

Exploring the Role of Moringa Oleifera Leaf Extract (MLE) in Enhancing Seed Germination, Seedling Growth, and Plant Development of Chili

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Abstract— This study investigates the effect of Moringa oleifera leaf extract (MLE) on chili seed germination, seedling development, and growth parameters. Utilizing a randomized complete block design, six treatments of MLE concentrations (1%-5%) and a control (distilled water) were applied to chili seeds. Results revealed that MLE significantly enhances germination, with the 2% concentration yielding the highest germination rate (99%) and germination index (12.353). Moreover, the 2% MLE treatment demonstrated superior seedling vigor index (1513.3), leaf count (7.78 leaves/plant), branch count (9.6 branches/plant), and overall plant height (15.134 cm), outperforming all other treatments. Root length (6.5 cm) and biomass results further confirmed the effectiveness of 2% MLE in promoting root growth and development. Additionally, chlorophyll content peaked at a SPAD value of 64.868 in the 2% MLE treatment, signifying enhanced photosynthetic capacity. This study concludes that the application of 2% MLE is the most effective for improving germination, seedling growth, and overall chili plant development.

Keywords— Priming, Moringa leaf extract (MLE), Chilies.

I. INTRODUCTION

Chilli (*Capsicum annum* L.) belongs to the family Solanaceae and it is one of the most important spices cultivated for its fruits. They are widely used as both green and ripe dried form for its pungency (Jalgaonkar et al., 2024) It is mainly used as a vegetable and also a condiment but the topmost use of chilli throughout the world is as a spice due to its pungency and pleasant flavor. Chilli is one of the most essential cash crops grown in Sri Lanka and it has become a vital ingredient in Sri Lankan meals (Mihiranie et al., 2020). The history of chilies dates back thousands of years, with their origins believed to be in the Americas (Andrews, J. (1995). Indigenous peoples in Central and South America were the first to cultivate and use chilies, incorporating them into their diets as well as using them for medicinal purposes (Foster, N., & Cordell, L. S. (Eds.). (1992). When Christopher Columbus arrived in the New World, he introduced chilies to Europe, sparking a worldwide exchange of crops during the Columbian Exchange, which led to chilies being integrated into the cuisines of Asia, Africa, and beyond. Today, chilies are an essential ingredient in many iconic dishes. From the fiery curries of India to the spicy salsas of Mexico and the heat-filled stir-fries of Thailand, chilies play a pivotal role in defining the flavor profile of these cuisines (Cai et al., 2021). Whether they are used fresh, dried, ground into powder, or made into sauces, chilies offer a range of flavors—from smoky and fruity to intensely hot—allowing for a vast spectrum of culinary applications (Peterson, J. (2017). Chilies also hold cultural significance, often being seen as a symbol of hospitality, vitality, and resilience in many societies. For example, in countries like Mexico and

India, chilies are used not only in cooking but also in traditional rituals, such as offerings to gods or as protective charms against evil spirits (Etkin, N. L. (2008). Beyond their culinary uses, chilies have been the subject of scientific research due to their potential health benefits. Capsaicin, the compound that gives chilies their heat, has been studied for its analgesic, anti-inflammatory, and metabolism-boosting properties. Moreover, the rich vitamin content of chilies, particularly vitamin C, adds to their nutritional value, making them both a flavorful and health-conscious addition to any diet (Gupta, E., & Mishra, P. (2021). *Moringa oleifera*, commonly known as the drumstick tree, is a fast-growing, drought-resistant plant native to parts of Africa and Asia (Kumar et al., 2020). Its leaves are a rich source of essential nutrients, including vitamins, minerals, and antioxidants, which have garnered significant attention for their potential applications in agriculture (El-Ramady et al., 2022). Recent studies have explored the use of *Moringa oleifera* leaf extract (MLE) as a natural biostimulant to enhance plant growth and development (Mashamaite et al., 2022). The bioactive compounds present in MLE, such as cytokinins, phenolic acids, and flavonoids, are believed to promote seed germination, stimulate root and shoot growth, and improve overall plant health (Hafeez et al., 2022).

II. MATERIAL METHOD

The experiment was carried out according to a randomized complete block design with three replicates. It was comprised of six treatments, viz. (T₁= Control-no priming), T₂ = Priming with 1% of MLE, T₃ = Priming with 2% of MLE, T₄ = Priming with 3% of MLE, T₅ = Priming with 4% of MLE, T₆ = Priming with 5% of MLE. The control treatment was represented by priming with distilled water.

III. RESULTS AND DISCUSSION

3.1 Germination Percentage:

The (Figure 1 a) showing the results Regarding germination percentage was statistically significant. The highest germination rate was observed in the treatment with 2% MLE (99%), followed by 5% MLE (76%) and 3% MLE (80%). The control group (T₁) exhibited the lowest germination percentage at 50%.

