

Comparative Study Infused Mechanism Among Absorbance Materials to Improve Plant Growth

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Abstract

Agriculture is the practice of cultivating land, growing crops, and raising livestock for human consumption. This experiment aims to assess how successful zeolite, charcoal, and kaolin are as slow-release fertilizers by investigating the adsorption performance of zeolite as a nutrient-uptake agent using various samples. This paper discussed the three absorbents that, when infused with the fertilizer, can affect plant growth, soil quality, conservation of water, and nutrient consumption. Since the infused absorbent shows the best quality in retaining water and nutrients, it enables it to collect hazardous substances quickly and efficiently from environmental pollution. The sample mixture contains 80 grams of soil and 5 grams of infused zeolite, charcoal, and kaolin for planting green beans. Adsorption and fertilizer testing were performed to see the physical properties of infused absorbent samples. In conclusion, the ability of zeolite and kaolin to retain nutrients was performed the best, while charcoal slightly displayed growth of the plants as shown by the result of the height, length of leaf, pH level, and humidity of the soil.

1. Introduction

Environmental issues in agriculture differ from one country to the next. Some are caused by natural circumstances (high native heavy metal content, drought, volcanic eruptions, and so on). In contrast, others are caused by agricultural activities (leaching of nutrients and pesticides, for example), and others are caused by human impact in other regions (air pollution). Besides that, several scientific studies have investigated the problems and their causes. However, many environmental issues that affect conventional agriculture are also prevalent in organic agriculture [1,2]. This is backed up by the claim that using N, P, and K-enriched zeolite increased crop yield by 20% and enhanced product quality. Finally, the expected outcome that needs to be achieved by this study can produce a new placement for absorbent fertilizers to improve plant growth and benefit the agricultural sector.

1.1 Zeolite

Zeolites have demonstrated the potential to improve agricultural crop yield output [3]. As reported previously, [4] and [5] both emphasize zeolites' capacity to increase soil water and nutrient retention, resulting in an improved agricultural yield. Most naturally occurring zeolites are derived from sedimentary and volcanic rocks like mordenite, clinoptilolite, and chabazite [6,7]. This tetrahedral alumina and silica structure has a mesoporous

shape that allows it to store nutrients that help the leaf grow while also being able to trap ions and minerals and perform ion exchange [8]. Zeolite helps to keep sandy soil soaked by maintaining critical nutrients and preventing them from draining away. Natural zeolites have been utilized as soil conditioners and slow-release fertilizers to the soil [9].

1.2 Charcoal

Charcoal has a strong absorption capability for colloidal particles, gases, and vapors. The distillation of wood and other carbonaceous materials produces it. Charcoal's composition and characteristics vary depending on its use [10]. Charcoal is an adsorbent that has a considerable influence on microtubule induction. It can boost tuber output while significantly reducing the time required for microtuber induction [11]. It may have inhibited light, but activated charcoal maintained a balance of major and minor components in the culture medium [12].

1.3 Kaolin

Kaolin is a mineral known as natural clay commonly used in gardening and other activities. Kaolin is a white mineral that is chemically inert, non-abrasive, non-toxic, and readily dissolves in water [13]. Once sprayed as a suspension on the leaf surface, water evaporates, leaving a protective particle coating [14]. Kaolin was initially developed for pest control, but its role in mitigating various environmental pressures has recently received more attention. Its efficacy is connected to the white protective particle layer on the leaf surface, which increases the reflection of excess radiation, lowering the risk of leaf and fruit damage caused by heat load buildup and sun harm [15]. As a result, kaolin can be utilized as a supplement to boost plant development. Kaolin increases plant height, dry mass, and water consumption efficiency in plants under water stress.

2. Materials and Method

The material and methods are known as a methodology that describes all the information required to show the effectiveness of the absorbent for the improvement of plant growth experiment.

2.1 Absorption Material

The absorbent material is highly effective in recovering contaminants from land, water, and internal surfaces. Its high absorption capacity enables it to collect environmentally hazardous substances quickly and efficiently, thereby preventing environmental pollution. The absorbent material is either spread or mechanically scattered to treat contaminated surfaces over the affected area. Once the pollution has been absorbed, the material is collected for disposal. The absorption process in water takes approximately 30- 60 seconds, after which the contaminated material is collected mechanically.

