International Journal of Plant & Soil Science

Volume 38, Issue 8, Page 119-130, 2026; Article no.IJPSS.160276
ISSN: 2320-7035

Magneto-priming Effect on Seed Germination, Growth and Yield of Bitter Melon (*Momordica Charantia* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2026/v38i86203

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/160276

Original Research Article

Received: 12/05/2026
Accepted: 11/07/2026
Published: 17/07/2026

Abstract

Background: Bitter melon (*Momordica charantia* L.) is an economically and medicinally important cucurbit. Improving its seed establishment, vegetative development, and yield through non-chemical pre-sowing treatments may support more efficient crop production.
Aims: This study evaluated the effects of different static magnetic-field intensities and exposure durations on seed germination, vegetative growth, and yield of bitter melon, and identified the most effective treatment combination under field conditions.
Methods: A field experiment was conducted at Navivasni village, Aravalli, Gujarat, from July to September 2022. Ten treatments were arranged in a randomised block design with three replicates. T1 was the untreated control, whereas T2–T10 comprised combinations of 70, 120, and 170 mT applied for 15, 20, or 25 minutes. Germination and selected vegetative and reproductive traits were assessed at specified days after sowing.

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Cite as: *Patel, C. K. M., Patel, K. R., Shilpkar, P. G., & Patel, D. M. (2026). Magneto-priming Effect on Seed Germination, Growth and Yield of Bitter Melon (Momordica Charantia L.) . International Journal of Plant & Soil Science, 38(8), 119–130. https://doi.org/10.9734/ijpss/2026/v38i86203*

Results: Treatment T9, consisting of 170 mT for 20 minutes, produced the best overall response. It recorded 60% germination, compared with 20% in the control. At 42 days after sowing, T9 produced 191.33 leaves, a leaf area of 182.78 cm², a total plant length of 317.70 cm, a shoot length of 266.63 cm, and a root length of 67.00 cm. It also recorded 46.67 fruits at 63 days after sowing, with fresh and dry fruit weights of 132.85 and 13.07 g, respectively, at 56 days after sowing.
Conclusion: Under the tested conditions, magneto-priming at 170 mT for 20 minutes was the most effective treatment. Further multi-location and multi-season validation under diverse agroecological and seasonal conditions is required before wider field adoption.

Keywords: Momordica charantia L.; magneto-priming; static magnetic field; seed germination; vegetative growth; fruit yield; seed treatment; magnetic-field intensity; exposure duration.

1. Introduction

Bitter gourd (*Momordica charantia* L.), also known as bitter melon, balsam pear, and African cucumber, is a medicinal plant that has been consumed as a vegetable for thousands of years. It is also known as karela in Gujarat. This tropical vine belongs to the family Cucurbitaceae (Jia et al., 2017). Its fruits have considerable economic value, and various parts of the plant are used for nutritional and therapeutic purposes.

Recent reviews further indicate that *Momordica charantia* L. contains diverse cucurbitane-type triterpenoids, polysaccharides, phenolics, and other bioactive fractions associated with its nutritional and pharmacological relevance (Jia et al., 2017; Mahwish et al., 2021).

The fruit of *Momordica charantia* L. has a low-calorie profile while providing a dense concentration of essential micronutrients and bioactive compounds. Vitamins B1, B2, B3, and C are present in the fruits of *Momordica charantia* L.

Pharmacological Applications: Modern scientific research has focused on evaluating the ethnomedicinal claims associated with *M. charantia*. Reported properties include hypoglycaemic activity (Joseph & Jini, 2013), antioxidant and anti-inflammatory activity (Mahwish et al., 2021), and antimicrobial potential (Upadhyay et al., 2015). However, the biomedical evidence base remains heterogeneous, and clinical and experimental findings should be interpreted cautiously because the plant part, cultivar, extraction method, dose, and experimental design may influence the reported outcomes (Joseph & Jini, 2013; Upadhyay et al., 2015).

M. charantia and diabetes: Data from the 11th edition of the IDF Diabetes Atlas confirm that diabetes is among the fastest-growing global health emergencies of the 21st century. In 2024, an estimated 588.7 million people were living with diabetes, and this number is projected to reach 852.5 million by 2050 (International Diabetes Federation, 2025). Bitter melon contains polypeptide-p and is commonly used in traditional approaches to diabetes management (Khanna et al., 1981).

For crop-improvement research, enhancing seedling vigour and yield in bitter gourd is relevant because physical seed stimulation may offer a low-input, residue-free approach when treatment intensity and exposure duration are optimised (Mahajan & Pandey, 2015; Vashisth & Nagarajan, 2008). Recent crop studies indicate that magneto-priming may influence germination and early growth; however, the magnitude and direction of the response vary with crop species, magnetic-field strength, and exposure duration (Gutierrez et al., 2024; Mohammed et al., 2024; Muthal et al., 2025). Research on bitter melon and related cucurbit seeds has also shown that germination and early seedling development can vary according to the pre-sowing treatment applied (Vadera et al., 2021). Nevertheless, field evidence on the combined effects of static magnetic-field intensity and exposure duration on the germination, vegetative growth, and yield of bitter melon remains limited under the conditions evaluated in this study.

1.1 Objectives

- To determine the optimum magnetic-field strength and exposure duration for improved crop growth.
- To evaluate the effects of magnetic-field application on crop growth and yield.

