with MLE at 5% and 3% resulted in average seedling vigor index 1592.63 and 1286.48, respectively. A significant decrease in seedling vigor index (1011.01) was observed in MLE at 1%. The lowest seedling vigor index (764.18) was recorded when bottle gourd seeds were treated with tap water. Likewise, the minimum seedling vigor index 540.05 was observed in seeds without priming (Control).

Plant height (cm): Plant height of bottle gourd was significantly affected by Moringa Leaf Extract (MLE) concentrations (Table 1). The maximum plant height (22.05 cm) was recorded with MLE at 7%. Followed by MLE at 5% and priming with MLE at 3% resulted in average plant height (19.72 cm) and (17.29 cm). Furthermore the lowest results (14.88 cm) were recorded MLE at 1%, after tap water and control treatments which showed (12.37 cm) and (9.69 cm) results for plant height.

Leaves per plant: (Table 1) showed that highest leaf count per plant (9.13) was observed with MLE at 7%. Following this, the treatments of priming with (MLE) at 5% and at 3% resulted in average number of leaves per plant 8.16 and 7.18, respectively. The substantial decline in number of leaves per plant was observed in treatments that included priming with moringa leaf extract (MLE) at

1% (6.26). The lowest leaves (5.22) were recorded when bottle gourd seeds were treated with tap water and the minimum number of leaves plant^{-1} 4.18 was observed in control.

Fresh shoot biomass (g): The significant variation in fresh shoot biomass production was noted in each treatment (Table 2). Results pertained that the maximum fresh shoot biomass (4.64 g) was observed under MLE at 7% followed by priming with MLE at 5% and 3%, resulted in average fresh shoot biomass (3.97 g) and (3.30 g), respectively. Priming with MLE at 1% had lowest results (2.63 g) followed by control treatment which showed (1.29 g) fresh biomass of shoot.

Fresh root biomass (g): The highest biomass of root (0.99 g) was noted with MLE at 7% (Table 2). Following this, priming with MLE at 5% and priming with MLE at 3%, resulting in average fresh root biomass 0.86 g and 0.70 g, respectively. Significant reductions in fresh root biomass were observed in treatments that included priming with moringa leaf extract (MLE) at 1% (0.54 g). The lowest fresh shoot biomass (0.38 g) was recorded when bottle gourd seeds were treated with tap water (T_2). While the minimum fresh root biomass 0.22 g was observed in control.

Root length (cm): The analysis of variance showed that there was significant influence of various moringa leaf extract concentrations on root length (cm) (Table 2). The maximum root length (14.36 cm) was achieved with the with MLE at 7%. Following this, priming with (MLE) at 5% and priming with (MLE) at 3%, resulted in average root length 12.39 cm and 10.42 cm, respectively. Substantial decline in root length were observed in treatments that included priming with moringa leaf extract MLE at 1% (8.46 cm). The lowest root length (6.49 cm) was recorded when bottle gourd seeds were treated with tap water. Moreover, the minimum root length of 4.50 cm was observed in control.

Chlorophyll content (SPAD): The analysis of variance showed that chlorophyll content of bottle gourd was significantly affected by priming with moringa leaf extracts (Table 2). The maximum chlorophyll content (37.06) was depicted by (MLE) at 7% (T_6). Following this, priming with MLE at 5% and 3%, resulting in average chlorophyll content 33.31 and 29.58. The decline in results of chlorophyll content were observed in treatments that included priming with moringa leaf extract MLE at 1% (25.83). The lowest chlorophyll content (22.09) was recorded when bottle gourd seeds

Table 1. Selected growth traits of bottle gourd as affected by seed priming with moringa leaf extract at different concentrations

Treatment	Priming	Seed germination (%)	Germination index	Seedling vigor index	Plant height (cm)	Leaves per plant
T1	Nil (Control)	55.5F	2.22F	540.0F	9.69F	4.18F
T2	Water	61.9E	2.52E	764.2E	12.37E	5.22E
T3	1% MLE	67.9D	3.00D	1011.1D	14.88D	6.26D
T4	3% MLE	74.3C	3.49C	1286.5C	17.29C	7.18C
T5	5% MLE	80.7B	3.98B	1592.7B	19.72B	8.16B
T6	7% MLE	87.1A	4.47A	1896.5A	22.05A	9.13A
P-VALUE		0.0000	0.0000	0.0000	0.0000	0.0000
± STANDARD ERROR		1.9779	0.0310	0.1385	0.9104	0.0617
LSD 0.05		4.3095	0.0676	0.3018	1.9835	0.1344

** MLE: Moringa Leaf Extract*

Table 2. Shoot and root biomass, root length and chlorophyll content of bottle gourd as affected by seed priming with moringa leaf extract at different concentrations

Treatment	Priming	Shoot biomass (g)	Root biomass (g)	Root length (cm)	Chlorophyll content (SPAD)
T1	Nil (Control)	1.29F	0.22F	4.5F	18.3F
T2	Water	1.96E	0.38E	6.5E	22.1E
T3	1% MLE	2.63D	0.54D	8.5D	25.8D
T4	3% MLE	3.30C	0.70C	10.4C	29.6C
T5	5% MLE	3.97B	0.86B	12.4B	33.3B
T6	7% MLE	4.64A	0.99A	14.4A	37.1A
P-VALUE		0.0000	0.0000	0.0000	0.0000
± STANDARD ERROR		0.0451	0.0325	0.0642	0.0328
LSD 0.05		0.0982	0.0709	0.1398	0.0714

* MLE: Moringa Leaf Extract

were treated with tap water. Finally, the minimum chlorophyll content 18.29 was observed in control.