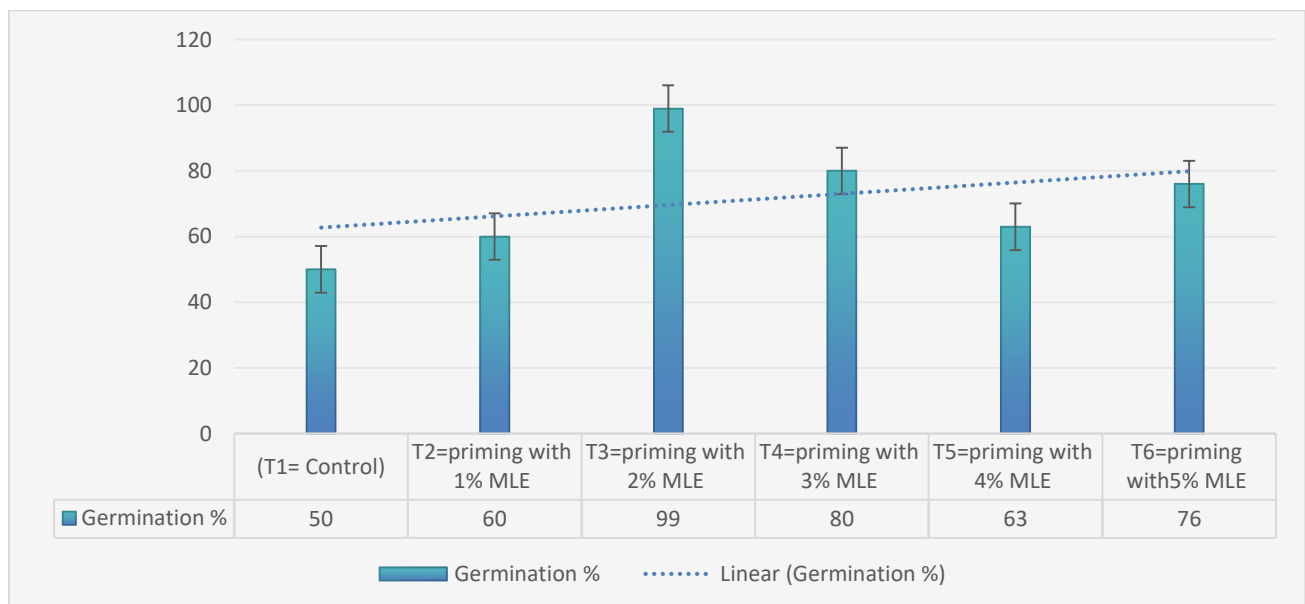


FIGURE 1 (a): Germination Percentage (%) of Chilli under the Influence of Varying Priming Treatments with MLE

3.2 Germination Index (GI):

The (Figure 1 b) showing the results Regarding germination Index (GI) was statistically significant. The 2% MLE treatment also recorded the highest GI (12.353), indicating faster and more uniform germination compared to other treatments. The control group had the lowest GI (10.313), suggesting slower germination.

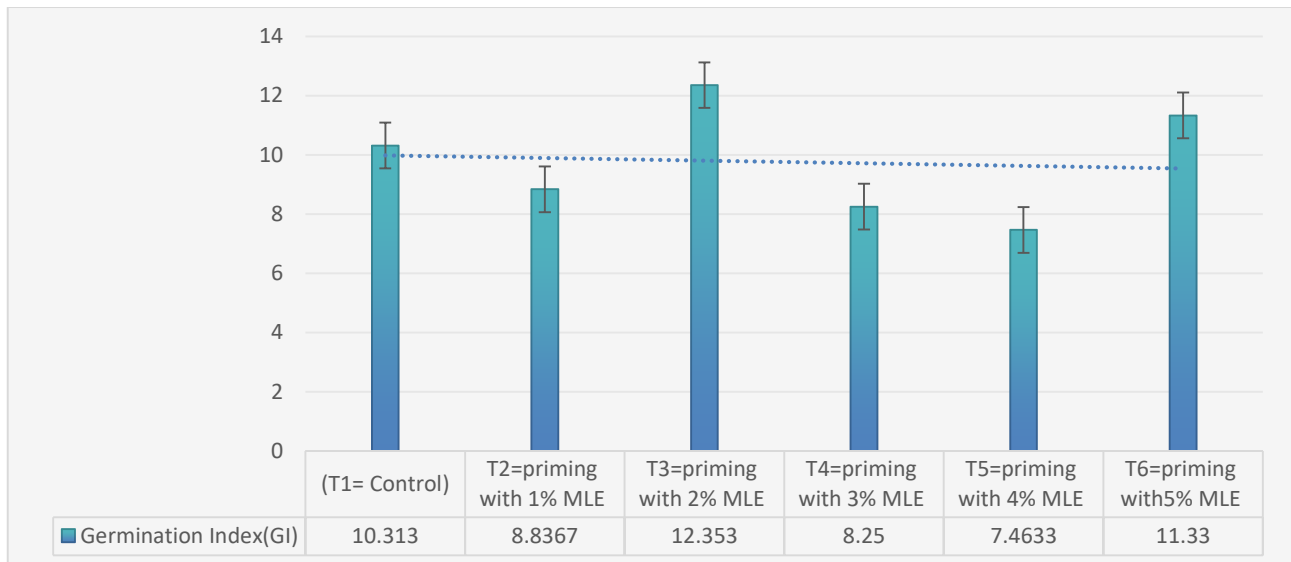


FIGURE 1 (b): Germination Index (GI) of Chilli under the Influence of Varying Priming Treatments with MLE.

3.3 Seedling Vigour Index (SVI):

The (Figure 1 c) showing the results Regarding **Seedling Vigour Index (SVI)** was statistically significant. The 2% MLE priming treatment also had the highest SVI (1513.3), suggesting better seedling growth and vigor. The control group had a significantly lower SVI (303.33), indicating weaker seedlings.

