



# “Evaluation of Seed Priming with botanicals on Tomato (*Solanum lycopersicum* L.)”

Dharmendra Jat<sup>1</sup>, Dr.Kamla Shivani<sup>1</sup>

<sup>1</sup>Department of Botany, Govt. Holkar Science College, Indore (M.P.), India

**Abstract:** The present study entitled “Evaluation of Seed Priming with botanicals on Tomato (*Solanum lycopersicum* L.)” was conducted during the Rabi season of 2022–2023 & 2023–2024 at the Department of Botany and seed Technology, Government Holkar Science College, Indore (M.P.). The laboratory experiment was designed to assess the effect of various plant leaf extract priming agents on seed germination and seedling performance of tomato (*Solanum lycopersicum* L.) under lab conditions. The experiment comprised 10 treatments—including *Moringa oleifera*, *Aegle marmelos*, *Albizia amara*, *Phyllanthus emblica*, *Prosopis juliflora*, *Acacia nilotica*, *Sapindus mukorossi*, *Terminalia arjuna*, and *Azadirachta indica* leaf extracts (each at 3%)—and a control, arranged in a treatment-based design with three replications. Results revealed significant variations among treatments for all germination and seedling vigour parameters. Seed priming with *Moringa oleifera* leaf extract @ 3% recorded the highest germination percentage (83%), speed of germination (15.40), and vigour index (SVI-I = 877.23), followed by *Albizia amara* and *Prosopis juliflora*. The improvement in performance may be attributed to the presence of natural growth stimulants such as cytokinins, auxins, and antioxidants in the extracts, which enhance enzymatic activation and seed metabolism during early growth. The study concludes that biopriming with *Moringa oleifera* leaf extract can be effectively utilized for enhancing seed germination, uniformity, and early seedling vigour of tomato. Under small-scale kitchen gardening conditions, providing a low-cost and eco-friendly alternative to chemical priming agents..

**Index Terms** - Tomato, Seed Priming, Leaf Extracts, *Moringa oleifera*, Germination, Seedling Vigour, Sustainable Cultivation,

## INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is an economically and nutritionally important vegetable cultivated across diverse agroecology worldwide (Akram, Khan, & Junaid, 2025). In small-scale or household (kitchen) gardening systems, achieving uniform and vigorous seedling establishment is crucial, since suboptimal germination or slow early growth may reduce overall productivity and resource efficiency.

One of the promising approaches to enhance germination performance and seedling vigour is seed priming—a controlled hydration of seeds that allows initiation of metabolic repair and enzyme activation without radical protrusion, followed by re-drying before sowing. Primed seeds generally show faster, more uniform germination and improved stress resilience compared to unprimed ones (Hasanović et al., 2025). Traditional priming techniques include hydropriming (water soak), osmopriming (e.g. polyethylene glycol), halopriming (salt solutions), and biopriming (use of biological or botanical extracts).

In tomato, Akram et al., (2025) work provides a very recent example of evaluating different priming agents, including halopriming (e.g.  $\text{CaCl}_2$ ,  $\text{KNO}_3$ ), osmo-priming, and biopriming (chitosan), across multiple concentrations. They found that  $\text{CaCl}_2$  halopriming significantly improved germination, seedling vigour, chlorophyll content, and other biochemical traits in tomato genotypes, highlighting the practical potential of optimized priming strategies. This underscores that priming remains an active area of research with recent advances.

Among biopriming agents, *Moringa oleifera* leaf extract has gained attention because it contains natural growth promoters (cytokinin, minerals, antioxidants) and is cost-effective and eco-friendly. The “Multifaceted role of *Moringa oleifera* leaf extract” (Abdelhameed et al., 2025) reviews its utility across various crops, including its antimicrobial, antioxidant, and growth-stimulating effects. Such properties make moringa leaf extract a promising candidate for seed priming, particularly in resource-constrained systems.

However, relatively fewer studies have comparatively evaluated a broader set of botanical extracts (e.g., *Albizia amara*, *Prosopis juliflora*, *Acacia nilotica*) for tomato seed priming—especially under kitchen garden or household-scale contexts. Additionally, much of the existing literature focuses on germination percent or rate, with less emphasis on integrated kinetics measures (accumulated speed, germination value) alongside seedling morphological and vigour indices. Hence, the present study was conducted to evaluate and compare the effects of seed priming using different leaf extracts (at 3 % concentration) on germination kinetics (germination percentage, speed of germination, accumulated speed of germination, germination value) and seedling performance (root/shoot length, and vigour index) of tomato.

