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Investigating the Influence of Magnets in the Growth of String Bean (*Phaseolus vulgaris*) Plant

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ABSTRACT

Magnetic treatment has potential as an agricultural tool, particularly for seed germination and seedling development. This study advances the knowledge of the effects of magnetic treatment on string beans (*Phaseolus vulgaris*) plants. The plants subjected to magnetic treatment are more significant in size, height, and overall health. The t-test result shows a considerable difference between the control and experimental groups, which signifies the effectiveness of the magnetic treatment in the growth of the string bean (*Phaseolus vulgaris*) plant. Farmers are encouraged to explore employing magnets as a low-cost alternative to fertilizer, enabling increased plant development and healthy growth even without traditional fertilizers. Economists may adopt magnetic treatment for its environmentally favorable properties and the transfer or continuing treatment of healthy, magnetically exposed seedlings. Future researchers are encouraged to perform more studies to acquire more evidence on the efficacy of magnetic treatment.

INTRODUCTION

The magnetic field is one of the natural components of the earth. Plants and other forms of life interact with magnetic fields daily. Generally, the earth acts as a magnet with its south and north poles, and the natural effects of the magnetic field have been changing plant growth and yield around the globe (Maffei, 2014). Specifically, the electromagnetic spectrum of sunlight stimulates the growth of plants by the process of photosynthesis. The possible mechanism would be a change in the electrostatic balance of the plant system at the cell membrane level, as it is the primary site for action of any inhibition or enhancement of plant growth. Magnetic treatments enhance seed vigor by influencing the biochemical processes, which stimulate the activity of proteins and enzymes. Then, some studies reported that the magnetic field positively affected the number of flowers and yield, nutrient and water uptake, and increased seed germination and plant growth, which are benefits of the magnetic field's higher strength.

According to studies, magnetic fields can significantly affect seed germination, plant growth, development, and yield depending on the species and exposure characteristics, such as strength and duration, which can affect the growth pattern of the plants (Da Silva & Dobránszki, 2016).

The influence of the magnetic treatment on a string bean plant is the main objective of this experimental research. The study explicitly aimed to respond to these questions:

i. What is the germination rate and mortality rate of the string bean (*Phaseolus vulgaris*) plant?

ii. What is the growth rate of the string bean plant (*Phaseolus vulgaris*) in terms of the size of its leaves and length of growth?

iii. Is there any significant influence between the control and experimental group?

LITERATURE REVIEW

Effects of Magnetic Treatment on Plants

Sunflower seedlings were subjected to static magnetic fields with strengths ranging from 0 to 250 mT in stages of 50 mT for 1 to 4 hours. Under laboratory germination tests, treatment of sunflower seeds in these magnetic fields accelerated germination and enhanced seedling length and dry weight. The best results came from applying 50 and 200 mT for two hours. Seed coat membrane integrity was improved, cellular leakage was decreased, and electrical conductivity was decreased when seeds were exposed to magnetic fields. In the soil, treated seeds produced 1-month-old seedlings with statistically increased seedling dry weight, root length, root surface area, and root volume. Alpha-amylase, dehydrogenase, and protease enzyme activity in the germination of seeds was considerably greater in treated seeds than controls. The quicker germination and early vigor of seedlings may be caused by the more significant enzyme activity in sunflower seeds treated with magnetic fields (Vashisth & Nagarajan, 2010).

Magnetic fields (MF) have recently been developed with positive effects on plant germination and growth. The goal is to ascertain the effects of magnetic treatment on the germination of the *Salvia officinalis L.* species and *Calendula officinalis L.* Different seed groups were subjected to MF of 125 mT for varying lengths of time. The findings of chronic exposure at 125 mT were the greatest, with MGT significantly reduced compared to controls. The metrics measured for both seeds with treatment and pre-treatment were lower than the value matching the control (Treatment 1-50) and markedly decreased (Carbonell, Florez, Martinez, & Montoya,

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2012). Researchers have found evidence that magnetic treatment can preserve crop production and water quality as well as quantity. This study thoroughly reviews studies conducted over the last 20 years on the impact of fields on plants. Investigations are conducted into how magnetic fields (MF) affect several elements of plant development, seed germination, yield, quality, and water. The studies' inconsistent findings and contradicting conclusions suggest that MF's effect on plants may depend on the species and MF traits like intensity and exposure period (Nyakane, Marku, & Sedibe 2019).

