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(RESEARCH ARTICLE)

Research on the influence of some types of water on seed germination in some vegetable plants

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Abstract

Numerous ancient cultures acknowledged the magnetic properties of magnets and utilized them as pain-relieving amulets. The Vedas, India's sacred books, discuss the use of magnets to control bleeding and treat specific female body ailments. Paracelsus, an alchemist and physician from the 16th century, discovered that magnets may cure most inflammations and ulcers, as well as many ailments of the bowel and uterus, and that they are beneficial for both internal and external illnesses. In the 18th century, Dr. Samuel Hahneman, the inventor of homeopathy, declared that "a magnetic wand can quickly and definitively cure a severe disease if it is brought close to the body."

Magnetized water is also used well to treat assimilation issues (such as calcium and magnesium deficiencies and iron deficiency anemia). Magnetized water promotes early germination in the three species of legumes. The number of germinated seeds on the eighth day is the same for bean seeds watered with ozonated and magnetized water, and there are no significant variations between seeds irrigated with ozonated, filtered, and magnetized water.

Keywords: Water; Germination; Genotypes; Biological agriculture

1. Introduction

Over the previous century, new agricultural technologies and the widespread use of chemical fertilizers, insecticides, and herbicides resulted in improved output at cheaper prices. The usage of such chemicals has resulted in pollution and ecosystem imbalance, and various studies have found a link between their use and an increase in malignancies and congenital illnesses in people [1,2]. Organic agriculture has grown over the last two decades to meet the demand of an increasing number of people prepared to pay extra for food produced using ecologically friendly practices and free of pesticide residues [3-5]. Water is one of the vegetative variables that humans have the most control over. Water has a unique role in plant life since it regulates physiological and biochemical processes, allowing for growth and development only in its presence. Water is a constitutional element, a biochemical and physiological reaction medium, a carrier of mineral and synthetic compounds, and a thermal regulator for tissues via transpiration and evaporation [6-8].

To better understand the effects of activated water irrigation on soybean growth under various drought conditions and to investigate the underlying mechanisms, Shapiro-Ilan D.I. et al. (2015) conducted a sheltered-space experiment under four humidity conditions: 95%-100%, 75%-85%, 55%-65%, and 35%-45% of the medium's maximum water holding capacity (80% humidity) [9]. Soybeans were watered with tap water, magnetized water, aerated water, and magnetized and aerated water, in that order. [10]. The results showed that the total biomass, leaf surface, root-to-stem ratio, and root length in the case of irrigation with magnetized water rose by 67.6%, 23.5%, 84.6%, and 122.8%, respectively,

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compared to tap water irrigation after 30 days of growth below 35%-45% severe drought conditions. All variables increased by 70.8%, 24.0%, 61.9%, and 162.3% in magnetized and aerated water treatments, respectively. There was no discernible difference in leaf chlorophyll concentration. The other water treatments had slightly lower levels than tap water. To summarize, the application of magnetized water effectively boosted soybean root growth, root-to-stem ratio, and water consumption efficiency while also mitigating the negative impacts of stress during extreme drought circumstances. [11].

2. Material and methods

To investigate the effect of various types of water on germination, the seeds of three vegetable species were used:

- Beans - Phaseolus vulgaris, SAXA variety: 60-65 days of growth, green pods up to 25 cm long, and a highly productive variety.
- Tomatoes - Lycopersicon esculentum, CHERRY: cultivar for planting in containers or pots, with small, round fruits.
- Cucumbers: Cucumis sativum, MARKETER variety: semi-early, semi-long fruit.

For this experiment, on March 2020, 2021 and 2022, 10 bean seeds, 20 tomato seeds and 10 cucumber seeds were germinated in four containers for each plant.

Four types of water were used for watering:

- Ozonated water obtained with the help of an ozone generator that produces 2mg ozone/30 min.
- Filtered/alkaline water obtained using a filter mounted on the tap
- GAV magnetized water obtained by passing water through a magnetic bar (magnetic field generated by 0.65 T and intensity of 13000 Gs)
- Tap water

During the period 6-11.04.2020, daily measurements of the number of germinated seeds are made.

(Source: Original)

Figure 1 Seeds prepared for germination

(Source: Original)

Figure 2 Grander informed water

(Source: Original)

Figure 3 Magnetized water

2.1. Statistical analysis

Statistical analysis. ANOVA (analysis of variance) is a statistical test that looks for significant variations between the means of groups of data. It is often used in experimental studies to compare the impact of several treatments or interventions on a specific outcome.

ANOVA divides the entire variability of data into two components: variance between groups (due to treatment) and variation within each group. The ANOVA test yields a F statistic, which represents the ratio of between-group variation to within-group variation.

