RESEARCH ARTICLE

Effect of Seed Magnetic Treatment on Next Generation of Green Gram (*Vigna radiata* L.)

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Abstract

Following the promising outcome obtained from the application of magnetic field treatment with varying intensities and durations during the initial green gram crop cultivation, treatment T_7 (225 mT for 75 min) emerged as the optimal choice among all treatments. A subsequent study was conducted at the farm of Navi vasni, Aravali, Gujarat to explore the continuous effect of magnetic field therapy on germination, growth, progress, and yield of green gram during the *kharif* season of 2023. Green gram (*Vigna radiata*) seeds from treatments T_1 (control) and T_7 (225 mT for 75 min) from the first crop cultivation were utilized without further treatment. Additionally, three other combinations were subjected to different magnetic field strengths (100, 350, and 225 mT) for durations of 75, 75, and 100 minutes, respectively, using an electromagnet unit. Each treatment, including non-treated seeds, was replicated three times and planted in the field following a Randomized Block Design (RBD), then further treated with regular water and vermicompost fertilizer. Observation of various physiological parameters (germination percentage, leaf area, shoot and root length, plant height) was recorded at 14-day intervals and chemical, biochemical and yield contributing parameters (N, P, K, Fe, Mn, Zn, Cu, chlorophyll a and b, carotenoid, acidity, vitamin C and seed yield plant^{-1}) were analyzed at the end of the cropping season. Through statistical analysis, the combination of non-treated seeds from the first crop with a magnetic field intensity of 225 mT and a duration of 75 minutes (T_{12}) demonstrated the best overall performance in this study.

Highlights

- Along with non-treated seeds, magnetic field treatment with various intensities and time exposure was given to seeds of mung bean.
- Various analysis techniques were used to determine the result and analyzed using ANOVA, as detailed in the paper.
- MF treatment in the initial cropping cycle enhances the growth, development and yield of mung bean and also continuous effect was found for the next cropping cycle.
- MF treatment also enhanced uptake intensities of seed when a particular magnetic field was applied, refer to optimal conditions of initial cropping.

Keywords: Germination, physiological parameters, chemical parameters, biochemical parameters, yield.

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Introduction

Green gram (*Vigna radiata*) stands as a crucial legume and a prevalent crop across numerous states in India. It spans cultivation across approximately 3600000 hectares, yielding a total grain production of roughly 1700000 tonnes, with an average productiveness of roughly 500 kg ha^{-1} Key states contributing significantly to green gram cultivation include Maharashtra, Orissa, Madhya Pradesh, Andhra Pradesh, Gujarat, Rajasthan, and Bihar (ICAR).

Research efforts spanning numerous years have focused on enhancing seed germination and extending their viability for planting purposes (Kelly, 1998). Various pre-sowing treatments, encompassing physiological elements like electric fields, magnetic fields, laser radiation, and microwave radiation, have contributed to the advancement in seed germination (Pietruszewski and Kania, 2010). Magnetic fields' impact on plant growth has been extensively explored over time. Notably, Savostin (1930) conducted studies indicating a doubling within the rate of seedling prolongation under magnetic setup.

Diverse approaches, encompassing both chemical and non-chemical means, have been employed to augment crop growth traits and quality. Among them, magnetic field treatment has emerged as a notable technique (Jinapang *et al.*, 2010). The initial observations of beneficial effects stemming from the application of magnetic fields to crops trace back to the 19th century, notably highlighted by Tolomei (1893). Tolomei's identification of magneto-tropism served as a cornerstone for subsequent investigations in this domain, with Audus (1960) later conducting more extensive analyses. Since then, a multitude of research initiatives have delved into the effects of magnetic field therapy on plant growth with developmental processes.

This work was planned to explore the next-generation crop effects of magnetic field on seed formation, growth, development also yield of green gram cultivated in soil condition of Navi Vasni, Aravali, Gujarat.