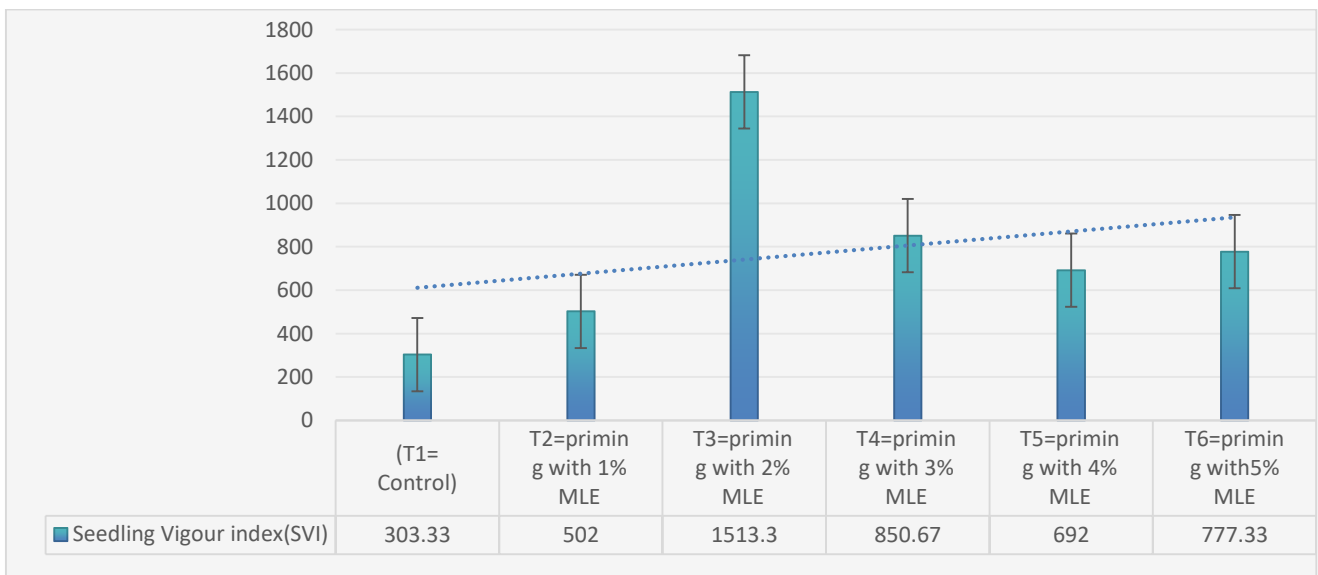


FIGURE 1 (c): Seedling Vigour index (SVI) of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 2 a) showing the results Regarding number of leaves per plant was statistically significant. The highest number of leaves per plant was observed with the 2% MLE priming treatment, which resulted in an average of 7.78 leaves. This suggests that 2% MLE is the most effective concentration for promoting leaf growth in chili plants. In comparison, the control group (T1), which did not receive any priming, had the lowest leaf count with only 4.89 leaves per plant. Other priming treatments showed varying levels of improvement in leaf number. For example, priming with 1% MLE (T2) resulted in 5.2 leaves per plant, while the 3% MLE treatment (T4) yielded 6.23 leaves per plant. Similarly, the 4% MLE treatment (T5) produced 5.89 leaves, and the 5% MLE priming (T6) resulted in 5.23 leaves per plant. Although these treatments led to an increase in leaf number compared to the control, they did not surpass the results of the 2% MLE treatment.