If the F-statistic is large enough and the associated value is less than a preset level (e.g., 0.05), there is strong evidence that at least one of the group means differs significantly from the other. In this scenario, extra post-hoc tests might be conducted to see if these particular groups differ from one another.

One-way ANOVA is a statistical test that detects significant differences between the means of two or more independent groups. It is used to compare the null hypothesis, that the means of all groups are equal, to the alternative hypothesis, that at least one or more of the means differ from the others.

To execute a one-way ANOVA, the following procedures were taken:

- Step One: Hypothesis Statement

The null hypothesis and alternate hypothesis were identified. The null hypothesis states that there are no significant differences between group means. The alternative hypothesis is that at least one group's mean differs significantly from the rest.

- Step 2: Data Collection

Data were gathered from each culture being compared. Each group must be independent, with a comparable sample size.

- Step 3: Calculate the mean and variance for each crop.

The average and variance of each culture were computed.

- Step 4: Compute the global mean and variance.Mean and variance were obtained by averaging the means and variances of the major worldwide civilizations.
- Step 5: Compute the sum of squares between groups (SSB).

To compute the sum of squares between groups (SSB), use the formula: $SSB = \Sigma ni\ (\bar{x}i - \bar{x})^2$, where ni is the sample size of the ith group (culture), $\bar{x}i$ is the mean of the ith group (culture), and $\bar{x}$ is the overall mean.

- Step 6: Computing the Sum of Squares Within Groups (SSW)

The formula for calculating the sum of squares within groups (SSW) is:

$SSW = \Sigma\Sigma(xi-\bar{x}i)^2$. xi is the second observation in the second group, $\bar{x}i$ is the mean of the second group, and j runs from 1 to k groups.

- Step 7: Calculating the F statistic.

The F statistic was computed by dividing the between-group variance (SSB) by the within-group variance (SSW): $F = (SSB / (k - 1)) / (SSW / (n - k))$, where k represents the number of groups and n represents the total sample size.

- Step 8: Determine the crucial value of F and the p-value.

The critical value of F and the accompanying p-value were calculated using the specified significance level and degrees of freedom.

- Step 9: Comparing the calculated F statistic to the crucial value of F.

When the estimated F statistic exceeded the critical value of F, the null hypothesis was rejected, and it was determined that there was a significant difference in the means of at least two groups. If the estimated F statistic was less than or equal to the critical value of F, the null hypothesis was not rejected, and the two groups' means did not differ significantly.

- Step 10: Post-hoc analysis (if necessary).

If the null hypothesis was denied, a post hoc analysis was used to identify whether groups differed significantly from one another. Tukey's HSD test, Bonferroni adjustment, and Scheffe's test are examples of common post-hoc analyses.

3. Results and discussion

3.1. Results regarding the influence of different types of water on the germination of cucumber seeds

In table 1, data are centralized regarding the average number of germinated cucumber seeds for the experimental model water types (2020, 2021, 2022).

Table 1 The average number of germinated cucumber seeds for the experimental model water types (2020,2021,2022)

CUCUMBERS - average total number of germinated seeds			
Type of water / Year	**2020**	**2021**	**2022**
Witness - tap water	0	0	0
Ozonate water	0	0	0
Filtered water (alkaline pH 9)	1	0	0
Magnetized water	0	2	1
Average	0.25	0.5	0.25

From the centralized data in table 1 regarding the germination of cucumber seeds for the experimental model water types, from the 10 seeds initially germinated, in 2020 only one seed irrigated with filtered water (alkaline pH 9) germinated, and in 2021 they two seeds germinated and in 2022 only one seed germinated, these (2021 and 2022) being irrigated with magnetized water.

Table 2 Statistical results regarding the average number of germinated cucumber seeds for the experimental model water types (2020,2021,2022)

Irrigation type	**Year**	**Mean Value Control**	**Ratio % Control**	**Difference**	**Estimate**
Witness - tap water	2020	0.00	0.00	0.00	o
	2021	0.00	0.00	0.00	o
	2022	0.00	0.00	0.00	o
Ozonate water	2020	1.00	0.00	1.00	*
	2021	0.00	0.00	0.00	o
	2022	0.00	0.00	0.00	o
Filtered water (alkaline pH 9)	2020	0.00	0.00	0.00	o
	2021	2.00	0.00	2.00	**
	2022	1.00	0.00	1.00	*
Magnetized water	2020	0.00	0.00	0.00	o
	2021	0.00	0.00	0.00	o
	2022	0.00	0.00	0.00	o

The statistical results regarding the average number of germinated cucumber seeds (table 2) show the fact that in ozonated water (2020) and filtered water (alkaline pH 9) in 2022 there was a significant increase in seed germination, and in 2022 there was a distinctly significant increase in seed germination in filtered water (alkaline pH 9).