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Materials and Methods

In the subsequent crop cycle, seeds from the initial cultivation batches of T_1 (control) and T_7 (subjected to 225 mT for 75 minutes) were directly utilized for sowing without any additional treatment, aiming to observe the sustained impact of magnetic treatment across successive crop cycles. Notably, T_7 represented the optimum condition in the initial crop cycle. Subsequently, three additional treatments underwent magnetization using an electromagnetic unit, adhering to predetermined magnetic field strengths and exposure durations.

For magnetizing the seeds, we utilized a double-coiled electromagnet unit with a magnetic field spanning from 0 to 0.700 Tesla. The spacing between the magnetic poles was adjustable through rotating knobs positioned at the ends of the electromagnets (Fig. 1). We regulated the magnetic field intensity by manipulating the coil rotation and employing a variable power supply, as indicated by the Gauss meter readings of the magnetic unit. Samples were positioned within the gap between the two poles of the magnetic coil for treatment.

We obtained verified green gram seeds (variety: Gujarat-4) from Gujarat State Seeds Corporation Ltd. These seeds were subsequently categorized into five groups (two untreated and three treated), designated as T_{11} to T_{15}, with each group containing five seeds and replicated three times. The selection of magnetic treatment combinations was based on the optimal conditions identified during the initial crop cultivation. Comprehensive details of all treatments can be found in Table 1.

On July 11th, 2023, seeds corresponding to each treatment with three replications, were sown in the open field across 15 separate blocks, each covering an area of approximately 3x3 square feet. This adhered to the randomized block design (RBD) principles. We strictly adhered to standard agricultural practices in accordance with the conventional methods endorsed by the Ministry of Agriculture for green gram cultivation. Table 2 gives data on the experimental soil's chemical examination obtained from lab tests.

Throughout the growth phase of the green gram plants, various physiological parameters such as germination percentage, were observed at 21 DAS, while leaf area, root length, shoot length, and plant height were observed at 14-day intervals. At the end of the cropping cycle, we measured the weight of seeds (both dry and fresh) and recorded grain yield. Leaf and bean samples were collected for subsequent chemical analyses, including chlorophyll a and b, carotenoids, essential mineral concentrations (Fe, Mn, Cu, Zn), nitrogen (N), phosphorus (P), potassium (K), as well as vitamins and titratable acidity. These analyses were performed through laboratory tests conducted at Navsari Agricultural University (NAU). All analyses were done as per the method described in Table. 3.

The data regarding percent germination rate, physiological, chemical and biochemical parameters and yield were exposed to the investigation of fluctuation (ANOVA) with the critical difference (CD) intended at a 0.05 probability level by the statistical method suggested by Panse and Sukatme (1954).

Table 1: Experimental treatments

Treatments	*Details*
T_{11}	Seeds of T_1 from initial crop cultivation (without any treatment)
T_{12}	Seeds of T_7 from initial crop cultivation (without any treatment)
T_{13}	Magnetize seeds at 100 mT for 75 minutes
T_{14}	Magnetize seeds at 350 mT for 75 minutes
T_{15}	Magnetize seeds at 225 mT for 100 minutes

Each treatment contains 3 replications

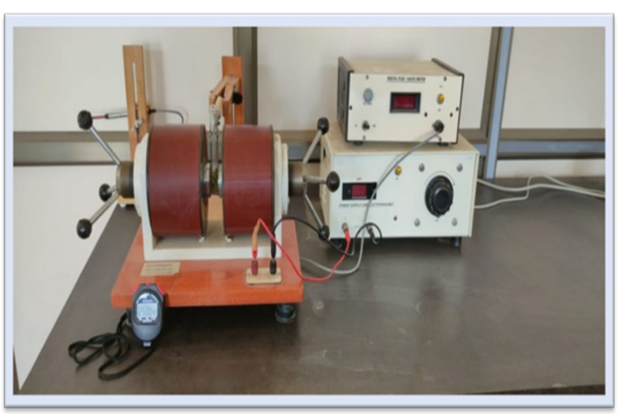

Fig. 1: Electromagnetic unit setup for seed magnetization

Results

Seed germination

The seeds subjected to magnetic treatment, particularly in treatment T_{12} (non-treated seeds of 225 mT for 75 min), displayed enhanced germination rates compared to both untreated seeds (T_{11}) and other magnetic treatments, as shown in Fig. 2. At 21st DAS, treatment T_{12} (non-treated seeds of 225 mT for 75 min) achieved the highest germination rate of 93.33%, while it stood at 73.33% for treatment T_{11} (Control). Treatments T_{12} and T_{11} were significantly comparable to each other. However, there were no critical contrasts observed in the germination rates between