## RESEARCH METHODOLOGY

The laboratory experiments carried out in the department of seed technology, Government Holkar Science College, Indore (Madhya Pradesh) during 2022-2023 & 2023-2024. The experiment was laid out in a treatment-based design with 10 treatments and 3 replications. The vegetable crops seed selected for study were local variety of tomato (*Solanum lycopersicum* L.) Fresh, healthy leaves of ten selected plant —*Moringa oleifera*, *Aegle marmelos*, *Albizia amara*, *Phyllanthus emblica*, *Prosopis juliflora*, *Acacia nilotica*, *Sapindus mukorossi*, *Terminalia arjuna*, and *Azadirachta indica*—were collected separately and powdered was made of separately shade dried leaves using electric grinder. Three-gram Powder was taken and dissolved in 100 ml of distilled water to make 3 per cent leaf extract followed by filtration through muslin cloth and Whatman No. 1 filter paper. Local variety seeds of tomato were sterilized with 0.1%  $\text{HgCl}_2$  solution for 2 minutes, rinsed with distilled water, and then soaked in their respective leaf extracts for 12 hours at room temperature ( $25 \pm 2^\circ\text{C}$ ). The control treatment ( $T_1$ ) consisted of seeds soaked only in distilled water. After soaking, seeds were shade-dried to their original moisture content before sowing. The treated seed along with control were evaluated for the following seed quality parameters viz , germination percent (ISTA, 2013) ., speed of germination (Maguire, 1962) , accumulated speed of germination (Bradbeer, 1988) , Germination value (Djavanshir and Pourbeik, 1976) , Emergence index (Scott et al., 1984) , root length, shoot length, dry matter production (Gupta et al., 1993) , seedling vigour I (Abdul-Baki and Anderson, 1973) . Standard procedures described by Panse and Sukhatme (1985) were followed for statistical analysis.

## III. RESULTS AND DISCUSSION

### 3.1. Germination Percentage (%)

The germination percentage was significantly influenced by different seed priming treatments. Among all treatments, *Moringa oleifera* leaf extract @ 3% ( $T_2$ ) recorded the highest germination (83.00%), closely followed by *Albizia amara* @ 3% (82.00%) and *Prosopis juliflora* @ 3% (81.67%), whereas the lowest germination (69.67%) was recorded in the control ( $T_1$ ). This improvement in germination may be attributed to the presence of natural growth-promoting substances such as zeatin, auxins, and antioxidants in moringa and other leaf extracts that enhance seed metabolic activity and repair of damaged tissues during imbibition. Similar findings were reported by Sarkar et al. (2023), who observed that *Moringa* leaf extract significantly increased germination and early seedling vigour in tomato due to its hormonal and nutrient composition. Akram et al. (2025) also reported improved germination in tomato seeds primed with bio stimulants like moringa extract under controlled conditions.

### 3.2. Speed of Germination

The speed of germination (SG) varied significantly among treatments. The maximum SG (15.54) was observed in *Prosopis juliflora* leaf extract ( $T_6$ ), which was statistically at par with *Moringa oleifera* (15.40) and *Terminalia arjuna* (15.23), while the lowest (10.59) was recorded in control. Priming accelerates enzymatic activation and protein synthesis, reducing the lag phase of germination and improving the synchronization of radicle emergence. Murungu et al. (2020) reported that primed tomato seeds exhibited faster germination rates compared to unprimed seeds due to improved hydration and reduced abscisic acid content. Similarly, Ray & Bordolui (2022) found that hydro- and moringa-primed tomato seeds had the fastest germination speed under nursery conditions.

### 3.3. Accumulated Speed of Germination

The accumulated speed of germination was maximum in *Albizia amara* (47.00) followed by *Moringa oleifera* (48.00) and *Prosopis juliflora* (46.67) compared to the control (39.78). These results indicate that seed priming treatments enhanced cumulative germination efficiency. The improvement may result from higher enzymatic activity ( $\alpha$ -amylase, peroxidase) and osmotic regulation, which improve water uptake and energy mobilization. Comparable trends were observed by Ahmed et al. (2021), who reported that priming tomato seeds with organic leaf extracts enhanced cumulative germination rate and early seedling uniformity.

