J. Soils and Crops 35 (1) 127-134, June 2025

ISSN 0971-2836 (Print)
ISSN 2582-2756 (Online)

MAGNETIZED SEEDS AND THEIR INFLUENCE ON PHYSIOLOGICAL, CHEMICAL AND BIOCHEMICAL PARAMETERS AND YIELD OF GREEN GRAM (*Vigna radiata* L.)

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ABSTRACT

A study was conducted to investigate the impact of magnetic seed treatment on the growth, chemical and biochemical parameters and yield of green gram (*Vigna radiata* L.). A field experiment was conducted at farm of Navi Vasni, Aravali, Gujarat during the *kharif* season of 2022. Seeds were subjected to varying magnetic field intensities (200, 225, and 250 mT) for durations of 25, 50, and 75 minutes using an electromagnet. Total ten treatments along with untreated controls were tested. Each treatment was replicated three times and planted in the field using a randomized block design (RBD). The plants were irrigated with regular water and fertilized with vermicompost. Observations on physiological parameters i.e. germination (at 21 DAS), leaf area, root and shoot length, plant height (at 70 DAS) were recorded and chemical, biochemical and yield contributing parameters i.e. N, P, K, Fe, Mn, Zn, Cu, chlorophyll a and b, acidity, vitamin C and seed yield plant^{-1} were analysed at the end of the growing season. Results showed that seeds exposed to the magnetic fields significantly enhanced physiological parameters as well as chemical and biochemical parameters and yield of green gram. Statistical analysis revealed that the treatment T_7 (225 mT magnetic field with a 75-minute exposure time) gave significantly higher results in most of the parameters under study.

(Key words: Magnetic field, germination, physiological, chemical and biochemical parameters, yield)

INTRODUCTION

Green gram (*Vigna radiata*) is one of the most important beans and popular crops grown in many states of India. It is grown in about 36 lakh hectares with the total production of about 17 lakh tonnes of grain with a productivity of about 500 kg ha^{-1}. The important green gram growing states in the country are Orissa, Maharashtra, Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan and Bihar (ICAR). Kalaiarasi *et al.* (2024) suggest that a multifaceted approach is needed for enhancing efficiency in India's agriculture sector to ensure food security, reducing poverty and promoting economic growth.

Various methods, both chemical and non-chemical, have been employed to enhance crop yield and quality, with magnetic field treatment being one such method (Jinapang *et al.*, 2010). Besides a chemical treatment Mandal and Bala (2023) found that seed treated with an electric stimulus and salt priming for a predetermined time influenced the role of physiological and biochemical activities that leads to enhanced growth of seedlings. The initial documentation of positive outcomes resulting from the application of magnetic fields to plantations dates back to the 19th century, as noted by Tolomei (1893). Tolomei's discovery of magneto-tropism laid the foundation for further exploration in this field, with Audus (1960) subsequently conducting more comprehensive studies. Since then, numerous research endeavours have delved into the effects of magnetic field treatment on plant growth and developmental processes.

Currently, green gram is cultivated on more than 7.3 million hectares worldwide and global annual production is approximately 5.3 million tonnes. India and Myanmar are the greatest green gram producer countries in the globe each supplying approximately 30%, followed by China (16%), and Indonesia (5%) (Nair, 2022). The report also revealed that green gram grain yields are quite low on a global scale, averaging 0.73 t ha^{-1}, and there is great potential to develop better -performing varieties.

This research aimed to explore the impact of magnetic fields on the germination, growth, and yield of green gram in the soil environment of Navi Vasni, Aravali, Gujarat. Specially, green gram is no major crop of this particular area. Additionally, it sought to identify alternative methods to chemical treatments, which often pose risks to soil and water, in order to enhance yield production effectively.

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MATERIALS AND METHODS

To magnetize the seeds, a double coiled electromagnet unit was employed, featuring a magnetic field range of 0-0.700 Tesla. The gap between magnetic poles could be customized using the rotating knobs located at the ends of the electromagnets (Figure 1). The intensity of the magnetic field was controlled by adjusting the coil rotation and utilizing a variable power supply.