- To assess the effects of a static magnetic field on bitter melon seedling establishment and plant growth.
- To compare the germination time of magnetically treated seeds with that of untreated control seeds.

2. Materials and Methods

The Pusa Do Mausami variety of bitter gourd was used in this experiment. Seeds were purchased from the APMC market, Talod, with a truthful label indicating a minimum germination of 60%, minimum pure seed content of 99%, maximum inert matter of 1%, and minimum genetic purity of 98%.

Number of seeds per treatment: 10
Plot size: 9 ft x 30 ft (each block: 3 ft x 3 ft).
Number of plants sampled: 3

2.1 Method of Magneto-Priming

Bitter gourd seeds were treated with a magnetic field at Saraswati Master of Science College, Viravada, Gujarat. A Helmholtz coil connected to a variable DC power supply was used to generate magnetic fields of varying intensities, usually ranging from 50 to 300 mT (Vashisth & Nagarajan, 2008).

Fig. 1. Magnetic seed germination experimental arrangement

When an electric current passes through the coils, a non-uniform and dynamic magnetic field is generated in the air space between the two bars. The magnetic-field treatment was applied according to Iqbal et al. (2012), with some modifications.

Non-exposed seeds were used as the control (T1). Dry, mature, and healthy seeds were placed in Petri plates (3 x 10 cm) between the poles of an electromagnet, where they were exposed to a non-uniform magnetic field for the required duration. Magnetic-field strength was varied by changing the current in the electromagnet coil and was measured between the poles using a magnetic flux meter. All treatments were conducted simultaneously under similar conditions. Following treatment at the specified magnetic-field strength and duration, the seeds were washed with a fungicide solution to prevent fungal contamination and then placed on filter paper in circular glass Petri plates.

Table 1. Experimental treatments

Treatment	Combination of Magnetic Field and Time-Duration
T1	Control
T2	Seed treated by magnetic field of 70mT for 15 minutes
T3	Seed treated by magnetic field of 70mT for 20 minutes
T4	Seed treated by magnetic field of 70mT for 25 minutes
T5	Seed treated by magnetic field of 120mT for 15 minutes
T6	Seed treated by magnetic field of 120mT for 20 minutes
T7	Seed treated by magnetic field of 120mT for 25 minutes
T8	Seed treated by magnetic field of 170mT for 15 minutes
T9	Seed treated by magnetic field of 170mT for 20 minutes
T10	Seed treated by magnetic field of 170mT for 25 minutes

Table 2. RBD for different types treatments

T5 (1)	T4 (2)	T6 (3)	T9 (4)	T3 (5)	T8 (6)	T6 (7)	T7 (8)	T1 (9)	T1 (10)
T10 (11)	T2 (12)	T1 (13)	T10 (14)	T3 (15)	T3 (16)	T9 (17)	T6 (18)	T8 (19)	T5 (20)
T4 (21)	T2 (22)	T9 (23)	T5 (24)	T8 (25)	T7 (26)	T4 (27)	T10 (28)	T7 (29)	T2 (30)

3. Results and Discussion

Analysis of variance revealed significant differences ($p < 0.05$) among the ten treatments for almost all measured parameters at the different DAS. SEM error bars and significance letters (a, b, c, etc.) in the graphical data illustrate distinct statistical groupings, indicating that some treatments performed better than the control during the vegetative and reproductive stages.

Table 3. Chemical analysis of the experimental soil

Components	Value of components
pH	7.0
Organic carbon	0.37
Macronutrients	
Nitrogen (kg ha^{-1})	163
Phosphorus (kg ha^{-1})	56
Potassium (kg ha^{-1})	302
Micronutrients	
Cu (mg kg^{-1})	0.61
Fe (mg kg^{-1})	8.21
Mn (mg kg^{-1})	7.9
Zn (mg kg^{-1})	1.23
Soluble ions	
SO_4^{-2}	11.83

Table 4. Methods and references used for the measurement of growth and yield parameters. Leaf area was estimated using the method described by Cardozo et al. (2009)

Parameters	Methods	References
Leaf area	Using formula Sf=0.4963*(C*L)	Cardozo & Parreira method
shoot length, root length, plant height	Scale measurement by standard process	-
weight of fruits (dry/fresh)	Scientific weighing unit	-

3.1 Seed Germination

Germination, defined morphologically as the visible emergence of a 2 mm radicle, was recorded daily at 24-hour intervals for 14 DAS. The data were used to calculate the final germination percentage (GP) using the following standard equation:

$$GP = \text{Number of Total Germinated Seeds} / \text{Total Number of Seeds} \times 100.$$

Treatment T9 produced the highest mean germination, with 6.0 seeds per replicate, corresponding to a germination rate of 60%. In contrast, T1 produced the lowest mean, with 2.0 seeds per replicate (20%). The remaining treatments (T2-T8 and T10) showed a uniform, moderate response, averaging 5.0 germinated seeds per replicate (50% germination).

Table 5. Seed Germination Percentage

Treatment	Mean Germinated	Seed Germination %
T1	2	20.0%
T2	5	50.0%
T3	5	50.0%
T4	5	50.0%
T5	5	50.0%
T6	5	50.0%
T7	5	50.0%
T8	5	50.0%
T9	6	60.0%
T10	5	50.0%

3.2 Vegetative Growth and Biomass Accumulation

Vegetative parameters, including plant length, shoot length, root length, and leaf area, increased consistently from 14 to 42 DAS.