2.2 Hydrochloric Acid (HCL)

Treating MFI zeolite in a NaOH aqueous solution increased catalytic activity for cumene cracking and altered the pore volume and pore-size distribution of mesopores. Based on a recent work by Hudec et al., the supermicropores were formed by treating NaY zeolites with HCl. Thus, the production mechanisms of mesopores should be investigated in terms of zeolite pore-size regulation. This experiment aimed to record the chemical interaction of NaOH with the materials by introducing a few drops of NaOH into water. The result will be seen in the absorption process testing.

2.3 Sodium Hydroxide (NaOH)

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2.4 NPK

NPK fertilizer is applied to the soil to modify its properties and give greater crop yield. This fertilizer modifies the properties of the soil, including unit weight, void ratio, water content, plasticity, tensile strength, compressibility, permeability, and compatibility. As a result, it's essential to examine the engineering properties of NPK 20-10-5 fertilizer-modified soils. After analyzing the test results, it was found that adding fertilizer caused a decrease in

the soil's liquid limit, shrinkage limit, coefficient of permeability, and void ratio. It also reduced the soil's shear strength parameters.

2.5 Methods

2.5.1 Absorption Test

In this experiment, hydrochloric acid and sodium hydroxide were also used to show the effectiveness of absorption tests on the absorbent. Six beakers of absorbents, such as zeolite, charcoal, and kaolin, were prepared in each beaker. The absorbent will be tied into small pieces using tissue with 5 grams without fertilizer. Then, the absorbent was soaked in 50ml of water and 1 gram of fertilizer. The absorption occurs when the infused absorbent is stored in nutrients. Three beakers were used for the absorption of the acidic reaction test, while three other beakers were used for the alkaline reaction test. A few droplets of HCL and NaOH in each of the three beakers had already been set up. Following the completion of this experiment, the following absorbent will be measured: the concentration of chemicals or impurities within the solution. The result will be measured by using a TDS Meter (PPM).

2.5.2 Fertilization Test

To ensure that the green bean seeds would develop healthily, the NPK fertilizer was administered to the seeds after the absorption test for the fertilizer had been finished. Seven samples were taken from green beans to be used as specimens. Six samples were given an amendment to be added. Still, three specimens were given an infused zeolite, charcoal, and kaolin modification, respectively, while three other specimens had natural zeolite, charcoal, and kaolin. One of the specimens only has fertilizer and soil. The tools determine the typical amounts of soil moisture using a soil moisture meter to measure pH and humidity. The green bean plant has also observed the leaf's height and length.

3. Results and Discussions

The results will be presented with the number of parts per million (PPM) concentration of solution for the absorption method, the pH level, and the humidity of the soil. The same goes for the plant's height and the leaf's length.

Table 1 The result of natural absorption testing for absorbent

Day	Zeolite	Charcoal	Kaolin
1	392 ppm	734 ppm	527 ppm
2	410 ppm	739 ppm	570 ppm
3	379ppm	806 ppm	569 ppm
Total Absorption Percentage (%)	0.033	-0.099	-0.080

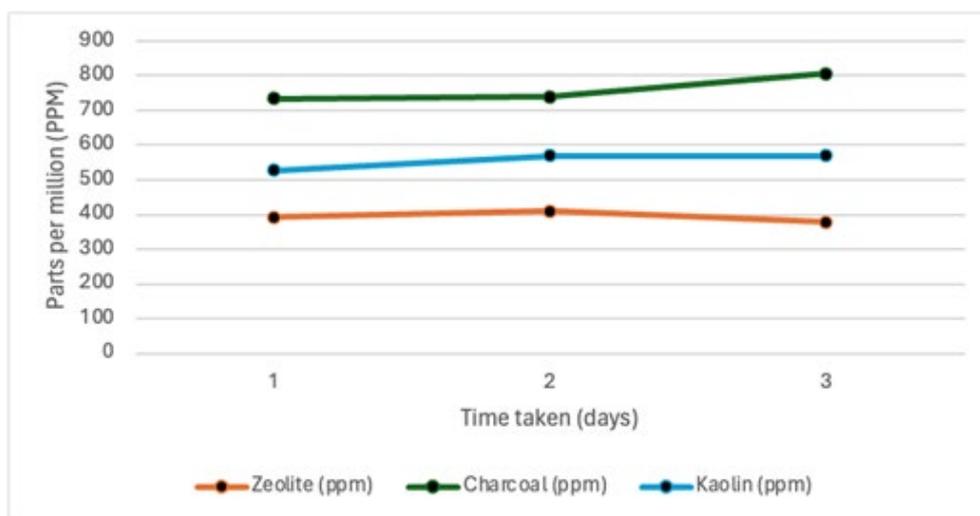


Fig. 1 Graph Parts of Million (PPM) vs Time Taken (Days)