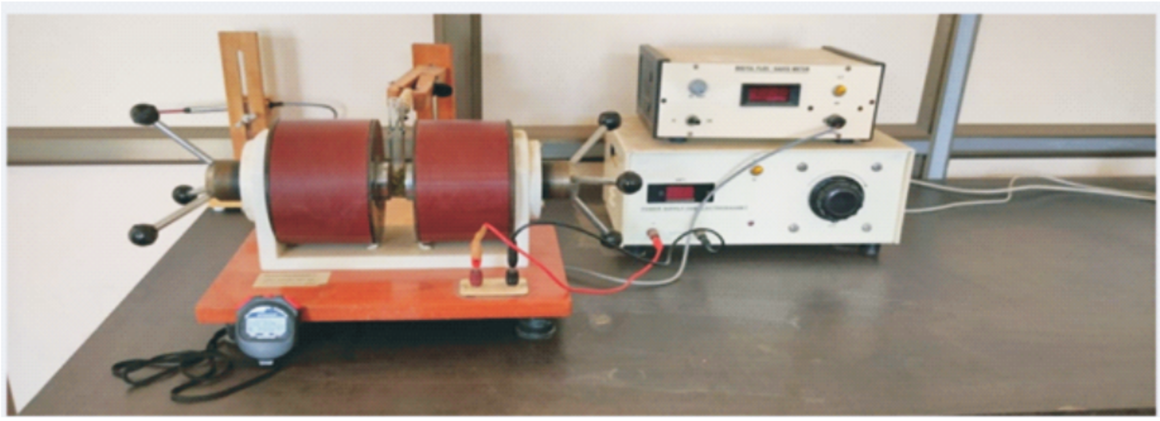

Figure 1. Electromagnetic unit setup for seed magnetization

Authenticated seeds of green gram (variety: Gujarat-4) were procured from Gujarat State Seeds Corporation Ltd. The seeds were then divided into 10 groups, labelled T_1 to T_{10}, each treatment containing 5 seeds with 3 replications. Magnetic treatment combinations were determined within the range of 86-226 mT based on the recommendations provided in the article by Maffei (2014). The details of all treatments are outlined in Table 1.

Table 1. Experimental treatments

Treatments	Detail
T_1	Control seeds
T_2	Magnetize seeds at 200 mT for 25 minutes
T_3	Magnetize seeds at 200 mT for 50 minutes
T_4	Magnetize seeds at 200 mT for 75 minutes
T_5	Magnetize seeds at 225 mT for 25 minutes
T_6	Magnetize seeds at 225 mT for 50 minutes
T_7	Magnetize seeds at 225 mT for 75 minutes
T_8	Magnetize seeds at 250 mT for 25 minutes
T_9	Magnetize seeds at 250 mT for 50 minutes
T_{10}	Magnetize seeds at 250 mT for 75 minutes

The seeds for each treatment, replicated three times, were planted in the open field on June 12th, 2022, within 30 distinct blocks, each spanning approximately a 3x3 square feet area, adhering to the principles of Randomized Block Design (RBD). Standard agricultural procedures were followed, aligning with the conventional methods prescribed by the Ministry of Agriculture for green gram cultivation.

Table 2. Provides information on the soil's chemical analysis determined according to lab test.

Table 2. Chemical analysis of the experimental soil

Components	Available values
pH	6.8
Organic carbon (%)	0.2709
Nitrogen (kg ha^{-1})	154
Phosphorus (kg ha^{-1})	51
Potassium (kg ha^{-1})	281
Micronutrients	
Cu (mg kg^{-1})	0.68
Fe (mg kg^{-1})	7.46
Mn (mg kg^{-1})	8.4
Zn (mg kg^{-1})	1.12
soluble ions	
SO_4^- (mg kg^{-1})	11.3

Physiological parameters such as germination percentage (21 DAS), leaf area, root length, shoot length and plant height (70 DAS) were recorded. Fruit yield weight (fresh and dry) was recorded at the end of cropping cycle. Leaf and bean samples for chemical and biochemical parameters including chlorophyll a and b, carotenoids, concentrations of essential minerals (Fe, Mn, Cu, Zn), nitrogen (N), phosphorus (P), potassium (K), as well as vitamins and titratable acidity were analysed in the laboratory of Navsari Agricultural University (NAU), Gujarat.