3.2. Results regarding the influence of different types of water on bean seed germination

In table 3. are centralized data on the average number of bean seeds germinated in the experimental model different types of water.

Table 3 Average number of germinated bean seeds for the experimental model water types (2020, 2021, 2022)

BEANS - average total number of germinated seeds			
Type of water / Year	**2020**	**2021**	**2022**
Witness - tap water	1.17	0.53	0.52
Ozonate water	2.52	3.56	3.43
Filtered water (alkaline pH 9)	2.54	3.27	2.29
Magnetized water	3.15	5.27	4.35
Average	2.34	3.13	2.64

Regarding the average number of germinated seeds in beans for the experimental model water types, the data were centralized in table 4. Thus, it is found that the highest average of germinated bean seeds was recorded in 2021, registering an average of 5.27 germinated seeds in those irrigated with magnetized water, and at the opposite pole the least germinated bean seeds were in the year 2022 for the control - tap water recording an average of 0.52 germinated seeds.

The statistical results regarding bean seed germination in the experimental model water types are centralized in table 4.

Table 4 Statistical results average number of bean seeds germinated for the experimental model water types (2020, 2021, 2022)

Irrigation type	**Year**	**Mean Value Control**	**Ratio % Control**	**Difference**	**Estimate**
Witness - tap water	2020	1.00	5.00	-1.00	
	2021	0.00	0.00	-2.00	
	2022	0.00	0.00	-2.00	
Ozonate water	2020	2.00	150.00	0.00	*
	2021	3.00	150.00	1.00	*
	2022	3.00	150.00	1.00	*
Filtered water (alkaline pH 9)	2020	2.00	100.00	0.00	*
	2021	3.00	150.00	1.00	*
	2022	2.00	100.00	0.00	*
Magnetized water	2020	3.00	150.00	1.00	**
	2021	5.00	250.00	3.00	**
	2022	4.00	200.00	2.00	**

The statistical results on the average number of germinated bean seeds (table 4.) show that there were significant seed germinations for the seeds irrigated with ozonated water and filtered water (alkaline pH 9) in the year and a distinctly significant increase in seed germination in magnetized water.

3.3. Results regarding the influence of different types of water on the germination of tomato seeds

In table 5. data on the average number of tomato seeds germinated for the water types experiment (2020, 2021, 2022) are centralized.

Table 5 The average number of tomato seeds germinated for the water type experiment model (2020,2021,2022)

TOMATOES - average total number of germinated seeds			
Type of water / Year	**2020**	**2021**	**2022**
Witness - tap water	8.43	2.57	6.83
Ozonate water	6.33	3.51	12.12
Filtered water (alkaline pH 9)	9.23	6.45	14.10
Magnetized water	13.15	11.52	16.13
Average	9.28	6.01	12.29

According to the centralized data in table 5. it is found that the highest average number of germinated seeds was recorded in plants irrigated with magnetized water, 16.13 germinated seeds (2022), and the lowest average number of germinated seeds was recorded in the control - tap water recording an average of 2.57 germinated seeds (2021). It is also observed that in 2022 the average number of germinated tomato seeds was 12.29 seeds.

Table 6 Statistical results average number of tomato seeds germinated for the water type experiment model (2020,2021,2022)

Irrigation type	**Year**	**Mean Value Control**	**Ratio % Control**	**Difference**	**Estimate**
Witness - tap water	2020	8.00	133.33	2.00	
	2021	2.00	33.33	-4.00	
	2022	6.00	100.00	0.00	
Ozonate water	2020	6.00	100.00	0.00	**
	2021	3.00	50.00	-3.00	*
	2022	12.00	200.00	6,00	***
Filtered water (alkaline pH 9)	2020	9.00	150.00	3.00	**
	2021	6.00	100.00	0.00	**
	2022	14.00	233.33	8.00	*
Magnetized water	2020	13.00	216.67	7.00	***
	2021	11.00	183.33	5.00	***
	2022	16.00	266.67	10.00	***

The statistical results regarding the average number of germinated tomato seeds (table 6.) show that there were very significant increases in seed germination in those irrigated with magnetized water.

Table 7 summarizes data on the average number of germinated seeds for cucumber, bean and tomato species.

The experimental model was carried out on plant material such as cucumber, bean and tomato seeds as a support for validating the influence of water types (ozonated, filtered, magnetized and mator - tap water).

Table 7 Results on the average number of germinated seeds for cucumbers, beans and tomatoes (2020, 2021, 2022)

Species	2020	2021	2022	Average
Witness - tap water	0.17	0.15	0.11	0.14
Cucumber	0.25	0ş52	0ş25	0.33
Beans	2.34	3.02	2.64	2.66
Tomato	9ş29	6.01	12.29	9.19
Average	3.01	2,42	3.82	3.08

The experimental model was carried out on plant material such as cucumber, bean and tomato seeds as a support for validating the influence of water types (ozonated, filtered, magnetized and mat water from the tap).