3.1 Result Neutral Absorption

The provided data in Table 1 presents the absorption of a neutral pH solution by three different substances over three days. Zeolite shows a slight increase in absorption percentage with a total absorption percentage of 0.033% compared to other absorbance materials. This is because zeolite has ion-exchange properties and a high surface area for absorption, which makes it practical for adsorbing various substances. Charcoal exhibits a decrease in absorption percentage compared to Zeolite, with a total absorption percentage of -0.099%; meanwhile, Kaolin also shows a reduction in absorption percentage, with a total absorption percentage of -0.080%. This could be due to the concentration of absorbed materials in charcoal and kaolin. Since charcoal has a faster absorbance, the possibility of absorbing the fertilizer and achieving the saturated condition may be very fast. Meanwhile, less effective kaolin will not strongly absorb but achieve the saturated condition.

3.2 Result Acidic Absorption

The absorption testing was conducted in the absorption reaction when hydrochloric acid with pH 4 was mixed with absorbents such as zeolite, charcoal, and kaolin. Based on Table 2, all absorbents show a decline in absorbance performance as the measured durations increase. Zeolite exhibited the lowest slight decline as compared to others' absorbance. This suggests that zeolite's ability to absorb in an acidic solution is reduced compared to the neutral condition. In contrast, charcoal experienced a more pronounced decline in absorption percentage than zeolite, with a total absorption percentage of -0.720%. Charcoal is known for its high absorption capacity due to its porous structure, which efficiently traps pollutants. Kaolin exhibited the most significant decline in absorption percentage among the three chemicals, with a total absorption percentage of -0.164%. Both charcoal and kaolin show more decreases in absorption percentage compared to zeolite, indicating that they may be due to less stable structures that readily react with acidic have that may reach saturation points or experience structural changes affecting their absorption capacities.

Table 2 The result of acidic absorption pH 4 (HCL) testing of absorbent

Day	Zeolite	Charcoal	Kaolin
1	775 ppm	1005 ppm	854 ppm
2	794 ppm	1450 ppm	871 ppm
3	797 ppm	1019 ppm	962 ppm
4	791 ppm	1592 ppm	1026 ppm
5	800 ppm	1692 ppm	996 ppm
6	776 ppm	1729 ppm	994 ppm
Total Absorption Percentage (%)	-0.013	-0.720	-0.164

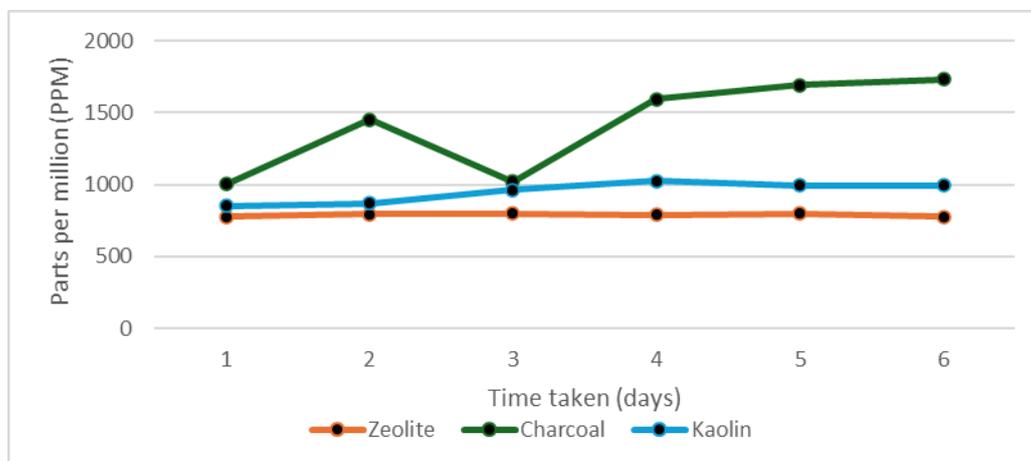


Fig. 2 Graph Parts of Million (PPM) vs Time Taken (Days)

3.3 Result Alkaline Absorption

Table 3 shows the concentration of NaOH (in parts per million, ppm) on different days. The material was exposed to NaOH at pH 7, and the concentration was measured over seven days. All the absorbents show a slight decrease

in absorbance performance compared to the neutral condition. Among all absorbances, zeolite can function as a good absorbance in alkaline conditions. Negative absorption percentages indicate the absorbance cannot absorb more solute particles due to less stability, incapability in the absorbability mechanism, or having achieved saturation earlier. Charcoal might have reached its maximum absorption capacity, leading to a significant decrease in absorption efficiency over time. Meanwhile, Kaolin's pores might have become partially blocked by absorbed NaOH solution or reaction products, reducing its absorption capacity. This suggests that charcoal and kaolin are less effective in alkaline mediums for nutrient absorption and are unsuitable for use as soil enhancers.