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

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 by standard process	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	-

Data on germination rate, physiological, chemical and biochemical parameters and yield were analysed using ANOVA with the Critical Difference (CD) at 0.05 probability level by statistical method suggested by Panse and Sukatme (1954).

RESULTS AND DISCUSSION

Seed germination: The germination rates of seeds subjected to magnetic treatments showed improvement compared to untreated seeds, as indicated in Figure 2. At 21 days, the highest germination rate of 100% was attained in treatments T_7 (magnetize seed of 225 mT for 75 min) and T_9 (magnetize seed of 250 mT for 50 min), whereas it was only 40% in untreated seeds. Here, most of the magnetic treatment found significant than control treatment except treatment T_{10} (magnetize seed of 250 mT for 75 min). The germination percentage increased by 85.71% in T_7 and T_9 over the control in magnetized seeds.

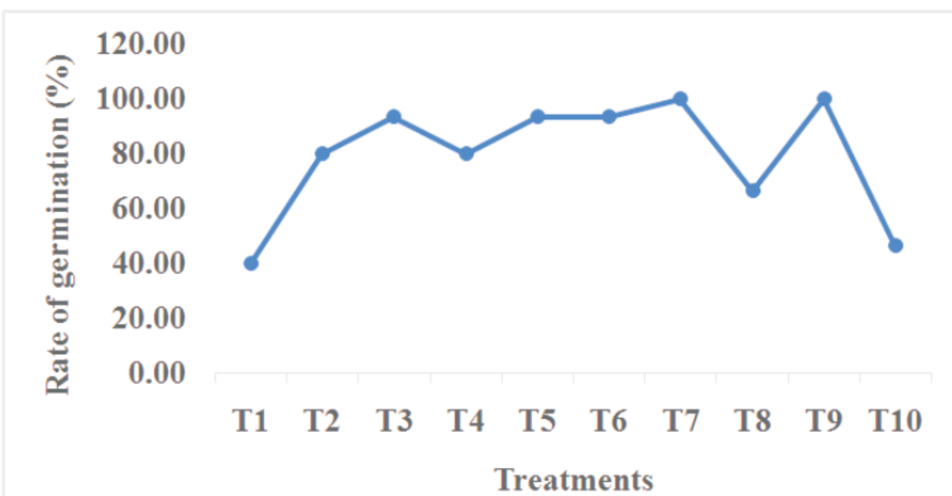

Figure 2. Effect of magnetic field on germination of green gram seeds recorded at 21 DAS

Vegetative growth: Table 4 illustrates the impact of magnetic field treatments on the vegetative growth traits of green gram plants. It was observed that the values of vegetative growth parameters were notably better in treated plants compared to control and the effect of treatments was found significant at 5% level of significance.

Leaf area

The data indicates that leaf area values ranged from 169.12 cm^2 in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 199.13 cm^2 in treatment T_7 (magnetize seed of 225 mT for 75 min). Significantly maximum leaf area was recorded in treatment T_7 (225 mT for 75 min) when compared with control and other treatments. Rest of the treatments showed non significant differences between each other.

Shoot length

In terms of shoot length, values were from 65.20 cm in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 86.47 cm in treatment T_7 (magnetize seed of 225 mT for 75 min). Here, significantly more shoot length was found in combination treatment T_7 (225 mT for 75 min) followed by treatment T_9 (250 mT for 50 min) when compared with treatment T_1 (control) and other treatments. Again, several treatments showed non significant differences between themselves.