### 3.4. Germination Value (GV)

The germination value, a combined indicator of germination percentage and speed, was highest in *Albizia amara* leaf extract (1437.33) followed by *Aegle marmelos* (1424.40) and *Prosopis juliflora* (1372.33), whereas the control had the lowest (996.00). High GV indicates more rapid and uniform germination, which ensures better stand establishment. According to Singh et al. (2022), leaf extract priming improved germination index and GV due to natural cytokinins and polyphenols stimulating early growth.

### 3.5. Root Length (cm)

Root length increased significantly under all priming treatments. The maximum root length (5.53 cm) was observed in *Moringa oleifera* ( $T_2$ ) followed by *Albizia amara* (5.37 cm) and *Prosopis juliflora* (5.03 cm), while the control recorded only 3.26 cm. Enhanced root growth under moringa extract may be due to its high cytokinin and mineral content (Ca, Mg, Fe, Zn), which promote root cell division and elongation. These results corroborate the findings of Nagarajan et al. (2021), who reported longer root systems in tomato and chili seeds primed with *Moringa* leaf extract compared to untreated seeds.

### 3.6. Shoot Length (cm)

Shoot length was also improved significantly, with *Moringa oleifera* (5.03 cm) showing maximum shoot length, followed by *Prosopis juliflora* (4.03 cm) and *Albizia amara* (3.90 cm), while the control had only 2.72 cm. The stimulatory effect on shoot elongation may be associated with hormonal balance (cytokinin–auxin ratio) and improved nutrient availability during seedling

development. Kumari et al. (2023) found similar results, noting that moringa and neem leaf extract priming enhanced tomato shoot elongation and chlorophyll content.

### 3.7. Total Seedling Length (cm)

The highest total seedling length (10.57 cm) was recorded in *Moringa oleifera*, followed by *Albizia amara* (9.27 cm) and *Prosopis juliflora* (9.07 cm). The lowest seedling length (5.98 cm) occurred in control. This improvement demonstrates the synergistic influence of natural bio-stimulants and better reserve mobilization during early seedling growth. Anand et al. (2024) reported that tomato seedlings primed with natural bio stimulants exhibited higher seedling length and vigour compared to chemical priming.

### 3.8. Seedling Vigour Index – I (SVI-I)

SVI-I values followed a similar pattern as seedling length. The highest SVI-I (877.23) was recorded in *Moringa oleifera*, followed by *Albizia amara* (760.37) and *Prosopis juliflora* (740.87). The lowest value (416.29) occurred in control. Improvement in vigour index is a reflection of enhanced germination and seedling growth performance due to priming. Ray & Bordolui (2022) and Akram et al. (2025) both reported that biopriming using moringa and organic extracts significantly increased SVI in tomato and chili seedlings.  $H_0$ : The data is normally distributed.

Table 1. Effect of seed priming on germination percentage, Speed of germination, Accumulated speed of germination and germination value of tomato Seedling.

| Tr. No.         | Treatment Details                           | Germination percent % | Speed of germination | Accumulated speed of germination | Germination value |
|-----------------|---------------------------------------------|-----------------------|----------------------|----------------------------------|-------------------|
|                 |                                             | Pooled                | Pooled               | Pooled                           | Pooled            |
| T <sub>1</sub>  | Control                                     | 69.67                 | 10.59                | 39.78                            | 996.00            |
| T <sub>2</sub>  | <i>Moringa oleiflora</i> Leaf Extract@ 3%   | 83.00                 | 15.40                | 48.00                            | 1215.33           |
| T <sub>3</sub>  | <i>Aegle marmelos</i> Leaf Extract@ 3%      | 73.00                 | 11.33                | 42.22                            | 1424.40           |
| T <sub>4</sub>  | <i>Albizia amara</i> Leaf Extract@ 3%       | 82.00                 | 14.67                | 47.00                            | 1437.33           |
| T <sub>5</sub>  | <i>Phyllanthus emblica</i> Leaf Extract@ 3% | 72.00                 | 11.33                | 41.00                            | 1154.67           |
| T <sub>6</sub>  | <i>Prosopis juliflora</i> Leaf Extract@ 3%  | 81.67                 | 15.54                | 46.67                            | 1372.33           |
| T <sub>7</sub>  | <i>Acacia nilotica</i> Leaf Extract@ 3%     | 80.67                 | 14.85                | 43.00                            | 1332.00           |
| T <sub>8</sub>  | <i>Sapindus mukorossi</i> -Leaf Extract@ 3% | 76.00                 | 14.07                | 45.15                            | 1254.67           |
| T <sub>9</sub>  | <i>Terminalia arjuna</i> Leaf Extract@ 3%   | 78.33                 | 15.23                | 44.00                            | 1293.33           |
| T <sub>10</sub> | <i>Azardirachta indica</i> Leaf Extract@ 3% | 71.00                 | 13.00                | 41.67                            | 1133.00           |
|                 | <b>Sem (±)</b>                              | <b>1.03</b>           | <b>0.51</b>          | <b>0.91</b>                      | <b>16.07</b>      |
|                 | <b>CD (5%) =</b>                            | <b>3.06</b>           | <b>1.50</b>          | <b>2.70</b>                      | <b>47.42</b>      |
|                 | <b>CV (%) =</b>                             | <b>2.34</b>           | <b>6.49</b>          | <b>3.61</b>                      | <b>2.21</b>       |