In Rio & Rio's (2013) study, both exposed and unexposed eggplants were discovered to have identical growth characteristics. Additionally, it was shown that plants of okra, tomatoes, and eggplant exposed to EMF had fewer insects and pests than plants that were not. Further research on the beneficial impact of EMF on the growth features of okra while considering other factors is advised.

Research Paradigm

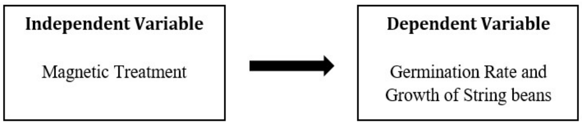

Figure 1: The relationship between independent and dependent variables

Hypothesis of the Study

H_0: There is no significant difference between the control (no magnets) and experimental (with magnets) groups of the String Bean (*Phaseolus vulgaris*) Plants.

MATERIALS AND METHODS

Research Design

This paper is a quantitative study that utilized an experimental research design to investigate the influence of magnets in the growth of string beans (*Phaseolus vulgaris*) plants.

Sample Description

String beans are one of the most widely grown vegetables in the Philippines. It is a true legume and botanically more closely related to cowpea. A total of 60 samples of string beans (*Phaseolus vulgaris*) plants were utilized: 30 samples with no magnetic treatment (control group) and 30 samples with magnetic treatment (experimental group).

Preparation and Data Gathering Procedure

The researchers gather essential materials, such as soil, seeds, seedling bags, and magnets, to plant the string bean seed. As the materials needed are prepared, the researchers start cultivating the soil and transferring it into each seedling bag. The researchers count the total number of seeds present and divide them equally into two groups, "with magnetic treatment" and "without magnetic treatment." The researcher starts to plant the seeds in the corresponding seedling bags. There are 30 planted seeds with the magnetic treatment and 30 without the magnetic treatment. Every day, the researcher takes care of the crops and waters them. The researcher also ensured that the crops received the right amount of sunlight. Every day, the researcher checks the plants to monitor their growth so they may measure it along with the development of the plant's leaves.

Statistical Analysis

Statistical analysis is performed using the Statistical Package for Social Science (SPSS) software. The data obtained from the germination rate, mortality rate, sizes of leaves, and length of the plant are subjected to descriptive analysis using the central tendency, the mean score. As for the significance of observed differences, a t-test is utilized.

RESULTS AND DISCUSSION

Descriptive Analysis of the Growth of the Control and Experimental Groups

Table 1 shows the bean (*Phaseolus vulgaris*) plant's growth under normal conditions and magnetic treatment. The unhealthy changes on the leaf and stem started to appear in the second week, especially in the control groups, followed by the experimental (with magnets) groups. At the end of the fourth week of observation, four samples died in the control group, while only one sample died in the experimental group. Overall, 26 out of 30 in the control group survived, while 29 out of 30 stayed in the experimental group throughout the research observation. The result of the study implies that the bean plant in the observed growth has a significant growth rate compared to the bean plant samples in the control group.