Table 3 The result of alkaline absorption pH 7 (NaOH) testing of absorbent

Day	Zeolite	Charcoal	Kaolin
1	803 ppm	1017 ppm	770 ppm
2	786 ppm	1579 ppm	835 ppm
3	789 ppm	1657 ppm	888 ppm
4	790 ppm	1692 ppm	918 ppm
5	739 ppm	1780 ppm	897 ppm
6	722 ppm	1725 ppm	859 ppm
Total Absorption Percentage (%)	0.100	-0.670	-0.120

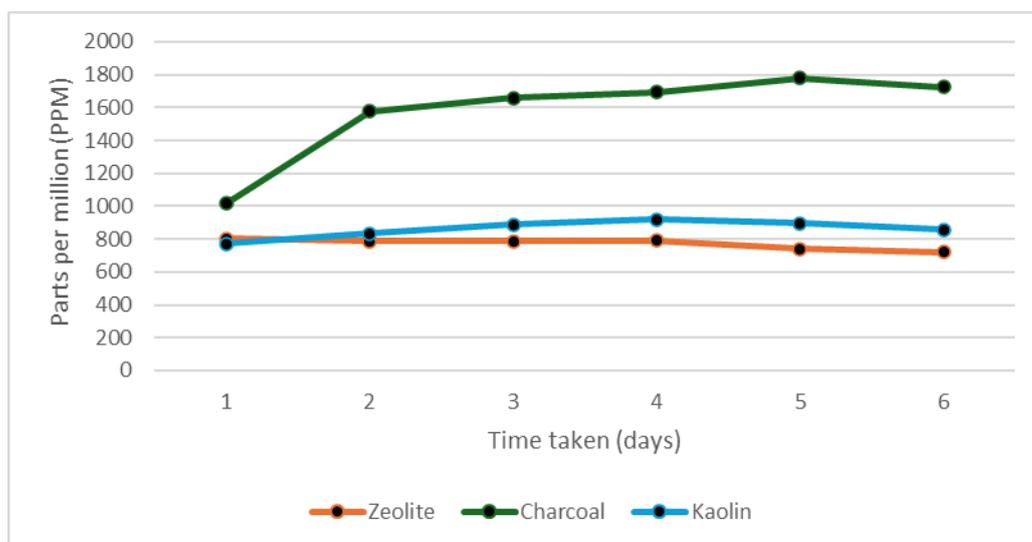


Fig. 3 Graph Parts of Million (PPM) vs Time Taken (Days)

3.4 Fertilizer Planting Result

According to the results, green plants in zeolite and kaolin develop more quickly than the other samples, with zeolite among the best. This experiment demonstrates that zeolite-treated plants grow better and quicker, which may be due to the ability of zeolite and kaolin to retain nutrients within their structure that act as slow-release fertilizer to the soil, as seen in both samples B and E. Both zeolite and kaolin have similar chemical structures and are chemically compatible and stable with the soil structure. Aside from that, kaolin also has the highest capacity to hold nutritional compounds, allowing the plant to remain healthy and grow effectively. In Sample B, zeolite was likewise an excellent absorption agent and retained water and nutrients better than charcoal, but infused zeolite performed the best. Samples D and E demonstrate that the plant has the most extended height compared to the other plants. Charcoal in Samples C and F grew the quickest at first but slowly retard the growth over the last four days due to increased nutrient release and absorption. However, samples D and G with kaolin exhibit relatively stable, the most promising length of plant growth plants.