Root length

Root length ranged from 10.53 cm in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 15.63 cm in treatment T_7 (magnetize seed of 225 mT for 75 min). In terms of root length treatment T_7 (225 mT for 75 min) was significantly performed better than control and other treatments. While other treatments displayed non significant differences among themselves.

Plant height

Plant height ranged between 75.73 cm in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 102.10 cm in treatment T_7 (magnetize seed of 225 mT for 75 min). Here, treatment T_7 (225 mT for 75 min) gave significantly more plant height when compared with control and other treatments. while the remaining treatments not varied significantly between each other.

In comparison, green gram plants subjected to magnetic field treatment T_7 (magnetize seed of 225 mT for 75 min). exhibited increase of 10.02 %, 15.58 %, 25.70 %, and 17.08 % in leaf area, shoot length, root length, and plant height, respectively, when compared with untreated plants (control).

Magnetic pre-germination treatment of seeds can considerably enhance germination rates and promote plant growth, leading to reduced planting costs (Mahajan and Pandey, 2014; Menegatti *et al.*, 2019). Numerous studies have documented the metabolic changes that occur during seed germination in response to magneto priming in non-stressed environments (Kataria *et al*., 2015; Anand *et al.*, 2019).

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

Treatments	Average leaf area at 70 DAS (cm^2)	Average shoot length at 70 DAS (cm)	Average root length at 70 DAS (cm)	Average plant height at 70 DAS (cm)
T_1	180.13^{a}	73.97^{a}	$12.07^{a,b}$	86.03^{a}
T_2	188.57^{d}	$77.90^{a,b,c}$	$12.83^{a,b,c}$	$90.73^{b,c}$
T_3	$186.43^{c,d}$	$79.30^{b,c,d}$	$12.90^{b,c}$	$92.20^{b,c,d}$
T_4	193.32^{e}	$81.47^{c,d}$	$13.50^{c,d}$	$94.97^{c,d}$
T_5	$186.29^{c,d}$	$76.83^{a,b}$	$12.43^{a,b}$	$89.27^{a,b}$
T_6	$185.10^{b,c}$	$75.77^{a,b}$	11.93^{a}	$87.70^{a,b}$
T_7	**199.13**	**86.47**^{e}	**15.63**	**102.10**
T_8	$182.66^{a,b}$	$77.57^{a,b,c}$	$12.53^{a,b}$	$90.10^{a,b}$
T_9	194.59^{e}	**82.47**^{d,e}	14.27^{d}	96.73^{d}
T_{10}	169.12	65.20	10.53	75.73
SED (±)	**1.188**	**1.422**	**0.333**	**1.589**
CD (5%)	**2.495**	**2.987**	**0.699**	**3.339**

Same alphabet shows treatments are at par among themselves

Yield

Seeds exposed to magnetic treatments showed a significantly higher fresh and dry weight of seeds compared to untreated seeds.

Fresh weight of beans

Fresh weight values ranged from 15.04 g in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 79.71 g in treatment T_7 (magnetize seed of 225 mT for 75 min) at the end of cropping cycle. Among the treatments, treatment T_3 (200 mT for 50 min), T_4 (200 mT for 75 min), T_7 (225 mT for 75 min) and T_9 (250 mT for 50 min) were found significant above control and all other treatments. While other treatments did not exhibit any significant differences.

The highest increase in fresh weight (55.58%) was observed in treatment T_7 (magnetize seed of 250 mT for 75 min) compared to the untreated control T_1. Additionally, yields for treatments T_3 (200 mT for 50 min), T_4 (200 mT for 75 min), and T_9 (250 mT for 50 min) were significantly higher by 42.43%, 50.67%, and 53.88%, respectively, than the untreated seeds.

Dry weight of beans

Dry weight ranged from 12.35 g in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 69.55 g in treatment T_7 (magnetize seed of 225 mT for 75 min) at the end of cropping cycle. Significantly more dry weight was found in treatments T_4 (200 mT for 75 min), T_7 (225 mT for 75 min) and T_9 (250 mT for 50 min) when compared with treatment T_1 (control) and other treatments. Whereas the rest of the treatments displayed no significant variations between them.