From the centralized data in table 6.15. regarding the average number of germinated seeds, it can be observed that the most seeds germinated in tomatoes registering an average of 9.19 seeds, and the fewest seeds germinated in cucumbers registering an average of 0.33 seeds.

Table 8 Statistical analysis of the average number of germinated seeds for the experimental model of seed germination using different types of water (2020, 2021, 2022)

Irrigation type	Year	Mean Value Control	Ratio % Control	Difference	Estimate
Witness - tap water	2020	0.00	0.00	0.00	o
	2021	0.00	0.00	0.00	o
	2022	0.00	0.00	0.00	o
Cucumber	2020	0.00	0.00	0.00	o
	2021	0.00	0.00	0.00	o
	2022	0.00	0.00	0.00	o
Beans	2020	2.00	0.00	2.00	*
	2021	3.00	0.00	3.00	*
	2022	2.00	0.00	2.,00	*
Tomato	2020	9.00	0.00	9.00	***
	2021	6.00	0.00	6.00	***
	2022	12.00	0.00	12.00	***

Statistical analysis on the average number of cucumber, bean and tomato seeds germinated for the experimental seed germination model using different types of water shows us that tomato seeds recorded very significant germination and bean seeds recorded significant germination.

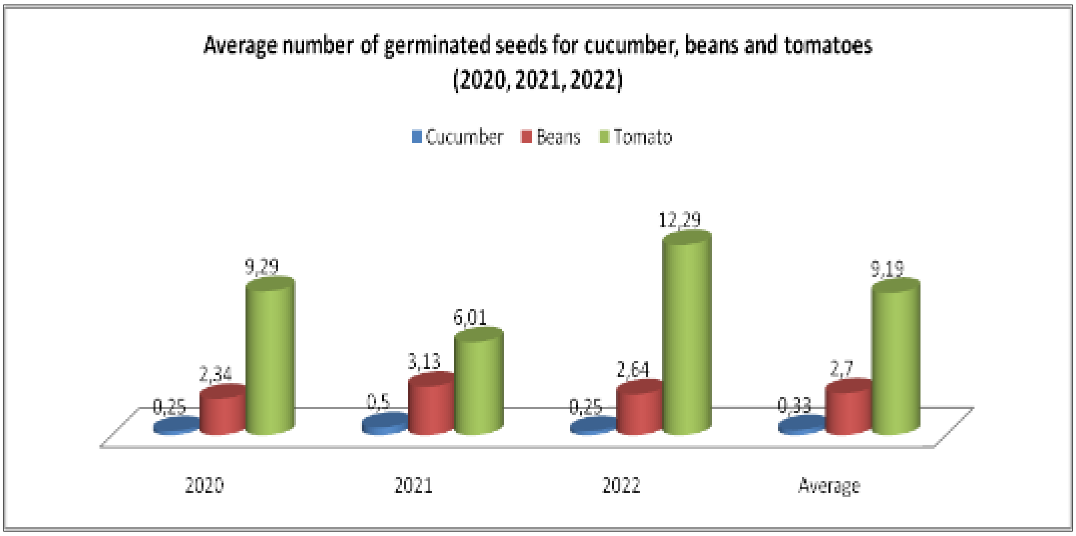

Figure 4 Graphic representation of the average number of cucumber, and tomato seeds germinated in 2020, 2021, 2022

4. Conclusion

Magnetized water produces early germination in the case of the three types of legumes.

Regarding the number of germinated seeds on the eighth day, it is equal for the bean seeds watered with ozonated and magnetized water, and with insignificant differences in the case of seeds irrigated with ozonated, filtered and magnetized water.

From the determinations made, it appears that not every genotype can be influenced. Each genotype itself has its own and particular response.

Following the results, it was highlighted that the informed water had the best influence on the development of the black radish species.

The influence of informed water on the moon radish species was similar to that of red cabbage, but superior to the other types of water.

The physiological processes that take place during germination and plant growth are positively influenced by alkaline water. This can be explained by the fact that no pathogenic organism can develop in an alkaline environment, in other words, offering protection against pathogens (respectively Botrytis or molds that appear at the first stages of plant development);

In the case of magnetized water, no major differences were found between the 4 plant species in terms of development during the studied time period.

The studies carried out recommend the informed type of water for use in watering plants, stimulating their good development.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed by Alecsandru-Valentin GHIORGHIU, Gabriela BUTNARIU, Adrian CHIRA, Mihaela VLAD, Ligia ION.

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