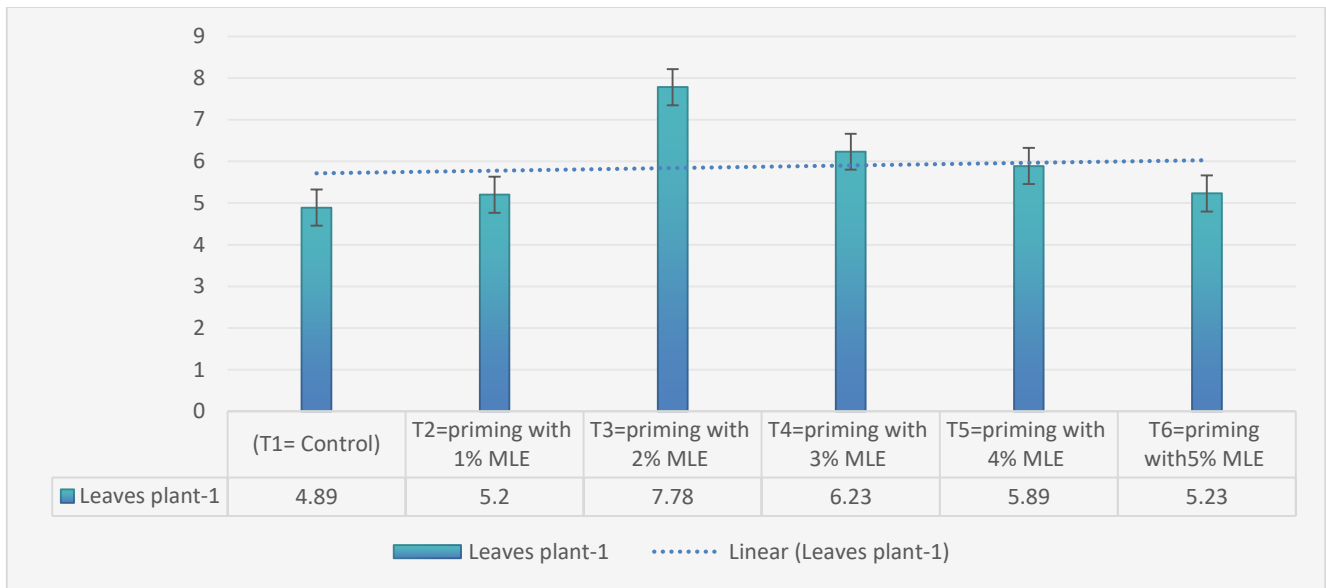


FIGURE 2 (a): Leaves plant-1 of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 2 b) showing the results Regarding number of branches per plant was statistically significant. Among the different treatments, the 2% MLE priming (T3) proved to be the most effective, resulting in the highest number of branches per plant, with an average of 9.6 branches. This indicates that the 2% MLE concentration promotes optimal branching in chili plants. In contrast, the control group (T1), which did not receive any priming, had the lowest number of branches, with only 3.56 branches per plant. Priming with 1% MLE (T2) also showed a significant improvement, leading to 5.34 branches per plant. The 3% MLE treatment (T4) resulted in 6.34 branches per plant, demonstrating a moderate increase in branching. However, treatments with 4% MLE (T5) and 5% MLE (T6) produced fewer branches, averaging 4.23 and 4.67 branches per plant, respectively. While these treatments showed some improvement over the control, their effect was not as pronounced as that of the 2% MLE treatment. The enhanced differentiation of shoots and leaves in pepper plants in response to moringa leaf extracts according to our results might be due their content of hormones, namely cytokinins, that cause higher cell extension which promotes enhanced metabolite production and thus higher food translocation to young expending shoots (Nouman et al., 2012, Rady et al., 2015).

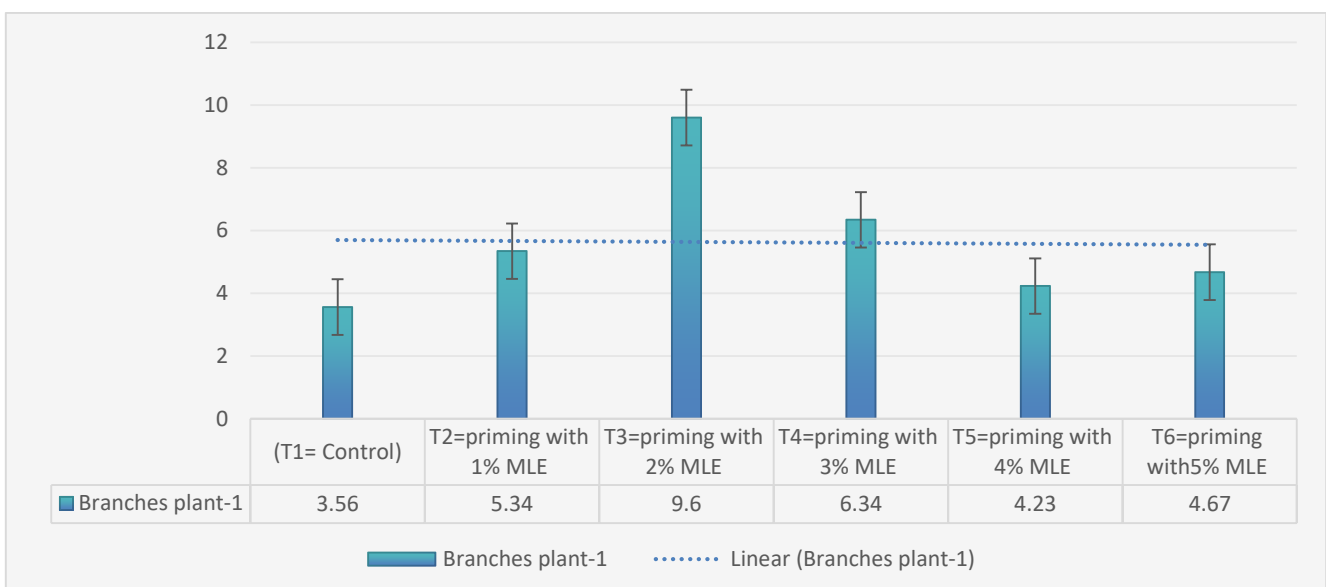


FIGURE 2 (b): Branches plant-1 of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 2 c) showing the results Regarding Seedling height (cm) was statistically significant. The 2% MLE treatment (T3) resulted in the tallest seedlings, with an average height of 15.134 cm, making it the most effective treatment for promoting seedling growth. In contrast, the control group (T1), which did not undergo any priming, showed the shortest seedlings, with a height of only 7.06688 cm. Seedlings treated with 1% MLE (T2) exhibited a moderate increase in height, averaging 8.3334

cm. Similarly, priming with 3% MLE (T4) led to a noticeable improvement, with seedlings reaching an average height of 10.634 cm. The 4% MLE treatment (T5) also resulted in taller seedlings, averaging 11 cm, while the 5% MLE treatment (T6) produced seedlings with an average height of 10.134 cm.