Table 2: Chemical analysis of the experimental soil

Components	*Available values*
pH	7.0
Organic carbon (%)	0.39
Nitrogen (kg ha^{-1})	166
Phosphorus (kg ha^{-1})	53
Potassium (kg ha^{-1})	293
Micronutrients	
Cu (mg kg^{-1})	0.64
Fe (mg kg^{-1})	8.22
Mn (mg kg^{-1})	8.1
Zn (mg kg^{-1})	1.18
soluble ions	
SO_4^- (mg kg^{-1})	11.90

Table 3: Standard methods used for physiological, chemical, biochemical and yield parameters

Parameters	*Methods*	*References*
Leaf area, shoot length, root length, plant height	Scale measurement by standard process	-
Nitrogen content	Kjeldahl method	Jackson, 1973
Phosphorus content	Vanadomolybdophosphoric yellow color method	Jackson, 1973
Potassium content	di-acid digests method using flame photometer	Jackson, 1973
Fe, Mn, Zn, Cu	digestion method followed by Atomic Absorption Spectrophotometry	Lindsey and Norvell, 1978
Chlorophyll a and b	Extraction with 80% acetone using a spectrophotometer	Sadasivam and Manickam, 1992
Carotenoids	Extraction using a colorimeter	Jensen, 1978
Acidity and Vitamin C	Water bath and extraction	Nakano and Asada. 1987
Weight of beans	Using scientific weighing unit	-

Table 4: Effect of magnetic field on vegetative growth of green gram at 70 DAS

Treatments	*Average leaf area (cm^2)*	*average shoot length (cm)*	*average root length (cm)*	*average plant height (cm)*
T_{11}	160.96	62.57^{b}	19.37	81.93
T_{12}	176.01^{b}	66.80^{b}	22.83^{b}	89.63^{c}
T_{13}	102.25^{a}	48.27^{a}	15.13^{a}	$63.40^{a, b}$
T_{14}	97.55^{a}	48.70^{a}	14.93^{a}	63.63^{b}
T_{15}	91.10^{a}	43.90^{a}	12.93	56.83^{a}
SED (±)	4.673	1.654	0.577	2.062
CD (5%)	10.182	3.605	1.256	4.493

Values are means of 3 replications; Same alphabet shows treatments are at par among themselves.

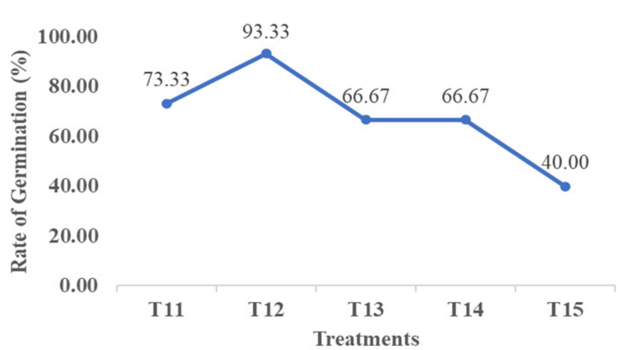

Fig. 2: Effect of magnetic field on the percent germination rate of green gram seeds at 21 DAS

magnetic treatments T_{13} (100 mT for 75 min), T_{14} (350 mT for 75 min), with T_{15} (225 mT for 100 min). Notably, in treatment T_{12}, the germination percentage increased by 24% over treatment T_{11} (control), by 33.32% over treatments T_{13} and T_{14}, and by 80% over treatment T_{15}, respectively.