The gradual increase in vegetative traits is consistent with reports that magneto-priming can improve water uptake, hydrolytic enzyme activity, antioxidant balance, and early seedling vigour, although such effects are dose- and species-dependent (Bhardwaj et al., 2012; Kataria et al., 2017; Ureta-Leones et al., 2021).

3.2.1 Number of Leaves and Leaf Area

At 42 DAS, T9 recorded the highest number of leaves (191.33; group 'a'), followed by T10 (175.33; group 'b'). In contrast, T1 recorded the lowest value (101.67; group 'g'), which did not differ significantly from T2 (106.67; group 'fg'). A similar trend was observed for leaf area. T9 recorded the highest value at 42 DAS (182.78 cm^2; group 'a'), which did not differ significantly from T8 (166.75 cm^2; group 'ab'). T1 recorded the lowest leaf area (114.40 cm^2; group 'f'), which did not differ significantly from T2 (117.69 cm^2; group 'ef'), T3 (112.23 cm^2; group 'f'), or T4 (120.47 cm^2; group 'def') (see Figs. 2 and 3).

The larger leaf area observed in T9 may indicate improved canopy formation rather than a direct causal mechanism because magnetic-field responses are often mediated through early germination vigour, metabolic activation, and antioxidant regulation (Anand et al., 2019; Gupta et al., 2015; Kataria et al., 2017).

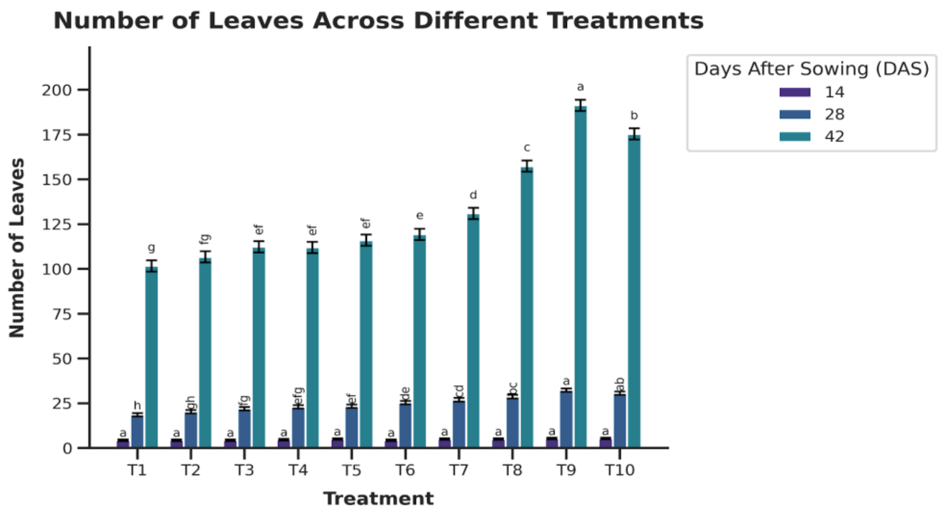

Fig. 2. Number of Leaves in M. charantia across treatment groups monitored at 14, 28, and 42DAS. Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

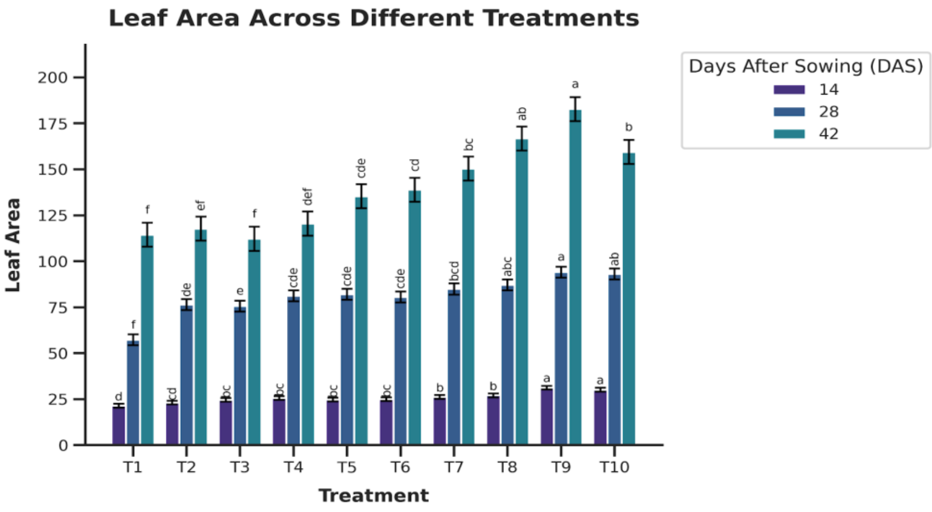

Fig. 3. Leaves Area(cm^2) in M. charantia across treatment groups monitored at 14, 28, and 42DAS. Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

3.2.2 Number of Branches

During the early growth stage (28 DAS), branching was limited, reflecting early vegetative establishment. However, statistical differentiation was already evident. T9 recorded the highest number of branches (3.67; group 'a'), followed by T10 (3.33; group 'ab'). The control and lower-performing treatments (T1-T3) recorded lower values (1.33; group 'c'), indicating slower structural development. By the mid-vegetative stage (42 DAS), the difference in branching frequency had widened. T9 recorded the highest value (13.33; group 'a'), followed by T10 (12.00; group 'ab'). T7 and T8 also improved relative to their earlier values, reaching 11.00 (group 'abc'), suggesting that the treatment effects persisted as the plants matured. T2 (8.00; group 'd') and T3 (7.33; group 'd') recorded the lowest branching values (see Fig. 4).