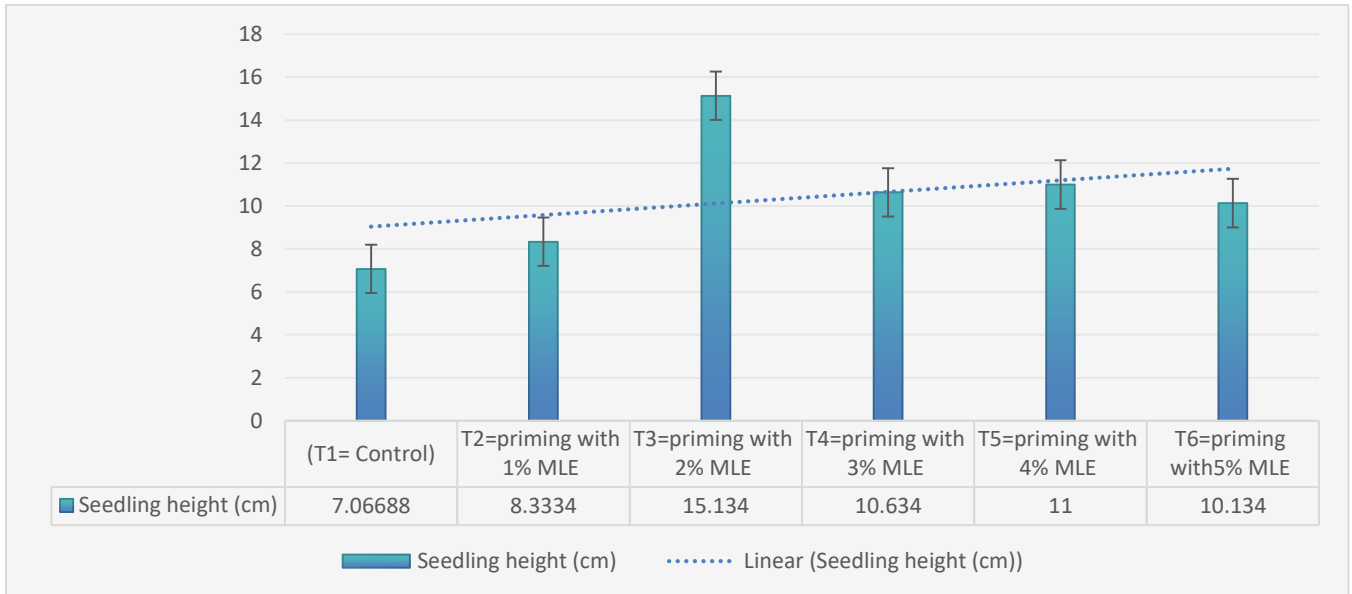


FIGURE 2 (c): Seedling height (cm) of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 3 a) showing the results Regarding Root length (cm) was statistically significant. The 2% MLE priming treatment (T3) resulted in the longest roots, with an average length of 6.5 cm, indicating that this concentration was the most effective for promoting root growth. In contrast, the control group (T1), which did not receive any priming, showed the shortest root length, measuring only 1.3668 cm. Priming with 1% MLE (T2) led to a moderate increase in root length, with an average of 2.3668 cm. Similarly, priming with 3% MLE (T4) resulted in roots averaging 3.5 cm in length, which is a noticeable improvement compared to the control. The 4% MLE treatment (T5) also promoted root growth, with an average root length of 5.4667 cm, while the 5% MLE treatment (T6) produced roots with an average length of 4.7 cm. In agreement with the results of the present study several reports indicated the favorable effects of Moringa on various chillies species which included significant effects on plant height, no. of leaves and branches, seedlings fresh and dry weight, leaf chlorophyll content, yield components and mineral content (Abou El-Nour and Eweis,2017, Dunsin and Odeghe, 2015, Aluko, 2016, Weerasingha and Harris, 2020).