Vegetative growth

Table 4 presents the impact of magnetic treatments on the vegetative development characteristics of green gram after 70 DAS. Treatment T_{12} (non-treated seeds of 225 mT for 75 min) notably outperformed other magnetic treatments but was found at par with treatment T_{11} (control) in one of the physiological parameters. Treatment T_{12} significantly affects vegetative growth parameters at a 5% level of significance.

Leaf area

Leaf area varied between 91.10 cm^2 (T_{15}) and 176.01 cm^2 (T_{12}). A significantly higher value of leaf area was obtained in treatment T_{12} (non-treated seeds of 225 mT for 75 min). When compared to other treatments. In contrast, other treatments fail to show significant differences among themselves.

Shoot length

Average shoot length ranged from 43.90 cm (T_{15}) to 66.80 cm (T_{12}), with treatments T_{12} (non-treated seeds of 225 mT for 75 min) and T_{11} (control) obtained significantly better values than T_{13}, T_{14}, and T_{15} magnetic treatment. Here, other treatments fail to reach significance among themselves.

Root length

Average root length varied between 12.93 cm (T_{15}) and 22.83 cm (T_{12}). Significantly enhanced value was observed in treatment T_{12} (non-treated seeds of 225 mT for 75 min) when compared to control and other treatments. While, treatments T_{13}, T_{14}, and T_{15} not reaching significance among themselves.

Plant height

Average plant height ranged from 56.83 cm (T_{15}) to 89.63 cm (T_{12}). A high significance value was obtained in treatment T_{12} (non-treated seeds of 225 mT for 75 min), with treatments T_{11} (control), T_{13}, T_{14} and T_{15} failing to reach significance among themselves.

Notably, green gram plants under treatment T_{12} (non-treated seeds of 225 mT for 75 min) showed increases of 8.93%, 6.53%, 16.39%, and 8.97% in leaf area, shoot length, root length, and plant height, respectively, compared to Treatment T_{11} (control). However, treatment T_{11} (control) remains at par with treatment T_{12} in shoot length growth parameters.

Yield

Table 5 presents an overview of the yield growth traits of green gram. Notably, treatment T_{12} (non-treated seeds of 225 mT for 75 min) exhibited a significantly higher yield at a 5% significance level compared to other magnetic treatments.

Fresh weight of beans

Fresh weight noted between 22.05 g (T_{15}) and 79.93 g (T_{12}). Significantly better value was observed in treatment T_{12} (non-treated seeds of 225 mT for 75 min) than other magnetic treatments. Treatments T_{11}, T_{13}, T_{14} and T_{15} failed to show significant differences among themselves.

Dry weight of beans

Similarly, dry weight ranged from 18.37 g (T_{15}) to 68.07 g (T_{12}). In treatment T_{12} (non-treated seeds of 225 mT for 75 min) significantly higher value was observed when compared to T_{11} (control) and other magnetic treatments. While other treatment shows no significant difference between them.

The fresh weight of beans saw an increase of 12.16% in treatment T_{12} (non-treated seeds of 225 mT for 75 min) in comparison with T_{11} (control). Moreover, yield regarding T_{12} showed significant increases of 95.50%, 81.31%, and 113.51% compared to magnetic treatments T_{13}, T_{14}, and T_{15}, respectively. In both fresh and dry weight yield treatment T_{12} was found at par above all other treatments.

Chemical and biochemical parameters

Leaf content analysis at the end of the cropping cycle revealed significant differences at a 5% level of significance, particularly evident in treatment T_{12} (non-treated seeds of 225 mT for 75 min) compared to all other treatments.