Studies have reported improvements in seed germination, seedling growth, yield, and fruit quality, even under saline stress conditions. These improvements include increased root and stem length and enhanced germination dynamics in various seeds (Hozayn *et al*., 2018; Florez *et al*., 2019).

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

Treatments	Average fresh weight of seeds (g)	Average dry weight of seeds (g)
T_1	45.04[a]	38.63[a]
T_2	59.94[b,c]	50.55[b,c]
T_3	**69.30[c,d]**	59.11[c,d]
T_4	**75.61[d]**	**64.65[d,e]**
T_5	62.45[b,c]	52.96[b,c]
T_6	58.37[b,c]	50.11[b,c]
T_7	**79.71[d]**	**69.55[e]**
T_8	53.88[a,b]	46.41[a,b]
T_9	**78.26[d]**	**66.42[d,e]**
T_{10}	15.04	12.35
SED (±)	**4.217**	**3.601**
CD (5%)	**8.861**	**7.566**

Same alphabet shows treatments are at par among themselves

Chemical and biochemical parameters

Seeds that underwent magnetic treatments showed significantly higher values at the 5% significance level compared to those that were not treated (control).

Chemical parameters

N, P, K content in leaves were significantly higher in most of the magnetic treatments. Nitrogen content ranged from 1.46% in treatment T_3 (magnetize seed of 200 mT for 50 min) to 2.67% in treatment T_7 (magnetize seed of 225 mT for 75 min). Treatments T_1 (control) and T_7 (225 mT for 75 min) exhibited significantly higher values than all other treatment. However, maximum value was observed in treatment T_7. There were no significant differences were found among the other treatments. Phosphorus content ranged between 0.18% in treatment T_3 (magnetize seed of 200 mT for 50 min) and 0.33% in treatment T_4 (magnetize seed of 200 mT for 75 min). Significantly maximum phosphorus content was observed in treatments T_4 (200 mT for 75 min), T_6 (225 mT for 50 min) and T_7 (225 mT for 75 min) when compared with control (T_1) and other treatments. While other treatments not showing significant differences between each other. Potassium content ranged from 0.35% in treatments T_2 (magnetize seed of 200 mT for 25 min), T_3 (magnetize seed of 200 mT for 50 min) to 1.11% in treatment T_{10} (magnetize seed of 250 mT for 75 min). Here treatments T_7 (225 mT for 75 min) and T_{10} (250 mT for 75 min) found significantly better than control (T_1) and other treatments. There were no significant differences among other treatments.

Biochemical parameters

Values of biochemical contents (Fe, Mn, Zn, Cu, Chlorophyll, carotenoids) were significantly higher in magnetically treated plants. Iron (Fe) content ranged from 1415 ppm in treatment T_1 (control) to 2085 ppm in treatment T_9 (magnetize seed of 250 mT for 50 min), with significantly highest value in treatment T_9 (250 mT for 50 min) over the treatment T_1 (control) and other treatments. Manganese (Mn) content varied between 196 ppm in treatment T_7 (magnetize seed of 225 mT for 75 min) and 426 ppm in treatment T_1 (control). Here control (T_1) was found significantly best than all other treatments. Zinc (Zn) content align from 26 ppm in treatment T_5 (magnetize seed of 225 mT for 25 min) to 69 ppm in treatment T_{10} (magnetize seed of 250 mT for 75 min). Zn content was found significantly more in treatment T_{10} (250 mT for 75 min) than control (T_1) and other treatments. Copper (Cu) content ranged between 20 ppm in treatment T_2 (magnetize seed of 200 mT for 25 min) to 64 ppm in treatment T_1 (control). Again, treatment T_1 (control) stood first when compared with other treatments. Beside these treatments remaining treatments were found to be non-significant between themselves.