Table 4 Plant growth for height and leaf of green beans

Sample	Height (cm)							Leaf(cm)						
	2	4	6	8	10	12	14	2	4	6	8	10	12	14
A : Soil + NPK	2.2	5.2	9.6	10.4	13.9	15.1	17.3	0.2	0.4	0.5	0.6	0.7	0.9	1.0
B : Soil + NPK + Zeolite	2.7	7.0	10.2	12.5	15.5	18.4	21.1	0.5	0.9	1.2	1.6	2.2	2.9	3.2
C : Soil+ NPK+ Charcoal	2.9	7.1	8.9	10.1	12.0	14.2	16.0	0.3	0.6	0.9	1.2	1.4	1.7	1.9
D : Soil+ NPK + Kaolin	2.4	6.9	9.0	12.2	15.0	19.5	23.4	0.4	1.0	1.3	1.7	2.0	2.7	3.0
E : Soil + Infused Zeolite	2.6	6.8	9.9	13.0	15.9	19.0	21.5	0.6	1.0	1.2	1.7	2.1	2.8	3.3
F : Soil + Infused Charcoal	2.9	7.1	9.0	12.4	15.4	17.2	20.6	0.4	1.1	1.5	1.8	1.9	2.3	2.4
G : Soil + Infused Kaolin	2.5	6.0	8.7	11.8	16.0	19.2	22.4	0.5	0.6	1.4	1.6	2.2	2.9	3.2

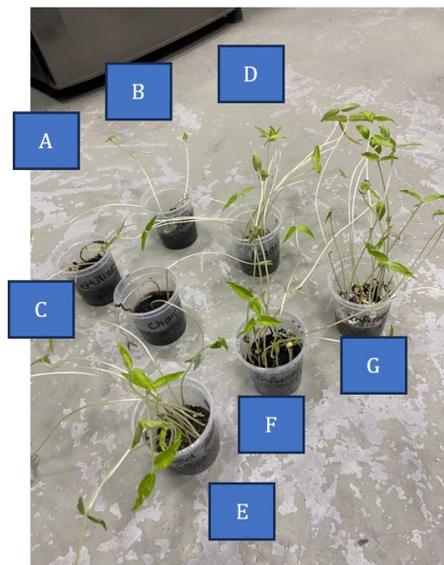


Fig. 4 Shows the growth of the green bean plant on day 14

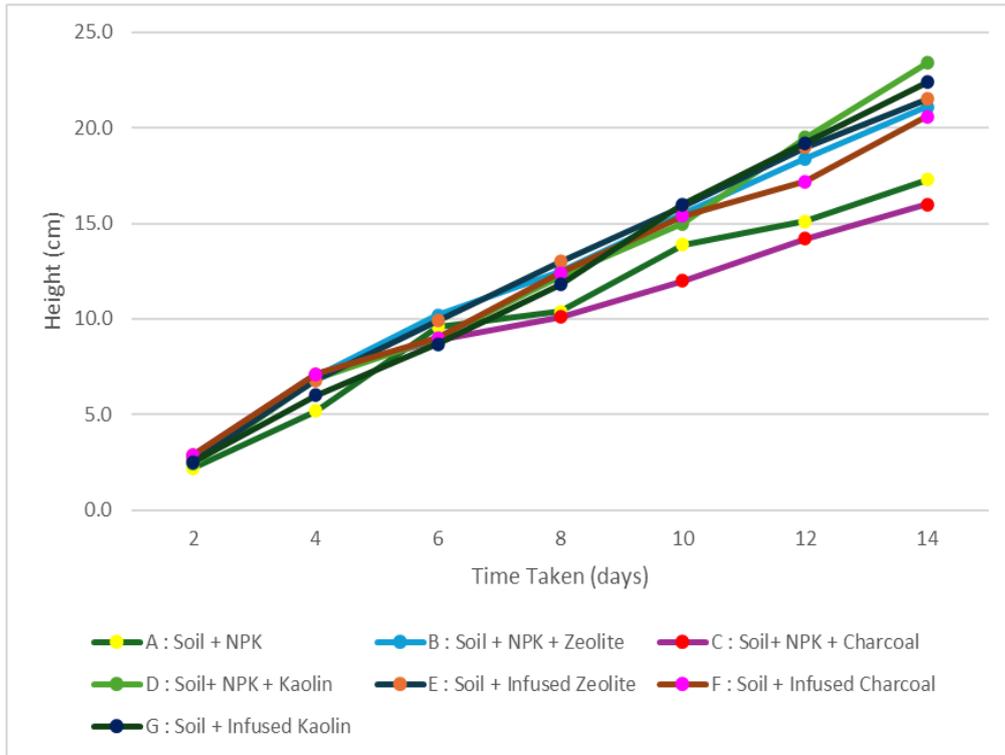


Fig. 5 Graph of Height (cm) vs Time taken (days)