Chemical parameters

Nitrogen (N) content varied between 2.27 % in treatment T_{14} (350 mT for 75 min) and 3.32% in treatment T_{12} (non-treated seeds of 225 mT for 75 min). Treatments T_{12} (non-treated seeds of 225 mT for 75 min) and T_{15} (225 mT for 100 min) showed significantly higher values than other treatments. Where treatments T_{11}, T_{13} and T_{14} fail to show significant differences among themselves. Phosphorus (P) content ranged from 0.27% in treatment T_{15} (225 mT for 100 min) to 0.34% in treatment T_{13} (100 mT for 75 min). Significantly more value was observed in treatments T_{12} (non-treated seeds of 225 mT for 75 min) and T_{13} (100 mT for 75 min). While treatments T_{11}, T_{14} and T_{15} failed to reach a level of significance. Potassium (K) content varied between 0.44% in treatment T_{14} (350 mT for 75 min) and 0.58% in treatment T_{15} (225 mT for 100 min). Treatments T_{12} (non-treated seeds of 225 mT for 75 min) and T_{15} (225 mT for 100 min) obtained significantly high value of potassium. Here, treatments T_{11}, T_{13} and T_{14} not reaching a level of significance.

Table 5: Effect of magnetic field on the yield of green gram

Treatments	*Average fresh weight (g)*	*Average dry weight (g)*
T_{11}	70.77	60.10
T_{12}	79.93^{c}	68.07^{c}
T_{13}	28.26^{a,b}	23.69^{a,b}
T_{14}	33.72^{b}	28.30^{b}
T_{15}	22.05^{a}	18.37^{a}
SED (±)	2.120	1.771
CD (5%)	4.621	3.859

Values are means of 3 replications; Same alphabet shows treatments are at par among themselves.

Biochemical parameters

Iron (Fe) content ranged from 193 ppm in treatment T_{13} (100 mT for 75 min) to 475 ppm in treatment T_{14} (350 mT for 75 min). Significantly, maximum iron content was obtained in treatment T_{14} (350 mT for 75 min). Other treatments do not show significant differences among themselves. Manganese (Mn) content varied between 112 ppm in treatment T_{11} (control) and 178 ppm in treatment T_{12} (non-treated seeds of 225 mT for 75 min). Treatment T_{12} (non-treated seeds of 225 mT for 75 min) was found most significant. While treatments T_{11}, T_{13}, T_{14} and T_{15} failed to reach significance among themselves. Zinc (Zn) content ranged from 14.0 ppm in treatment T_{13} (100 mT for 75 min) to 44.2 ppm in treatment T_{14} (350 mT for 75 min). Significantly more value was exhibited in treatments T_{12} (non-treated seeds of 225 mT for 75 min) plus T_{14} (350 mT for 75 min). Other treatments were found to be non-significant among themselves. Copper (Cu) content varied between 7.2 ppm in treatment T_{13} (100 mT for 75 min) and 15.4 ppm in treatment T_{12} (non-treated seeds of 225 mT for 75 min). Significantly enhanced value was observed in treatment T_{12} (non-treated seeds of 225 mT for 75 min) with other treatments failing to reach significance among themselves.

Chlorophyll A content ranged from 0.311 mg g^{-1} in treatment T_{14} (350 mT for 75 min) to 0.902 mg g^{-1} in treatment T_{12} (non-treated seeds of 225 mT for 75 min). Treatments T_{11} (control) and T_{12} (non-treated seeds of 225 mT for 75 min) were found to be significantly higher than other treatments. Treatments T_{13}, T_{14} and T_{15} failed to reach a level of significance. Chlorophyll B content varied from 0.379 mg g^{-1} in treatment T_{15} (225 mT for