Chlorophyll A content ranged from 0.376 mg g^{-1} in treatment T_1 (control) to 0.630 mg g^{-1} in treatment T_7 (magnetize seed of 225 mT for 75 min). Significantly highest chlorophyll content was found in treatment T_7 (225 mT for 75 min) over the control and remaining treatments. Chlorophyll B content varied from 0.063 mg g^{-1} in treatment T_{10} (magnetize seed of 250 mT for 75 min) to 0.227 mg g^{-1} in treatment T_3 (magnetize seed of 200 mT for 50 min). Treatment T_3 (200 mT for 50 min) was found to be significantly higher than control and other treatments in chlorophyll B content. Carotenoid content fluctuated between 0.223 mg g^{-1} in treatment T_1 (control) to 0.411 mg g^{-1} in treatment T_7 (magnetize seed of 225 mT for 75 min). Significantly more value of carotenoids was found in treatment T_7 (225 mT for 75 min) compared to treatment T_1 (control) and others treatments. While other treatments not showing significant differences between them. Results shows that magnetic treatment significantly influenced the leaf phosphorus, potassium, iron, zinc, chlorophyll A and B, and carotenoids as compared to the control. However, leaf nitrogen, manganese and copper were not significantly differed from the control. The significantly highest biochemical parameters were observed in treatment T_7 (225 mT for 75 min).

Bauer *et al.* (2017) investigated the effects of varying intensities (30 and 60 mT) and exposure durations (24 and 1 hour per day) of magnetic fields on cultures of *Chlorella kessleri*. They assessed the impacts on cell growth, biomass composition, pigment production, and antioxidant activity. Exposure to 60 mT for 1 hour day^{-1} resulted in an 83.2% increase in biomass concentration compared to the control culture. Additionally, this condition enhanced lipid synthesis by 13.7%, chlorophyll a by 38.9%, chlorophyll b by 59.1%, total carotenoids by 25.0% and antioxidant levels by up to 185.7%.

Radhakrishnan (2018, 2019) suggests that magnetic field treatment enhanced seed quality by regulating the metabolism of storage proteins and fatty acids, as well as controlling plant functions, growth, and increasing tolerance to environmental stresses. Mroczek-Zdyrska *et al*. (2016) observed that a 130 mT magnetic field enhanced seed germination, seedling growth, and mitotic activity in meristematic plant cells, along with increased glutathione peroxidase activity in the leaves of *Phaseolus vulgaris* (L.). Huo *et al.* (2020) reported that a 30 mT magnetic field could influence the biochemical composition of *Tribonema sp.* and promote oil accumulation.

In beans, the values of vitamin content were notably higher at the 5% significance level for most magnetic treatments compared to untreated seeds (Table 7). The Vitamin C content placed from 2.77 mg 100 g^{-1} in treatments T_3 (200 mT for 50 min), T_6 (225 mT for 50 min), T_{10} (250 mT for 75 min) to 5.00 mg 100 g^{-1} in treatments T_4 (200 mT for 75 min) and T_9 (250 mT for 50 min). For vitamin content treatment T_4 (200 mT for 75 min) and T_9 (250 mT for 50 min) were found significantly superior than control and other treatments. Vitamin C concentration was significantly higher in beans of magnetic treatments. Treatments T_3 (200 mT for 50 min), T_4 (200 mT for 75 min) T_7 (225 mT for 75 min), T_9 (250 mT for 50 min) and T_{10} (250 mT for 75 min) were found significant in terms of acidity. These treatments obtained normal value of acidity level so no major differences were found in terms of acidity.

External magnetic fields play a role in enhancing seed vigor by influencing biochemical processes and promoting the activity of proteins and enzymes. Various studies have proposed that magnetic fields contribute to increase ion uptake, consequently enhancing the nutritional value (Martinez *et al*., 2017).