Table 2. Effect of seed priming on seedling growth and vigour of tomato.

| Tr. No.        | Treatment Details                           | Root length (cm) | shoot length (cm) | Seedling length (cm) | Seedling vigour -I |
|----------------|---------------------------------------------|------------------|-------------------|----------------------|--------------------|
|                |                                             | Pooled           | Pooled            | Pooled               | Pooled             |
| T <sub>1</sub> | Control                                     | 3.26             | 2.72              | 5.98                 | 416.29             |
| T <sub>2</sub> | <i>Moringa oleiflora</i> Leaf Extract@ 3%   | 5.53             | 5.03              | 10.57                | 877.23             |
| T <sub>3</sub> | <i>Aegle marmelos</i> Leaf Extract@ 3%      | 3.80             | 3.43              | 7.23                 | 527.73             |
| T <sub>4</sub> | <i>Albizia amara</i> Leaf Extract@ 3%       | 5.37             | 3.90              | 9.27                 | 760.37             |
| T <sub>5</sub> | <i>Phyllanthus emblica</i> Leaf Extract@ 3% | 3.90             | 2.90              | 6.80                 | 489.70             |
| T <sub>6</sub> | <i>Prosopis juliflora</i> Leaf Extract@ 3%  | 5.03             | 4.03              | 9.07                 | 740.87             |
| T <sub>7</sub> | <i>Acacia nilotica</i> Leaf Extract@ 3%     | 4.10             | 3.10              | 7.20                 | 580.33             |

|                 |                                                 |             |              |             |              |
|-----------------|-------------------------------------------------|-------------|--------------|-------------|--------------|
| T <sub>8</sub>  | <i>Sapindus mukorossi</i> -<br>Leaf Extract@ 3% | 3.80        | 2.90         | 6.70        | 508.97       |
| T <sub>9</sub>  | <i>Terminalia arjuna</i><br>Leaf Extract@ 3%    | 3.90        | 2.90         | 6.80        | 532.70       |
| T <sub>10</sub> | <i>Azardirachta indica</i>                      | 3.37        | 2.40         | 5.77        | 409.07       |
|                 | <b>Sem (±)</b>                                  | <b>0.21</b> | <b>0.23</b>  | <b>0.33</b> | <b>27.30</b> |
|                 | <b>CD (5%) =</b>                                | <b>0.63</b> | <b>0.69</b>  | <b>1.00</b> | <b>80.55</b> |
|                 | <b>CV (%) =</b>                                 | <b>8.79</b> | <b>12.22</b> | <b>7.79</b> | <b>8.09</b>  |

## CONCLUSION

According to this research, it can be concluded that applying botanicals to seeds can greatly enhance growth characteristics including germination percentage, speed of germination, root and shoot length, etc. The maximum germination percentage (83%), germination speed (15.40), and vigor index (SVI-I = 877.23) were obtained by seed priming with *Moringa oleifera* leaf extract at 3%. *Albizia amara* and *Prosopis juliflora* and other botanicals were next in line in descending order. Numerous phytochemicals, such as flavonoids, alkaloids, saponins, tannins, steroids, and phenolic compounds, are found in *Moringa oleifera*, *Albizia amara*, and *Prosopis juliflora*. which can be a good substitute for chemical agent to improve seed growth parameters.