Greater branching under the 170 mT for 20 minutes treatment may therefore be interpreted as a downstream expression of improved vegetative establishment; similar studies on vegetable and field crops have reported treatment-specific improvements in plant height, leaf number, biomass, or yield after pre-sowing magnetic exposure (Efthimiadou et al., 2014; Koukounaras et al., 2023; Vashisth & Nagarajan, 2008).

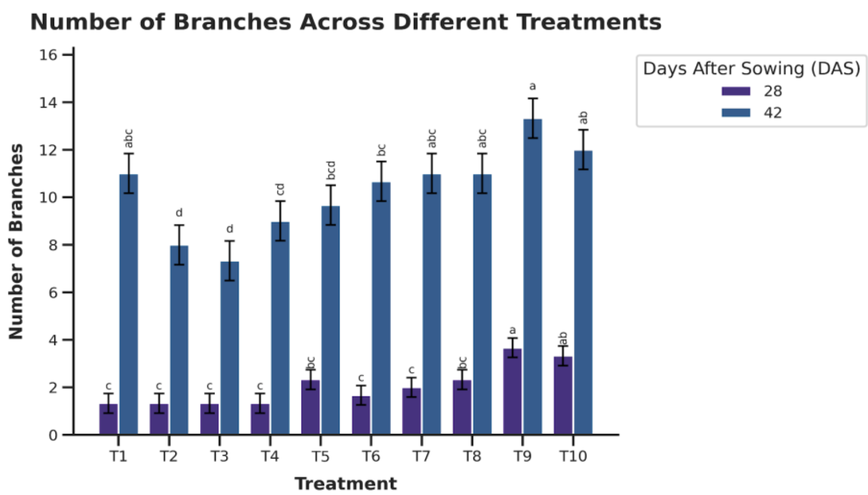

Fig. 4. Number of Branches in M. charantia across treatment groups monitored at 28, and 42DAS
Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

3.2.3 Plant, Root, and Shoot Lengths

Root and shoot lengths were greatest under T9 and T10. At the mid-vegetative stage, T9 recorded the highest total plant length (317.70 cm; group 'a'), exceeding T1 (245.30 cm; group 'g') but not differing significantly from T8 (312.40 cm; group 'a') and T9 (245.43 cm; group 'a'). In T9, root length (67.00 cm; group 'a') and shoot length (266.63 cm; group 'a') were also highest, followed by T10, with root and shoot lengths of 62.13 cm (group 'ab') and 252.13 cm (group 'ab'), respectively (see Figs. 5-7).

The root and shoot responses are consistent with the concept that magnetic exposure can enhance root growth and seedling vigour. However, they also reinforce the need for crop-specific optimisation because excessive or non-optimal combinations may not produce proportional benefits (Bhardwaj et al., 2012; Kataria et al., 2017; Ureta-Leones et al., 2021).

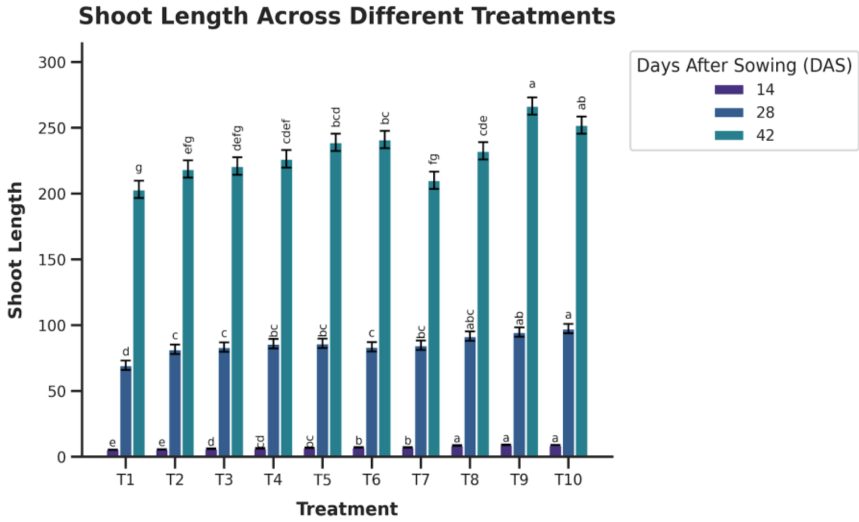

Fig. 5. Shoot Length(cm) in M. charantia across treatment groups monitored at 14, 28, and 42DAS
Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on the ANOVA test