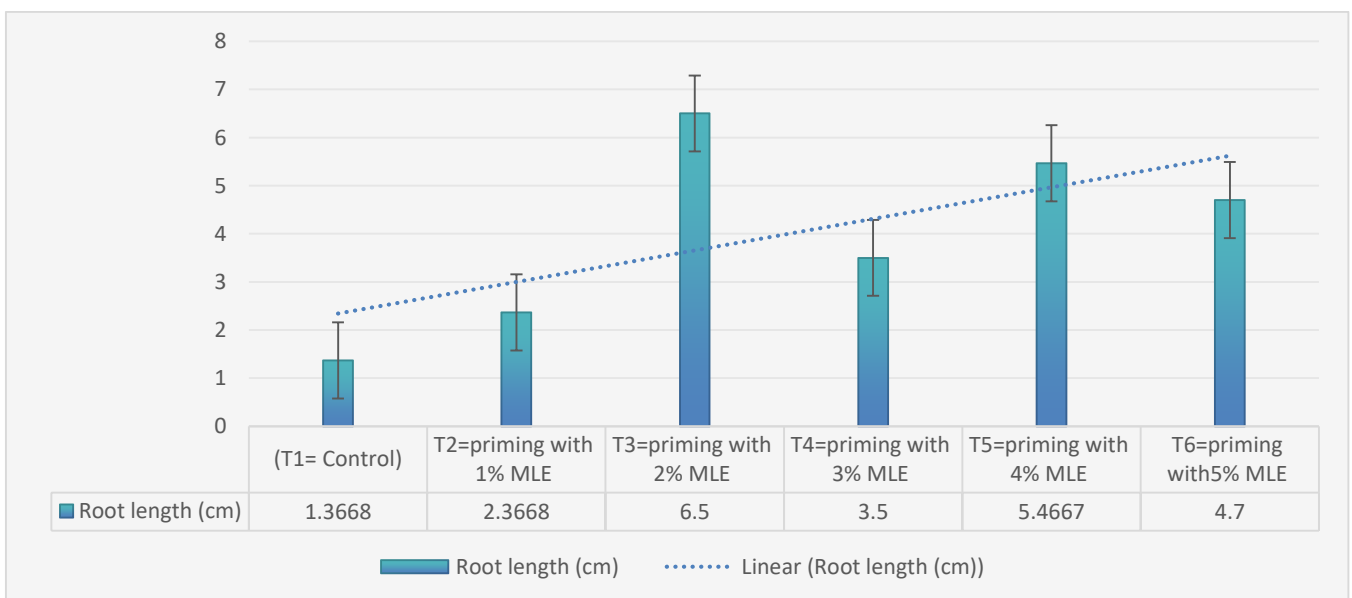


FIGURE 3 (a): Root length (cm) of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 3 b) showing the results Regarding Root Biomass (g) was statistically significant. The 2% MLE priming treatment (T3) resulted in the highest root biomass, with an average of 0.8668 g. This indicates that 2% MLE was the most effective treatment for promoting root biomass development in chili plants. In comparison, the control group (T1), which did not receive any priming, exhibited the lowest root biomass, with only 0.4634 g. Priming with 1% MLE (T2) led to an increase in root biomass, with an average of 0.58 g, while the 3% MLE treatment (T4) resulted in a root biomass of 0.63 g. Similarly, the 4% MLE treatment (T5) showed a moderate increase in root biomass, with an average of 0.6533 g. The 5% MLE treatment (T6), however, had a slight decrease in root biomass compared to other treatments, with an average of 0.52 g.

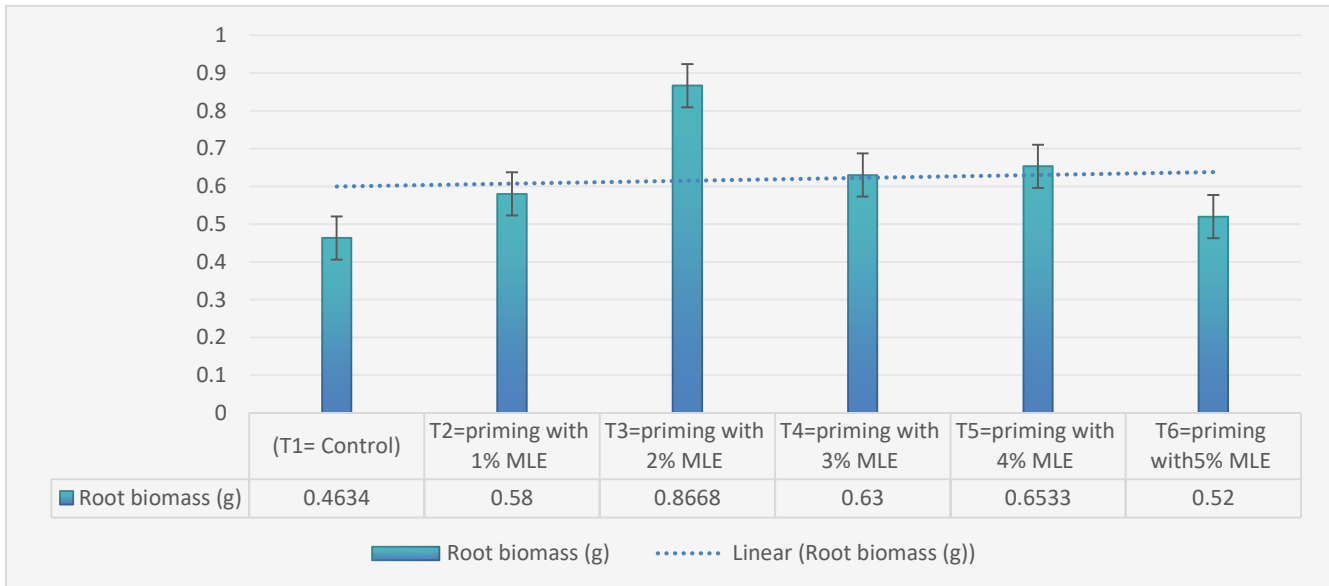


FIGURE 3 (b): Root biomass (g) of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 3 c) showing the results Regarding Shoot Biomass (g) was statistically significant. The highest shoot biomass was observed in the 2% MLE priming treatment (T3), with an average value of 1.3234 g. This suggests that priming with 2% MLE was the most effective for promoting shoot biomass accumulation in chili plants. In contrast, the control group (T1), which did not undergo any priming, showed a lower shoot biomass of 0.5868 g. Priming with 1% MLE (T2) resulted in a substantial increase in shoot biomass, with an average of 0.9368 g. The 3% MLE treatment (T4) also led to an increase in shoot biomass, with a value of 0.6668 g. However, priming with 4% MLE (T5) resulted in the lowest shoot biomass among all treatments, with only 0.5533 g. The 5% MLE treatment (T6) led to a moderate increase, yielding a shoot biomass of 0.63 g.