Table 6: Effect of magnetic field on chemical composition of green gram leaves

Treatments	*Total N (%)*	*Total P (%)*	*Total K (%)*	*Fe ppm*	*Mn ppm*	*Zn ppm*	*Cu ppm*	*Chlorophyll A (mg g^{-1})*	*Chlorophyll B (mg g^{-1})*	*Carotenoid (mg g^{-1})*
T_{11}	2.83^{b,c}	0.30^{a}	0.47^{a}	256	112^{a}	33.5^{b}	9.9^{a}	**0.816**^{a}	**0.577**^{b}	0.185
T_{12}	3.32^{c,d}	0.31^{a,b}	**0.57**^{b}	381	**178**^{b}	**41.9**^{b,c}	**15.4**^{b}	**0.902**^{a}	0.406^{a}	**0.998**^{b}
T_{13}	2.50^{a,b}	**0.34**^{b}	0.49^{a}	193	154	14.0^{a}	7.2^{a}	0.477	0.436^{a}	0.563^{a}
T_{14}	2.27^{a}	0.30^{a}	0.44^{a}	**475**^{a}	116^{a}	**44.2**^{c}	9.9^{a}	0.311	0.428^{a}	0.512^{a}
T_{15}	**3.07**^{c,d}	0.27	**0.58**^{b}	318	134	14.5^{a}	9.9^{a}	0.637	0.379^{a}	0.947^{b}
SED (±)	0.149	0.008	0.022	6.165	4.587	3.187	1.046	0.039	0.020	0.019
CD (5%)	0.324	0.017	0.048	13.433	9.995	6.945	2.279	0.085	0.043	0.041

Values are means of 3 replications; N: nitrogen, P: Phosphorus, K: Potassium. The Same alphabet shows treatments are at par among themselves.

Table 7: Effect of magnetic field on chemical composition of green gram beans

Treatments	*Titratable Acidity (%)*	*Vitamin C (mg 100 g^{-1})*
T_{11}	0.112^{a}	6.67^{b,c}
T_{12}	**0.128^{b}**	6.00$^{\mathbf{a}}$
T_{13}	0.112^{a}	6.33$^{\mathbf{a,b}}$
T_{14}	0.096	**7.00^{c,d}**
T_{15}	0.128^{b}	7.33^{d}
SED (±)	0.005	0.146
CD (5%)	0.010	0.319

Values are means of 3 replications; Same alphabet shows treatments are at par among themselves.

100 min) to 0.577 mg g^{-1} in treatment T_{11} (control). Treatment T_{11} (control) was obtained maximum significant value than all other treatments. Other treatments fail to reach a level of significance among themselves. Carotenoid content ranged between 0.185 mg g^{-1} with treatment T_{11} and 0.998 mg g^{-1} with treatment T_{12} (non-treated seeds of 225 mT for 75 min). Treatments T_{12} (non-treated seeds of 225 mT for 75 min) and T_{15} (225 mT for 100 min) obtained significantly more value than other treatments, with other treatments failing to show significant differences among themselves. Overall, treatment T_{12} significantly influenced the greatest number of leaf contents compared to T_{11} (control) and other magnetic treatments. However, the leaf content of Fe did not show significant differences in this treatment (Table -6).

In the analysis of beans, the majority of values exhibited similarity across treatments at a 5% significance level. The variation in Vitamin C content was observed, ranging from 6.00 mg 100g^{-1} in treatment T_{12} to 7.33 mg 100g^{-1} in treatment T_{15}. Significantly enhanced value was exhibited in treatments T_{14} (350 mT for 75 min) along with T_{15} (225 mT for 100 min). Notably, treatments T_{11}, T_{12} and T_{13} did not show significant differences among themselves. Interestingly, there were no substantial variations in acidity levels across all treatments (Table -7).

Discussion

Research conducted on different plant species has demonstrated that the implementation of magnetic treatment yields beneficial effects. Specifically, subjecting green gram seeds to magnetic treatment has been found to enhance their germination rate, as well as enhance the growth with the yield of the resulting plant.

In the study conducted by Celestino *et al.,* (2000), it was noted that seeds implemented to magnetic exposure exhibited accelerated germination when compared to control, accompanied by an increase in germination rate. Additionally, Alexander and Doijode (1995) found that treatment given before germination significantly enhanced both germination and vigor of rice seeds with low viability.