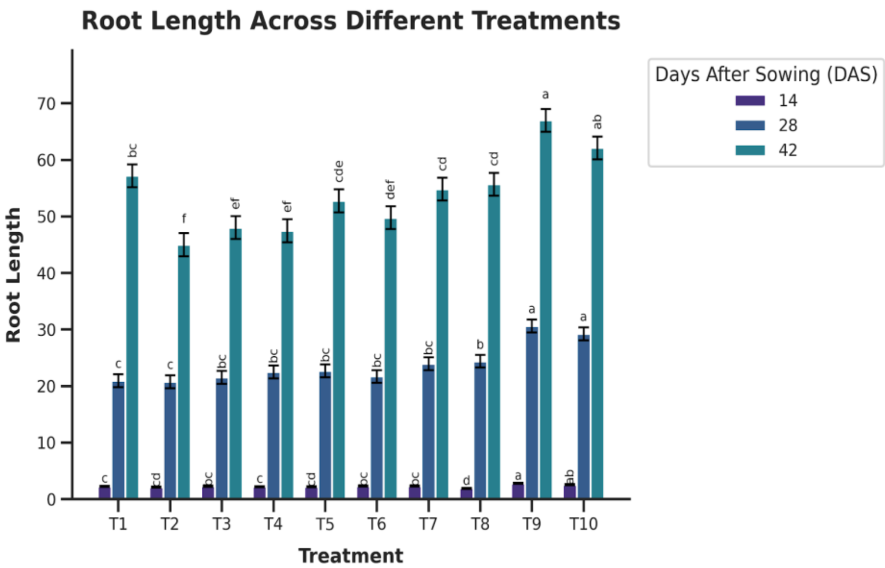

Fig. 6. Root Length(cm) in M. charantia across treatment groups monitored at 14, 28, and 42DAS
Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

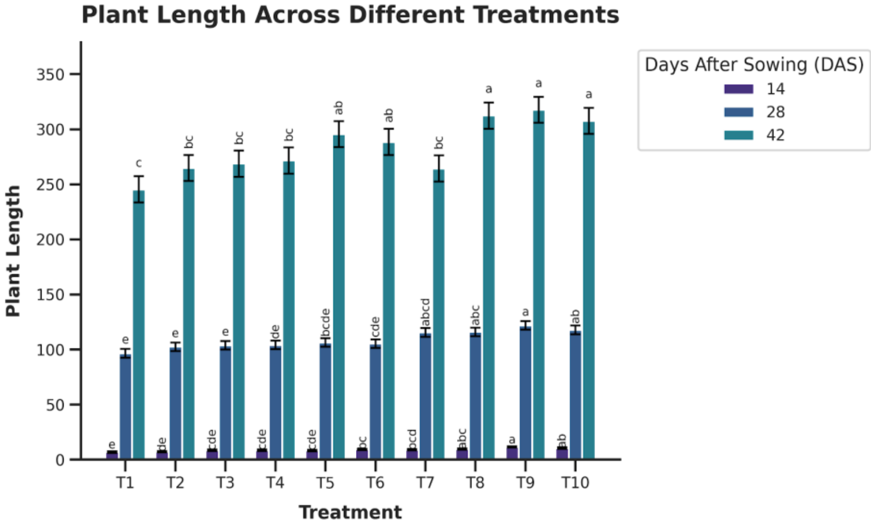

Fig. 7. Plant Length(cm) in M. charantia across treatment groups monitored at 14, 28, and 42DAS

Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

3.2.4 Number of Nodules

The number of root nodules increased over time. T9 recorded the highest nodule count at 42 DAS (147.33; group 'a'), indicating greater root development than the baseline groups. The narrow SEM margins suggest low variability among replicates under the experimental conditions (see Fig. 8).

Because *M. charantia* is not a legume, these nodule-like structures should be interpreted cautiously unless their identity and nitrogen-fixing activity are confirmed by anatomical or microbiological assays. Nevertheless, enhanced root-system development after magnetic seed treatment has been reported in other crops (Baghel et al., 2016; Vashisth & Nagarajan, 2008).

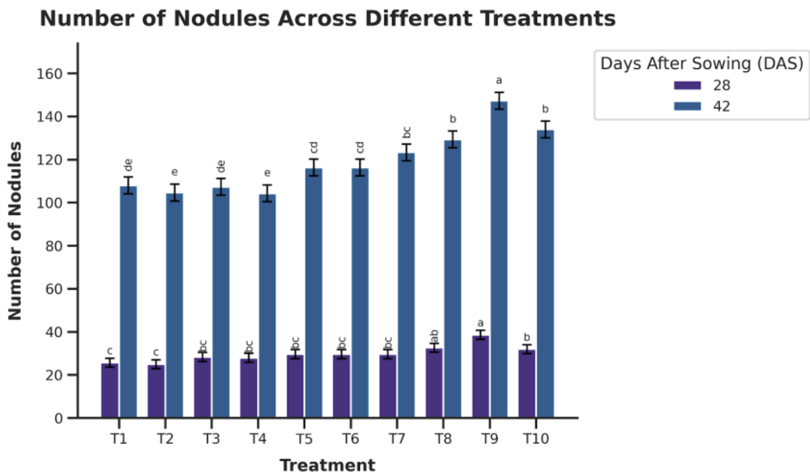

Fig. 8. Number of Nodules in M. charantia across treatment groups monitored at 28 and 42DAS

Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

3.3 Yield and Reproductive Components

The effects of the treatments were most evident in reproductive output, which was recorded from 42 to 63 DAS. Yield responses after magnetic seed stimulation have also been reported in tomato, sunflower, soybean, and bitter gourd, supporting the interpretation that improved early vigour can translate into reproductive output when the magnetic dose is within a favourable range (Afzal et al., 2021; Efthimiadou et al., 2014; Mahajan & Pandey, 2015).