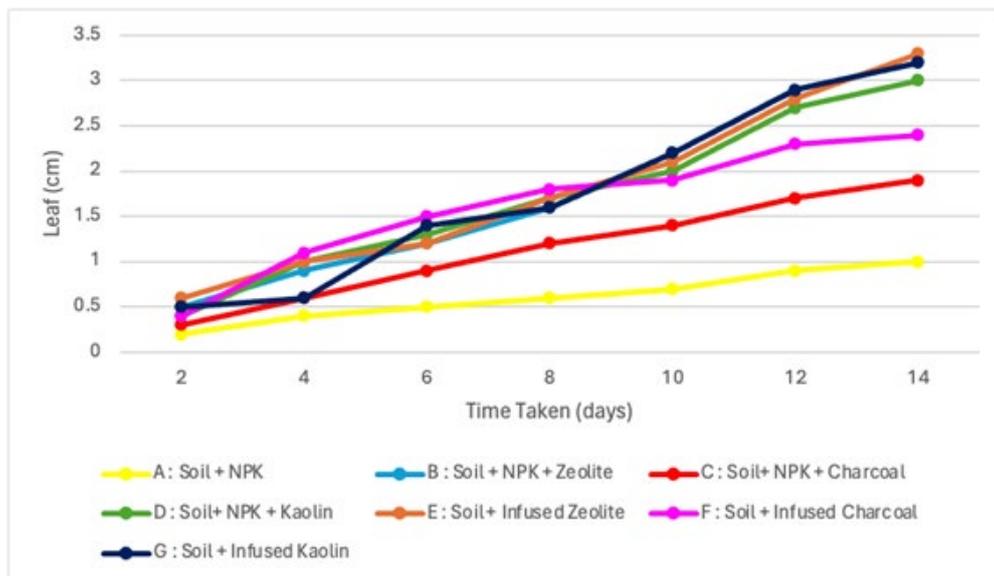


Fig. 6 Graph of Leaf (cm) vs. Time taken (days)

3.4.1 pH of soil plant

Table 5 shows that the initial pH levels across all treatments seem relatively consistent, ranging from 6.0 to 6.8 on the first day. This consistency indicates a balanced starting point for the experiment. When fertilizer is combined with absorbents like zeolite, charcoal, or kaolin, pH levels have more noticeable fluctuations. This suggests that these absorbents might influence the soil's pH balance. Zeolite seems to stabilize soil pH, as pH levels in plots treated with fertilizer and zeolite generally remain within a narrower range compared to other treatments. Charcoal appears to slightly lower pH levels, especially towards the later days of the experiment. Kaolin shows varying effects, sometimes stabilizing pH and causing slight fluctuations at other times.

Table 5 pH of soil

Day	Fertilizer only (2g)	Fertilizer (2g) + Zeolite (2g)	Fertilizer + Charcoal (2g)	Fertilizer (2g) + Kaolin (2g)	Infused Zeolite (5g)	Infused Charcoal (5g)	Infused Kaolin (5g)
1	6.8	6.6	6.4	6.6	6.8	6.2	6.2
2	6.8	6.7	6.3	6.3	6.5	5.8	6.6
3	6.8	6.5	6.6	6.2	6.5	6.4	6.3
4	6.7	6.8	6.4	6.8	6.5	6.2	5.8
5	6.7	6.1	6	6.5	6.1	5.4	6.7
6	6.8	6.8	6.2	6.7	6.8	6.6	6.2
7	5.2	6.6	6.5	5.6	6.4	6.8	5.7
8	6	6.2	6.2	6.2	6	6.5	5.8
9	6.3	6.7	5.3	6.4	6.2	6.3	6
10	6.2	6.5	5.6	6.3	6.4	6	6.2
11	5.2	6.5	6.7	6.7	6.8	6.8	5
12	5	5.1	6.5	6.8	6.6	6.7	6.8
13	5.9	6.5	6.2	6.5	6.3	6.5	6.7
14	5.8	6.7	6.2	6.8	6	6.1	6.6