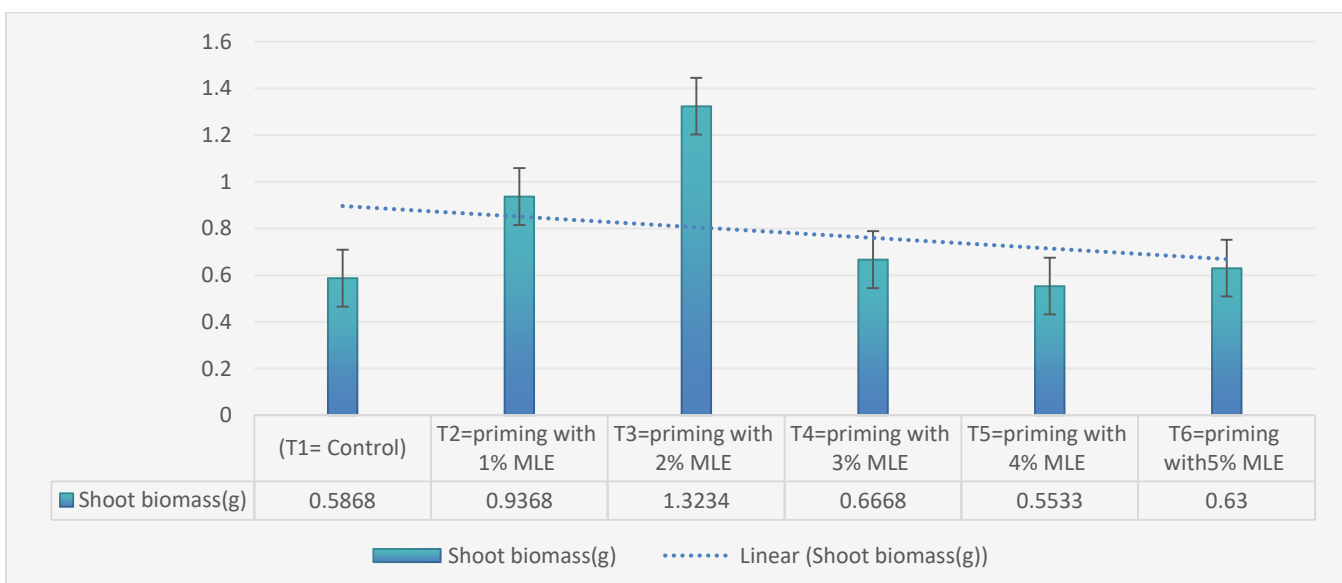


FIGURE 3 (c): Shoot biomass (g) of Chilli under the Influence of Varying Priming Treatments with MLE.

The (Figure 3 d) showing the results Regarding chlorophyll content was statistically significant. The 2% MLE priming treatment (T3) resulted in the highest chlorophyll content, with a SPAD value of 64.868. This indicates that 2% MLE priming was the most effective in enhancing chlorophyll production, which is essential for photosynthesis and overall plant health. In comparison, the control group (T1), which did not receive any priming, had the lowest chlorophyll content, with a SPAD value of 28.2. Priming with 1% MLE (T2) also led to an increase in chlorophyll content, with a SPAD value of 34.068. The 3% MLE treatment (T4) showed a moderate improvement, with a SPAD value of 35.9. Additionally, priming with 4% MLE (T5) resulted in a chlorophyll content of 42.634, and the 5% MLE treatment (T6) showed a SPAD value of 57.434, indicating that higher concentrations of MLE also enhanced chlorophyll content, though not as significantly as the 2% MLE treatment. Fuglie (2008) had reported that application of moringa leaf extract can increase yield of any crop by 25 to 30%. Nagar *et al.* (2006) pointed out that moringa leaves are rich in zeatin (naturally occurring cytokinin) hormone that enhances plant growth. Mvumi *et al.* (2012 and 2013) confirmed this on maize, beans and tomato buttressing the work of Fuglie (2000) that there was increased crop yields when crops were sprayed with and priming with extract from moringa leaves.

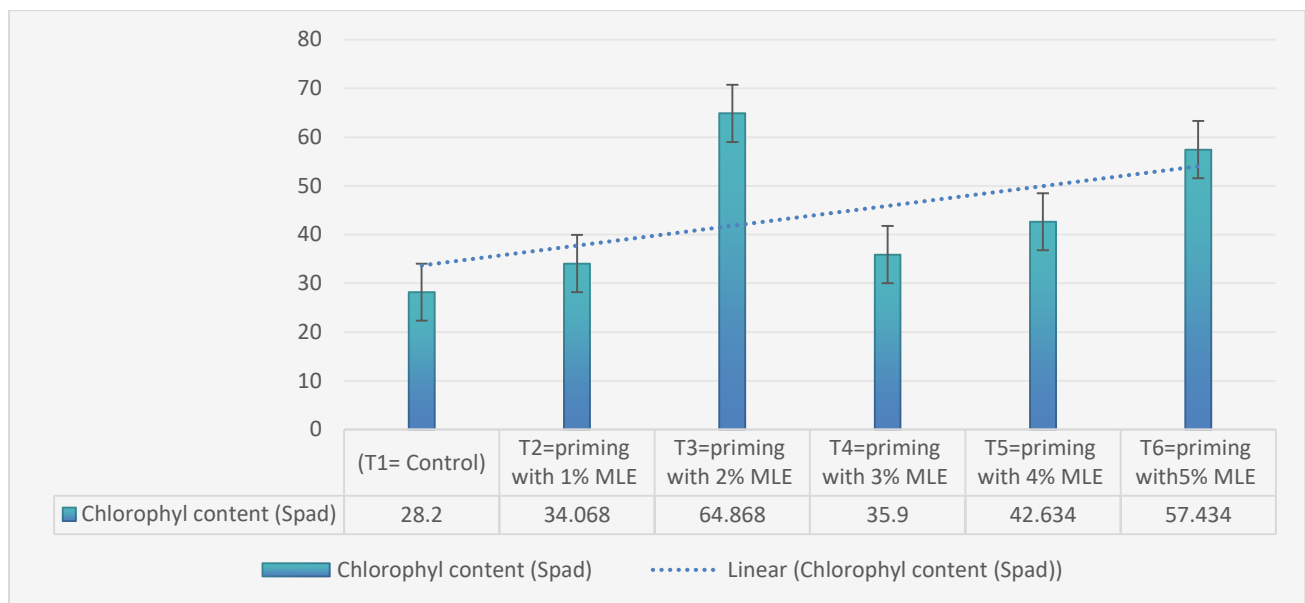


FIGURE 3 (d): Chlorophyll content of Chilli under the Influence of Varying Priming Treatments with MLE

IV. CONCLUSION

The priming with 2% MLE increased the germination of chili seeds, seedling growth, and plant development. This concentration showed the highest germination percentage, germination index, seedling vigor index, number of leaves and branches per plant, plant height, root length, root biomass, shoot biomass, and chlorophyll content. These results can be used to support the use of 2% MLE as a priming enhancing chili plant productivity and performance, thus providing valuable information for agricultural practices. Further research and field trials are therefore recommended to assess the practicality and benefits of MLE in chili production.