The percentage of germination rate exhibited a notable increase in response to the treatments T_{12} and T_{11}, as illustrated in Fig. 2. Prior research has indicated that magnetic treatment can give better seed germination faster growth, along with induced synthesis of proteins while stimulating root evolution (Aladjadjiyan, 2002; Atak *et al.*, 2003). Martinez *et al.,* (2017) highlighted that the outer magnetic field bolsters the seed vigor index by affecting biochemical norms through the activation of proteins with enzymes. These effects are likely assigned to the relation between a magnetic field and ionic currents within the cell membranes of plant buds, leading to modifications in osmotic stress as well as ionic immersion on both sides of tissue (Yaycili and Alikamanoglu, 2005). Reina and Pascual (2001) observed that ionic fluxes changed over cell membranes result in modifications in the water uptake mechanism, as osmoregulation in embryo cells depends on ion transport across the membrane. Furthermore, Radhakrishnan (2018, 2019) proposes that magnetic field treatment enhances seed standards by modulating the digestion of storage proteins with fatty acids, as well as regulating plant functions, growth, and increasing tolerance to environmental stresses.

The noticeable enhancement in vegetative growth, encompassing factors such as leaf area, shoot length, root length, and plant height in the treatment T_{12}, can be attributed to an increment within a concentration of carotenoids, including chlorophyll a and b. (Table 6). This elevation in pigment levels contributed to a heightened availability of absorbs for vegetative development, thereby resulting in a significant improvement in treated plants. Previous research has suggested that "magnetic fields induce alterations in the transport properties of cellular plasmatic membranes, which play a crucial role in regulating the assimilation of nutrients necessary for cellular function". (Azharonok *et al.*, 2009).

The implementation of a magnetic field in earlier crop cycles resulted in good results in both fresh weights plus dry weights of beans in the second cropping cycle, as detailed in Table 5. However, improvement in the yield of treatment T_{12}, coupled with a rise in the concentration of vitamin C as demonstrated in Table 7, is likely attributed to the increase in average bean weight under such treatments. Positive outcomes have been observed in other studies involving green gram (Huang and Wang, 2008), tomato (De Souza *et al.*, 2005, 2006), as well as snow peas with chickpeas (Grewal and Maheshwari, 2011) due to magnetic field treatment.

The benefits associated with magnetic fields can arise from the activation of bioenergetic structures, which stimulate cellular pumping and enzyme activity. These effects could impact the direction of vital particle instruments such as ATP hydrolysis and the potential conformation of important proteins (De Souza *et al.*, 2005). Outer magnetic fields were implicated in boosting seed vigor by affecting biochemical activity and restoring the function of proteins along with enzymes. Several works have recommended that magnetic fields facilitate greater ion absorption, thereby enhancing nutritional value (Martinez *et al.*, 2017).

Azimi *et al.,* (2018) Conducted a study to observe the magnetic water effect on Lentil (*Lens culinaris* L.). The results indicated better growth in plants with magnetic water treatment. Ercan *et al.*, (2022) Showed "the magnetic field (MF) interacts with biological systems and has the potential to increase germination, plant growth and productivity". Sarraf *et al.,* (2020) observed that "exposure of seeds to a low-to-medium level magnetic field (MF), in pulsed and continuous modes, as they have shown positive results in a number of crop seeds".

Conclusion

Results indicate that applying seed magnetic field treatment during the initial crop cycle also has a positive impact on the second crop cycle. In this cropping cycle, treatment T_{12} (non-treated seeds of 225 mT for 75 min), which represents the optimal condition from the initial crop cycle, gave positive outcomes across most parameters compared to all other magnetic treatments. Treatments T_{12} remains at par in most of the parameters and positively influences germination percentage, as well as growth, development, and yield concerning green gram plants. An important finding of this study is that magnetic treatment applied during the initial cropping cycle can continue to benefit in such a good way as some of its first cropping results but also revealed that particular magnetic field strength can enhance seed quality. Additionally, utilizing magnetic fields as an elective to chemical, as well as biological methods, offers the advantage of being environment-friendly.

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Author Contribution

The corresponding author and co-authors play a role in the visualization and execution of this experiment. The manuscript was prepared by the corresponding author and verified by co-authors. Correction was made at each stage where needed and the final manuscript was prepared with the consent of all three authors mentioned above.

Conflict of Interest

The writers affirm that they don't have any potential conflicts of interest related to their pursuits.

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