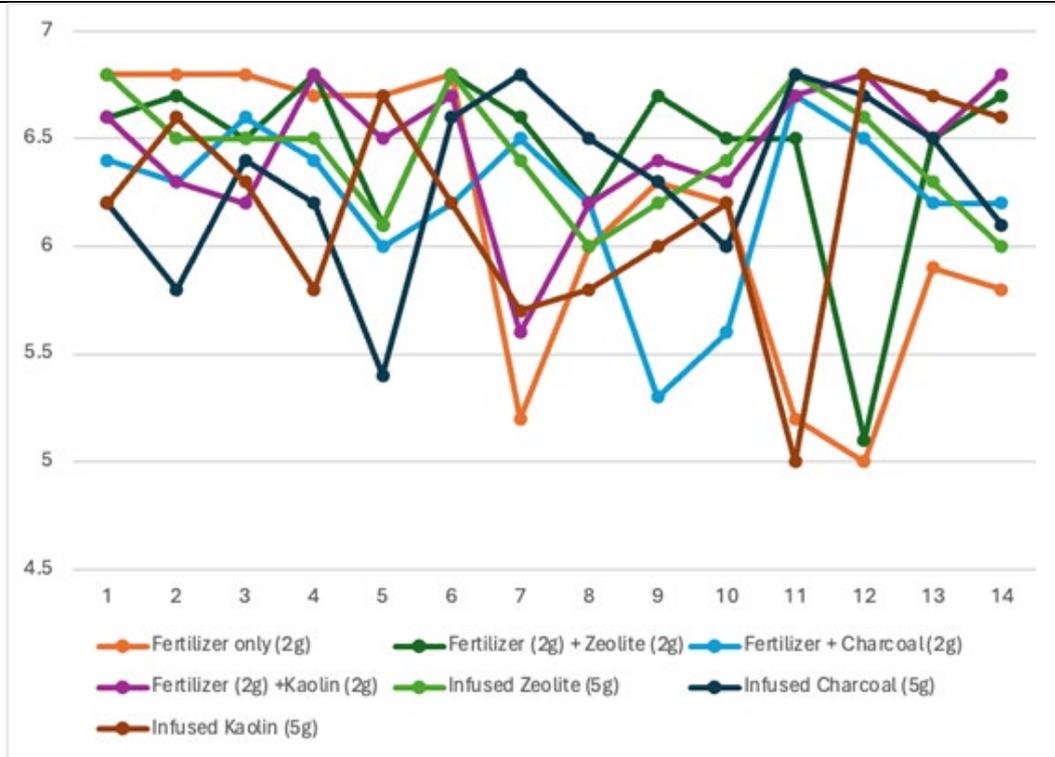


Fig. 7 Graph of pH vs. Time is taken (Days)

3.4.2 Soil Humidity

Table 6 Soil humidity

Day	Fertilizer only (2g)	Fertilizer (2g) + Zeolite (2g)	Fertilizer + Charcoal (2g)	Fertilizer (2g) + Kaolin (2g)	Infused Zeolite (5g)	Infused Charcoal (5g)	Infused Kaolin (5g)
1	30 (wet)	29 (dry)	28 (wet)	29 (wet)	30 (dry)	29 (wet)	30 (dry)
2	29 (dry)	29 (dry)	27 (wet)	30 (dry)	29 (dry)	28 (dry)	29 (wet)
3	29 (wet)	28 (wet)	28 (dry)	29 (wet)	29 (dry)	28 (wet)	28 (dry)
4	28 (dry)	28 (dry)	29 (wet)	29 (wet)	29 (dry)	29 (dry)	29 (dry)
5	30 (dry)	29 (dry)	29 (wet)	29 (dry)	30 (dry)	30 (dry)	30 (dry)
6	29 (wet)	29 (wet)	29 (wet)	30 (dry)	30 (dry)	30 (dry)	30 (dry)
7	29 (wet)	29 (wet)	30 (dry)	30 (dry)	31 (dry)	29 (wet)	30 (dry)
8	29 (dry)	30 (wet)	29 (wet)	30 (wet)	30 (dry)	29 (dry)	30 (dry)
9	30 (dry)	30 (dry)	30 (dry)	30 (dry)	30 (dry)	30 (wet)	30 (dry)
10	29 (dry)	28 (dry)	29 (dry)	30 (dry)	31 (dry)	30 (dry)	30 (dry)
11	30 (dry)	29 (wet)	31 (dry)	29 (dry)	30 (wet)	29 (dry)	29 (wet)
12	29 (wet)	30 (dry)	29 (wet)	30 (dry)	30 (dry)	30 (wet)	30 (dry)
13	30 (wet)	30 (wet)	30 (dry)	31 (wet)	29 (wet)	28 (wet)	29 (dry)
14	30 (wet)	30 (wet)	31 (dry)	30 (dry)	30 (dry)	30 (dry)	30 (dry)



Fig. 8 Shows the plant humidity measure using a 4-in-1 soil survey instrument tester.