Table 6. Effect of magnetic field on chemical and biochemical composition of green gram plant 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_1	**2.59^{e}**	0.26^{c}	0.49	1415	**426**	51^{e}	**64**	0.376^{a}	0.124^{c}	0.223
T_2	2.12^{d}	$0.25^{b,c}$	0.35^{a}	1906^{a}	326	$30^{a,b}$	20	0.392^{a}	0.197	0.241
T_3	1.46	0.18^{a}	0.35^{a}	1923	314^{a}	41^{c}	$29^{a,b}$	0.416	**0.227**	0.317^{a}
T_4	2.27^{d}	**0.33^{e}**	0.59^{b}	1735	343	35^{b}	$35^{b,c,d}$	0.483	0.179^{e}	0.339
T_5	2.22^{d}	$0.28^{c,d}$	0.80^{c}	1848	209	26^{a}	$30^{a,b,c}$	0.515^{b}	0.077^{b}	0.378^{b}
T_6	$2.11^{c,d}$	**$0.32^{d,e}$**	$0.83^{c,d}$	1871	297	33^{b}	$36^{c,d}$	$0.523^{b,c}$	$0.175^{d,e}$	0.385^{b}
T_7	**2.67^{e}**	**$0.31^{d,e}$**	**1.09^{e}**	1701	196	$43^{c,d}$	40^{d}	**0.630**	0.113^{c}	**0.411**
T_8	1.73^{a}	0.26^{c}	0.61^{b}	1900^{a}	312^{a}	53^{e}	$31^{a,b,c}$	0.554^{d}	$0.071^{a,b}$	0.265
T_9	$1.88^{a,b}$	0.20^{a}	0.88^{d}	**2085**	353	$48^{d,e}$	27^{a}	$0.540^{c,d}$	0.166^{d}	0.294
T_{10}	$1.94^{b,c}$	$0.21^{a,b}$	**1.11^{e}**	1949	333	**69**	39^{d}	0.512^{b}	0.063^{a}	0.312^{a}
SE(d) (±)	**0.056**	**0.014**	**0.015**	**2.44**	**2.03**	**2.09**	**1.99**	**0.007**	**0.004**	**0.006**
CD (5%)	**0.118**	**0.030**	**0.031**	**5.12**	**4.27**	**4.39**	**4.19**	**0.014**	**0.009**	**0.012**

Same alphabet shows treatments are at par among themselves

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

Treatments	Titratable acidity (%)	Vitamin C (mg 100 g^{-1})
T_1	0.064[a]	3.88[b]
T_2	0.076[a,b]	3.33
T_3	**0.128[c]**	2.77[a]
T_4	**0.128[c]**	**5.00[c]**
T_5	0.089[b]	4.44
T_6	0.089[b]	2.77[a]
T_7	**0.128[c]**	3.88[b]
T_8	0.089[b]	3.88[b]
T_9	**0.128[c]**	**5.00[c]**
T_{10}	**0.115[c]**	2.77[a]
SED(d) (±)	**0.005**	**0.058**
CD (5%)	**0.011**	**0.122**

Same alphabet shows treatments are at par among themselves

Treating green gram seeds by magnetic field enhanced all physiological, chemical and biochemical parameters and yield.

The observed improvement in physiological parameters, encompassing factors like leaf area, shoot length, root length, and plant height among the magnetically treated plants, can be attributed to an elevation in the concentration of photosynthetic pigments, including chlorophyll a and b and carotenoids (Table 6).

The application of a magnetic field resulted in a significant increase in both the fresh and dry weight of beans, as indicated in Table 5. This enhancement in yield, along with an elevation in the concentration of vitamin C (Table 7), is likely attributed to the increase in the average bean weight under magnetic treatments.

The findings indicate that the application of magnetic field seed treatment at various intensities and durations positively influenced the percentage of germination, as well as physiological, chemical and biochemical parameters and yield of green gram plants. In this experiment treatment T_7 (225 mT for 75 min) was found optimum with overall enhancement in most of the parameters. A notable advantage of employing magnetic fields as an alternative to chemical and biological methods lies in their environmentally friendly characteristics.

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Rec. on 01.09.2024 & Acc. on 16.09.2024