Table 1: Germination Rate and Mortality Rate of the String Bean (*Phaseolus vulgaris*) plants

Changes	Control	Experimental
Germination Rate	26/30 (4th week)	29/30 (4th week)
Unhealthy Leaf	2/30 (2nd week)	2/30 (3rd week)
Unhealthy Stem	1/30 (1st week)	2/30 (3rd week)
Plant Death	4/30	1/30

Seeds under magnetic treatment show 65 – 90 % of seed germination accompanied by high fresh and dry matter compared to seeds without magnetic treatment. It also revealed an increase in cellular metabolism in seeds under the experimental group. The magnetic field treatment accelerated seed germination, boosting seed metabolism (Bezerra, ., 2023). In a similar study, the application of magnetic field treatment alters the magnetic character of plants, enhances germination and photosynthetic machinery, and affects the nutrient uptake and tissue production of the plant (Ercan, 2022).

Descriptive Analysis of the Size of Leaves and Length of Growths

Table 2 shows the control and experimental groups' average plant height and size. The samples in the experimental group have more giant leaves (measured from margin to margin; width) than the sample in the control group. The experiment group is 24 percent bigger. Regarding plant growth, the average height after four weeks is 14.8 cm in the experimental group, 10% higher than the average height of the control group, 13.3 cm. The plant growth is measured from the base of the stem to the top of the plant. This implies that the leaves and growth of the bean plant exposed to the magnets grew more extensive and taller than those without magnets.

Table 2: Size of leaves and length of growth of the String bean (*Phaseolus vulgaris*) plants

Results	Size of Leaves (cm)		Length of growth (cm)	
	Control	Experimental	Control	Experimental
Week 1	0.9	1.2	5.3	5.9
Week 2	1.8	2.9	10.9	11.8
Week 3	2.4	3.1	17.4	19.3
Week 4	3.6	4.3	19.5	22.1
MEAN	**2.2**	**2.9**	**13.3**	**14.8**

Fu (2012) discovered that the plant growth and leaf size indicators of plant health, samples exposed to magnets tend to grow faster, taller, and bigger than those in control groups. In the study of Sarraf, Kataria, Taimourya, Santos, Menegatti, Jain, Ihtisham, & Liu (2020), the application of pulsating and continuous magnetic fields at low to medium intensity has been shown to impact seed germination and development in some plant species positively. Applying magnetic fields in plants has shown an increase in root and shoot growth, an increase in photosynthetic pigment content, and an increase in cell division, which leads to more extensive and taller plants.

Analysis of the Statistical difference between the Control and Experimental Group

The table below shows the t-test on the effectiveness of the magnetic treatment in the growth of the bean (*Phaseolus vulgaris*) plant between the control and experimental groups. The result revealed the value of p is 0.0025. The null hypothesis is rejected since it is less than the 0.05 level of significance. This implies a significant difference in the control and experimental groups regarding germination rate, plant growth and leaf size, and plant health.

Increasing the intensity of the magnetic fields yields significant physiological changes that positively affect the germination, growth, and health of a plant, contributing to an increase in productivity than without exposure to the magnetic field. Compared to traditional chemical methods, which can be expensive, harmful, and require precise application, using magnetic fields to stimulate germination is more straightforward, safer, and cost-effective. (Morillo-Coronado, Martínez-Anzola, Velandia-Díaz, & Morillo-Coronado 2022). A study revealed that magnetic fields significantly boosted plant growth. Seeds treated with magnetism had a higher germination rate and produced taller, more robust plants than the control group (Fu, 2012).

Table 3: Statistical comparison of control and experimental group using t-test

Comparison	t-value	p-value	Statistical Significance	Decision
Control vs. Experimental	4.05	0.0025 ($p < .05$)	Yes	Reject H_0

CONCLUSIONS

From the findings above, this study proved that magnetic treatments significantly impact the string bean plant. Samples under magnetic field treatment are healthy compared to the samples in the control group. It also proved that there is a difference in the height of the plant and the size of the leaves in the experimental and control groups. Magnetic treatment significantly influences the germination and growth of the String bean (*Phaseolus vulgaris*) plant. Using magnetic fields as a treatment for plant growth is a relatively new and emerging field with promising potential benefits. While the exact mechanisms are still being researched, studies suggest that magnetic fields can influence various aspects of plant physiology, leading to improved growth and yield.

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