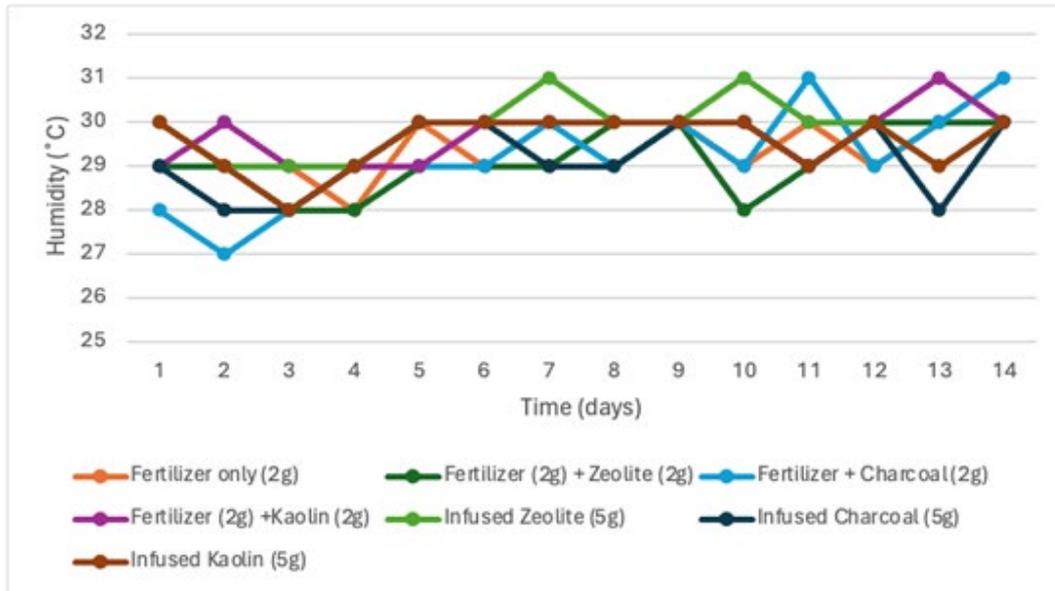


Fig. 9 Graph of Humidity (°C) vs Time (days)

4. Conclusion and Recommendation

Based on the findings of this research, it was possible to assess the ability of green to grow their root systems in the presence of adsorbents such as zeolite, charcoal, or kaolin. Zeolite-adsorbent infused with NPK fertilizer provided sufficient nutrients, resulting in excellent yield and crop development for both plant-based products. Compared to the standard sample, which only included NPK fertilizers, the infused adsorbent fertilizer, including zeolite and kaolin, grew faster than charcoal for both green beans. It promotes plant growth by stimulating the formation of root systems, maintaining adequate water in the root zone, and preventing nutrients from leaving the plant. Following that, this study aimed to investigate how the amount of infused adsorbent in soil may be modified by adding absorption materials to zeolite as a soil supplement. Regarding nutrient retention and preventing nutrients from being absorbed and released, infused zeolite outperformed infused charcoal and kaolin. Therefore, zeolite created by an infused technique can be the most absorbent, improving soil quality and plant development.

The combination of zeolite and kaolin is the most effective combination for increasing the output of agricultural yields. However, there are many different methods to make the adsorbent with zeolite as a soil supplement more effective. Consequently, several recommendations and proposals have been made to expedite the production of zeolite-adsorbent fertilizer.

1. It is recommended that the experiment or study be repeated using long-term plants or plants that have a long time to grow to determine the overall impact of plant growth.
2. In determining the maximum adsorption and relaxation ability in retaining nutrients, it is recommended to use a higher ratio of zeolite and infused application in a future research study.
3. The characterization phase for this development research must include Scanning Electron Microscopy Analysis (SEM) and Optical Microscopy. Analysis (OM).

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms contribution to the paper as follows: **study conception and design:** Zawati Harun, Wan Mohammad Hakim Wan Malik; **Preparation experiment:** Fazlannudin Hanur Harith, Anuar Ismail; **data collection:** Wan Mohammad Hakim Wan Malik; **analysis and interpretation of result:** Wan Mohammad Hakim Wan Malik, Faiz Hafeez Azhar; **draft manuscript preparation:** Wan Mohammad Hakim Wan Malik. All authors reviewed the result and approved the final version of the manuscript.

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