3.3.1 Fruit Count

Fruit set increased most strongly in T9, which recorded the highest number of fruits at 63 DAS (46.67; group 'a'). T1 recorded the lowest number (25.33; group 'de') (see Fig. 9).

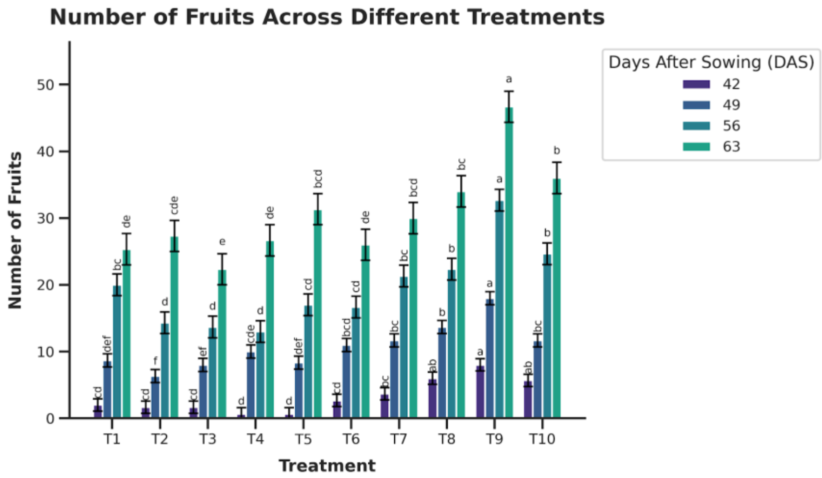

Fig. 9. Number of Fruits in M. charantia across treatment groups monitored at 42, 49, 56 and 63DAS
Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

The higher fruit number in T9 is consistent with this broader pattern; however, the present interpretation should remain treatment-specific because the response of fruit set to magnetic exposure may vary with species, field conditions, and exposure protocol (Afzal et al., 2021; Koukounaras et al., 2023; Ureta-Leones et al., 2021).

3.3.2 Fresh and Dry Fruit Weight

Fruit biomass followed a pattern similar to fruit count. At the final recorded stage (56 DAS), T9 recorded the highest fresh fruit weight (132.85 g; group 'a') and dry fruit weight (13.07 g; group 'a'). T8 was the next-highest-performing treatment for dry fruit weight (11.69 g; group 'b'). The significance groupings indicate that T9 and T8 produced higher fruit biomass than the control (T1), which was consistently placed in the lower statistical groups ('d' and 'de') (see Figs. 10 and 11).

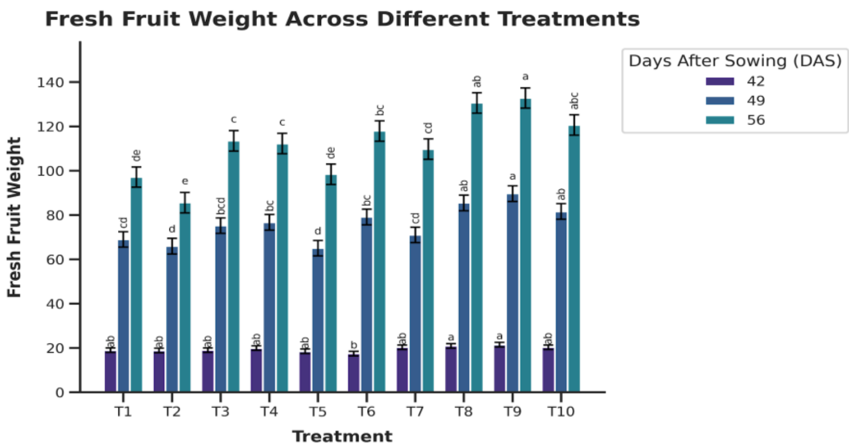

Fig. 10. Fresh Fruits Weight (gm) in M. charantia across treatment groups monitored at 42, 49, 56 DAS
Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

The concurrent increases in fresh and dry fruit weight suggest improved biomass partitioning rather than only greater water accumulation, a pattern broadly comparable to reports that optimised magnetic treatments can improve growth, photosynthetic performance, carbon and nitrogen metabolism, and yield-related traits (Afzal et al., 2021; Baghel et al., 2016; Efthimiadou et al., 2014).