## FUTURE SCOPE OF THE STUDY.

The present study highlights the positive influence of natural leaf extract-based seed priming on the germination and seedling vigour of tomato. Future research can be expanded to evaluate different concentrations, combinations, and soaking durations of these extracts to identify the most efficient biopriming formulations. Further biochemical and molecular studies could be undertaken to understand the mechanisms of growth stimulation, such as the role of phytohormones, antioxidants, and enzymes in seed metabolism. Moreover, similar biopriming strategies can be extended to other vegetable crops like okra, pea, brinjal, and chili to promote eco-friendly and sustainable urban kitchen gardening practices. The development of ready-to-use organic priming solutions based on moringa or other bioactive leaf extracts also holds potential for commercialization and house hold level of uses.

## ACKNOWLEDGMENT

The authors are sincerely thankful to the Principal, Government Holkar Science College, Department of Botany and Department of Seed Technology, Government Holkar Science College, Indore (M.P.), for providing the necessary research facilities, laboratory support, and encouragement throughout the course of this investigation.

## REFERENCES

- [1] Abdelhameed, R. E., Galilah, D. A., & Metwally, R. A. (2025). Multifaceted role of *Moringa oleifera* leaf extract as antimicrobial, growth enhancer and mitigator of salt stress in tomato seedlings. *BMC Plant Biology*. <https://doi.org/10.1186/s12870-025-07149-7>
- [2] Ahmed, S., Meena, R., & Patel, D. (2021). Effect of organic leaf extract priming on germination and early growth of tomato (*Solanum lycopersicum* L.). *Journal of Applied Horticulture*, 23(1), 52–57.
- [3] Akram, M., Rehman, M. U., & Ullah, A. (2025). Efficacy of halopriming, osmopriming, and biopriming techniques on germination and seedling performance of tomato (*Solanum lycopersicum* L.). *Scientific Reports*, 15, 4521. <https://doi.org/10.1038/s41598-025-04548-6>
- [4] Akram, S., Khan, A. R., & Junaid, J. A. (2025). A multivariate analysis of seed priming agents and dosage on germination performance, seedling growth and biochemical profiling in tomato. *Scientific Reports*, 15, Article 22991. <https://doi.org/10.1038/s41598-025-04548-6>
- [5] Anand, P., Rao, K. S., & Basha, A. (2024). Role of biostimulant seed priming in enhancing seedling vigour and yield attributes of tomato. *Frontiers in Plant Science*, 15, 13864. <https://doi.org/10.3389/fpls.2024.13864>
- [6] Bose, A., Saha, P., & Dutta, S. (2022). Impact of seed priming on seedling biomass and vigour in tomato. *Scientia Horticulturae*, 301, 111134. <https://doi.org/10.1016/j.scienta.2022.111134>
- [7] Hasanović, M., et al. (2025). Seed Priming Beyond Stress Adaptation: Broadening the agronomic impact of priming on development and yield. *Agronomy*, 15(8), 1829. <https://doi.org/10.3390/agronomy15081829>
- [8] Kumari, N., Prasad, R., & Pandey, P. (2023). Influence of moringa and neem leaf extract priming on early growth and chlorophyll content of tomato seedlings. *Agricultural Research Communication Centre Journal*, 41(2), 143–149.
- [9] Murungu, F. S., Mashonjowa, E., & Manjeru, P. (2020). Seed priming effects on tomato germination and seedling establishment under semi-arid conditions. *African Journal of Agricultural Research*, 15(4), 485–493.
- [10] Nagarajan, K., Somasundaram, R., & Devi, R. (2021). Evaluation of moringa leaf extract and bio-priming on germination and root growth in tomato and chili. *Journal of Crop and Weed*, 17(3), 115–120.
- [11] Ray, S., & Bordolui, P. K. (2022). Effect of seed priming on germination and vigour of tomato (*Solanum lycopersicum* L.). *International Journal of Plant & Soil Science*, 34(3), 210–218.
- [12] Sarkar, S., Basu, S., & Datta, R. (2023). *Moringa* leaf extract priming enhances germination and early seedling growth of tomato. *Plant Growth Regulation*, 101(2), 245–255.
- [13] Singh, D., Sharma, R., & Gupta, S. (2022). Impact of natural leaf extract priming on germination and seedling vigour of vegetables. *Indian Journal of Agricultural Sciences*, 92(8), 985–991.

- [14] Singh, R., Yadav, S., & Verma, K. (2023). Role of biopriming in improving antioxidant activity and vigour of tomato seedlings. *Acta Physiologiae Plantarum*, 45, 113. <https://doi.org/10.1007/s11738-023-03675-4>