Discussion

The successful establishment of seedlings is an essential initial phase in crop production and plays a decisive role in determining the results of the subsequent harvest (Savage and Bassel, 2016). Effective crop establishment relies on the quality of seeds, particularly their germination potential and seedling vitality (Adetunji et al., 2021). Pre-sowing seed treatment in which seeds are immersed in a priming solution until they reach the second part of germination, which differs between crops, and are then dried under shaded conditions. This technique can promote uniform seedling emergence and synchronized crop development. It has the capability to boost seedling vigor and germination potential in fresh seeds, while also demonstrating remarkable effectiveness in revitalizing partially aged seeds and enhancing field emergence (Thejeshwini et al., 2019). The practical approach for assessing the effectiveness of potential priming agent on seed germination and seedling establishment in an experiment is to analyze the significance of variations in germination and vegetative parameters. With this objective, our study was structured to assess these aspects comprehensively.

This research was carried out to examine the germination and growth response of bottle gourd upon priming the seeds with Moringa leaf extract. Our study resulted that all the observed parameters were significantly impacted with higher concentration of Moringa leaf extract because it increases the crop productivity in environmentally stressed regions (Khan et al., 2022). We found a profoundly high seed germination percentage, germination index and seedling vigour index. This finding links with the study of Hala et al. (2017) who demonstrated that priming seeds with varying concentrations of MLE improved the germination tendency of sweet pepper. This enhancement was credited to the presence of phyto-hormones, essential amino acids, and nutrient-rich mineral elements in MLE, which had a favorable impact on germination. Seed priming facilitates the transfer of stored nutrients from the endosperm to the embryo, leading to enhanced germination performance (Majda et al., 2019). Additionally, the higher germination rate in primed seeds can be linked to the activation of early metabolic activities during the hydration phase (Mir et al., 2021).

The taller plants were registered to the usage of MLE at higher concentrations. This statement is linked with the study of Dunsin et al. (2016), where similar result was observed in Cucumber when seed was primed with MLE. Further this statement is advocated by the study of Faried et al. (2024) where plant height of Shallot was influenced positively when seeds were primed with MLE, this could be due to the content of plant growth regulators in the MLE. Researchers identified various phytohormones in MLE, such as gibberellic acid, zeatin, and indole acetic acid. These phytohormones are well-known for their role in modulating plant growth and development (Alkuwayti et al., 2020). Gibberellic acid, in particular, acts as a plant growth regulator that enhances shoot development. It facilitates plant elongation by influencing cellular expansion and growth (Castro-Camba et al., 2022).

An increased number of leaves were found when the seeds were primed with the higher concentration of moringa leaf extract. Our study aligns with the study of Matthew (2016) observed a similar increase in leaf number in pepper plants following foliar spraying with MLE.

Our study showed positive effects of MLE on shoot and root fresh weight. A similar pattern was observed in field crops following the application of MLE (Khan et al., 2022). These advantageous effects of MLE are attributed to the presence of zeatin, a naturally occurring cytokinin known for its growth-promoting properties (Iqbal et al., 2015).

The seed primed with MLE also showed favorable effect on root length and chlorophyll content. Hala et al. (2017) reported that the presence of zeatin, a cytokinin in MLE extract, helps sustain a larger leaf area, which is essential for photosynthetic activity and higher leaf chlorophyll content. The presence of cytokinin in MLE stimulates cytokinin biosynthesis, promoting the movement of stem reserves to new shoots, which supports healthy plant growth and delays premature leaf senescence. Additionally, it helps maintain a larger leaf area for photosynthesis, resulting in enhanced leaf chlorophyll content (Rady & Mohamed, 2015). The phytohormones and nutritional content of MLE positively affect plant growth (Faried et al., 2024).

The enhanced plant growth observed with fresh MLE can be attributed to the presence of various secondary metabolites such as phenols and ascorbates (Jatana et al., 2024). In crux, the application of minerals, either independently or combined with growth promoters, contributes to the improvement of growth parameters in field crops.

Conclusion

The priming of bottle gourd seeds with moringa leaf extract with 7% concentration significantly enhanced all of its germination and growth traits.

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Conflict of Interest

No competing interests are disclosed by the authors.

Author Contribution

AN: Conducted experiment and collected data, wrote initial draft of MS; NAW: Planned and executed the research experiment, analyzed data, edited all drafts of MS; NH: Processed and presented the data, MFJ & AT: Literature review and interpretation of Results; MA & SAW: Revision of final manuscript draft, format and style. All authors approve and assume the responsibility of the content of MS.

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