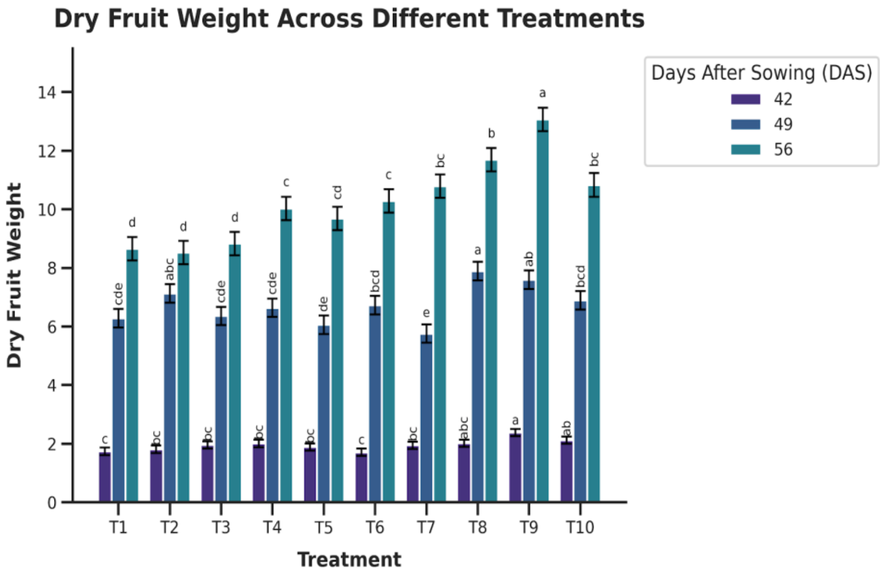

Fig. 11. Dry Fruits Weight (gm) in m*omordica charantia* L. across treatment groups monitored at 42, 49, 56 DAS

Data are presented as means ± SEm (n=3). Different letters indicate significant differences (P ≤ 0.05) based on ANOVA test

4. Conclusions

Magneto-priming influenced the germination, vegetative growth, and yield-related performance of bitter melon under the experimental conditions. Among the evaluated combinations of magnetic-field intensity and exposure duration, treatment T9, in which seeds were exposed to 170 mT for 20 minutes, produced the most favourable overall response. This treatment recorded 60% germination and comparatively higher values for leaf number, leaf area, branching, root length, shoot length, total plant length, fruit number, and fruit weight than the untreated control. Exposure to 170 mT for 15 minutes also produced favourable responses for several measured traits, although its overall performance was lower than that of T9. The findings indicate that the response to magneto-priming depends on the selected magnetic-field strength and exposure period, and that extending exposure beyond the most responsive treatment did not produce further improvement. Therefore, 170 mT for 20 minutes may be considered the most effective treatment among those examined. Confirmation through trials across additional locations, seasons, and field conditions is necessary before recommending this treatment for wider cultivation.

5. Limitation

The experiment was conducted at one location during a single growing season and included only selected magnetic-field intensities and exposure periods. Physiological, biochemical, anatomical, and microbiological assessments were not undertaken to explain the observed responses or verify the reported nodule-like structures. Multi-location and multi-season trials with expanded treatment ranges and complete data reporting are required to establish the consistency and practical applicability of magneto-priming in bitter melon.

Acknowledgements

The authors express their sincere gratitude to Gujarat Vidyapith for providing administrative support and resources necessary to conduct this research. We would also like to thank our colleagues who provided constructive critiques during the preparation of this manuscript.

Declaration of AI Use

This manuscript was prepared through the combined contributions of all author(s), including contributions to the study design, data, content development, results, interpretation, and related scholarly work. The author(s) acknowledge the use of Grammarly and ChatGPT to assist with grammar checking, language refinement, reference formatting. These AI-assisted tools were not used as authors and did not replace the intellectual contributions or scholarly judgment of the author(s). All AI-assisted outputs, including content, references, and interpretations, were carefully reviewed, revised, verified, and approved by the author(s). The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing Interests

Authors have declared that no competing interests exist.

References

Afzal, I., Saleem, S., Skalicky, M., Javed, T., Bakhtavar, M. A., ul Haq, Z., Kamran, M., Shahid, M., Sohail Saddiq, M., Afzal, A., Shafqat, N., Dessoky, E. S., Gupta, A., Korczyk-Szabo, J., Brestic, M., & El Sabagh, A. (2021). Magnetic field treatments improves sunflower yield by inducing physiological and biochemical modulations in seeds. *Molecules, 26*(7), 2022. https://doi.org/10.3390/molecules26072022

Anand, A., Kumari, A., Thakur, M., & Koul, A. (2019). Hydrogen peroxide signaling integrates with phytohormones during the germination of magnetoprimed tomato seeds. *Scientific Reports, 9*, Article 8814. https://doi.org/10.1038/s41598-019-45102-5

Baghel, L., Kataria, S., & Guruprasad, K. N. (2016). Static magnetic field treatment of seeds improves carbon and nitrogen metabolism under salinity stress in soybean. *Bioelectromagnetics, 37*(7), 455-470. https://doi.org/10.1002/bem.21988

Bhardwaj, J., Anand, A., & Nagarajan, S. (2012). Biochemical and biophysical changes associated with magnetopriming in germinating cucumber seeds. *Plant Physiology and Biochemistry, 57*, 67-73. https://doi.org/10.1016/j.plaphy.2012.05.008

Cardozo, N. P., Parreira, M. C., Alves, P. L. C. A., & Bianco, S. (2009). Foliar area estimate of two sugarcane-infesting weeds using leaf blade linear dimensions. *Planta Daninha, 27*(4), 683-687. https://doi.org/10.1590/S0100-83582009000400006

Efthimiadou, A., Katsenios, N., Karkanis, A., Papastylianou, P., Triantafyllidis, V., Travlos, I., & Bilalis, D. J. (2014). Effects of presowing pulsed electromagnetic treatment of tomato seed on growth, yield, and lycopene content. *The Scientific World Journal, 2014*, Article 369745. https://doi.org/10.1155/2014/369745