REFERENCES

- [1] Abou El-Nour H., Ewais N. 2017. Effect of *M. oleifera* leaf extract (MLE) on pepper seed germination, seedlings improvement, growth, fruit yield and its quality. *Middle East Journal of Agriculture Research*, 6 (2), 448–463.
- [2] Aluko M. 2016. Moringa leaf extract on the growth and yield of pepper (*Capsicum annumm*). *APRN Journal of Agricultural and Biological Science*, 11 (3), 107–109.
- [3] Andrews, J. (1995). *Peppers: The domesticated capsicums*. University of Texas Press.
- [4] Cai, W., Tang, F., Wang, Y., Zhang, Z., Xue, Y., Zhao, X., ... & Shan, C. (2021). Bacterial diversity and flavor profile of Zha-Chili, a traditional fermented food in China. *Food Research International*, 141, 110112.
- [5] Dunsin O., Odeghe T. 2015. Response of sweet bell pepper to moringa leaf extract and organo-bio degradable fertilizer. *Asian Journal of Agriculture and Biology*, 3 (4), 17–123.
- [6] El-Ramady, H., Hajdú, P., Törös, G., Badgar, K., Llanaj, X., Kiss, A., ... & Prokisch, J. (2022). Plant nutrition for human health: a pictorial review on plant bioactive compounds for sustainable agriculture. *Sustainability*, 14 (14), 8329.

- [7] Etkin, N. L. (2008). *Edible medicines: an ethnopharmacology of food*. University of Arizona Press.
- [8] Foster, N., & Cordell, L. S. (Eds.). (1992). *Chilies to chocolate: food the Americas gave the world*. University of Arizona Press.
- [9] Fuglie L. J. 2000. New Uses of Moringa Studied in Nicaragua: ECHO's Technical Network Site-networking global hunger solutions. ECHO, Nicaragua.
- [10] Fuglie L. J. 2008. New Uses of Moringa Studied in Nicaragua: ECHO's Technical Network Site-networking global hunger solutions. ECHO, Nicaragua. p. 1.
- [11] Gupta, E., & Mishra, P. (2021). Functional food with some health benefits, so called superfood: a review. *Current Nutrition & Food Science*, 17 (2), 144-166.
- [12] Hafeez, A., Tipu, M. I., Saleem, M. H., Al-Ashkar, I., Saneoka, H., & El Sabagh, A. (2022). Foliar application of moringa leaf extract (MLE) enhanced antioxidant system, growth, and biomass related attributes in safflower plants. *South African Journal of Botany*, 150, 1087-1095.
- [13] Jalgaonkar, K., Mahawar, M. K., Girijal, S., & Hp, G. (2024). Post-harvest profile, processing and value addition of dried red chillies (*Capsicum annum L.*). *Journal of Food Science and Technology*, 61 (2), 201-219.
- [14] Kumar, V., Kumar, A., Nayik, G. A., & Rafiq, S. M. (2020). Drum Stick (*Moringa oleifera*). *Antioxidants in Vegetables and Nuts- Properties and Health Benefits*, 249-264.
- [15] Mashamaite, C. V., Ngcobo, B. L., Manyevere, A., Bertling, I., & Fawole, O. A. (2022). Assessing the usefulness of *Moringa oleifera* leaf extract as a biostimulant to supplement synthetic fertilizers: A Review. *Plants*, 11 (17), 2214.
- [16] Mihiranie, S., Jayasinghe, J. K., Jayasinghe, C. V., & Wanasundara, J. P. (2020). Indigenous and traditional foods of Sri Lanka. *Journal of ethnic foods*, 7, 1-19.
- [17] Mvumi C., Tagwira F. and Chiteka A. Z. 2012. Effect of moringa extract on growth and yield of maize and common beans. *Greener Journal of Agricultural Sciences*. 3 (1): 055-062.
- [18] Mvumi C., Tagwira F. and Chiteka A. Z. 2013. Effect of moringa extract on growth and yield of tomato. *Greener Journal of Agricultural Sciences*. 2 (5): 207-211.
- [19] Nagar P. K., Iyer R. I. and Sircar P. K. 2006. Cytokinins in developing fruits of *Moringapterigosperma* Gaertn. *Physiol Plant*. 55: 45-50.
- [20] Nouman W., Basra S., Siddiqui M. 2012. *Moringa oleifera* leaf extract: An innovative priming tool for rangeland grass. *Turkish Journal Of Agriculture And Forestry*, 36 (1), 65-75.
- [21] Peterson, J. (2017). *Sauces: classical and contemporary sauce making*. Houghton Mifflin Harcourt.
- [22] Rady M.M., Mohamed G.F. 2015. Modulation of salt stress effects on the growth, physio-chemical attributes and yields of *Phaseolus vulgaris* L. plants by the combined application of salicylic acid and *Moringa oleifera* leaf extract. *Scientia Horticulturae*, 193, 105-113.
- [23] Weerasingha K.A.A.L., Harris K.D. 2020. Impact of foliar application of moringa leaf extract on yield and quality attributes of chilli (*Capsicum Annuum L.*) CV. Mipc-01. *Universe International Journal of Interdisciplinary Research*, 1 (2), 2582-6417.