Gupta, M. K., Anand, A., Paul, V., Dahuja, A., & Singh, A. K. (2015). Reactive oxygen species mediated improvement in vigour of static and pulsed magneto-primed cherry tomato seeds. *Indian Journal of Plant Physiology, 20*, 197-204. https://doi.org/10.1007/s40502-015-0161-8

Gutierrez, J., Alonso, F., Alvarez, J., Carbonell, M. V., Martinez, E., Florez, M., Delgado, M. M., Franco, B. K., & Hernandez-Aguilar, C. (2024). Magneto-priming of seeds decreases the saline effect of wastewater irrigation on broccoli germination and seedling growth. *Seeds, 3*(1), 169-178. https://doi.org/10.3390/seeds3010013

International Diabetes Federation. (2025). *IDF Diabetes Atlas* (11th ed.). https://idf.org/news-and-resources/resources/idf-diabetes-atlas-11th-edition-2025/

Iqbal, M., Haq, Z. U., Jamil, Y., & Ahmad, M. R. (2012). Effect of presowing magnetic treatment on properties of pea. *International Agrophysics, 26*(1), 25-31. https://doi.org/10.2478/v10247-012-0004-z

Jia, S., Shen, M., Zhang, F., & Xie, J. (2017). Recent advances in *Momordica charantia*: Functional components and biological activities. *International Journal of Molecular Sciences, 18*(12), 2555. https://doi.org/10.3390/ijms18122555

Joseph, B., & Jini, D. (2013). Antidiabetic effects of *Momordica charantia* (bitter melon) and its medicinal potency. *Asian Pacific Journal of Tropical Disease, 3*(2), 93-102. https://doi.org/10.1016/S2222-1808(13)60052-3

Kataria, S., Baghel, L., & Guruprasad, K. N. (2017). Pre-treatment of seeds with static magnetic field improves germination and early growth characteristics under salt stress in maize and soybean. *Biocatalysis and Agricultural Biotechnology, 10*, 83-90. https://doi.org/10.1016/j.bcab.2017.02.010

Khanna, P., Jain, S. C., Panagariya, A., & Dixit, V. P. (1981). Hypoglycemic activity of polypeptide-p from a plant source. *Journal of Natural Products, 44*(6), 648-655. https://doi.org/10.1021/np50018a002

Koukounaras, A., Boursianis, A., Kostas, S., Theopoulos, A., Bantis, F., & Samaras, T. (2023). Pre-sowing static magnetic field treatment of vegetable seeds and its effect on germination and young seedlings development. *Seeds, 2*(4), 394-405. https://doi.org/10.3390/seeds2040030

Mahajan, T. S., & Pandey, O. P. (2015). Effect of electric and magnetic treatments on germination of bitter gourd (*Momordica charantia*) seed. *International Journal of Agriculture and Biology, 17*(2), 351-356. https://scholars.mssm.edu/en/publications/effect-of-electric-and-magnetic-treatments-on-germination-of-bitt-2/

Mahwish, Saeed, F., Sultan, M. T., Riaz, A., Ahmed, S., Bigiu, N., Amarowicz, R., & Manea, R. (2021). Bitter melon (*Momordica charantia* L.) fruit bioactives charantin and vicine potential for diabetes prophylaxis and treatment. *Plants, 10*(4), 730. https://doi.org/10.3390/plants10040730

Mohammed, H. S., Shahin, A., & Amer, A. (2024). Frequency-dependent pre-sowing magneto-priming of anise seeds affecting their productivity. *Agricultural Research, 13*, 692-703. https://doi.org/10.1007/s40003-024-00733-7

Muthal, K., Dhar, V., Guruprasad, K. N., & Singh, P. (2025). Varietal performance of French bean and impact of magneto priming on their seed germination traits. *Journal of Advances in Biology & Biotechnology, 28*(10), 1493-1498. https://doi.org/10.9734/jabb/2025/v28i103164

Upadhyay, A., Agrahari, P., & Singh, D. K. (2015). A review on salient pharmacological features of *Momordica charantia*. *International Journal of Pharmacology, 11*(5), 405-413. https://doi.org/10.3923/ijp.2015.405.413

Ureta-Leones, D., Garcia-Quintana, Y., Vega-Rosete, S., Perez-Morell, L., Bravo-Medina, C. A., & Arteaga-Crespo, Y. (2021). Effect of pre-germination treatment with direct magnetic field exposure: A systematic review and meta-analysis. *European Journal of Forest Research, 140*, 1029-1038. https://doi.org/10.1007/s10342-021-01400-0

Vadera, H. R., Pandya, J. B., & Mehta, S. K. (2021). Developmental changes in seedlings of *Luffa cylindrica* M. Roem. and *Momordica charantia* L. due to the seed germination treatments. *Asian Journal of Plant and Soil Sciences, 6*(1), 68-81. https://doi.org/10.56557/ajopss/2021/v6i144

Vashisth, A., & Nagarajan, S. (2008). Exposure of seeds to static magnetic field enhances germination and early growth characteristics in chickpea (*Cicer arietinum* L.). *Bioelectromagnetics, 29*(7), 571-578. https://doi.org/10.1002/bem.20426

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