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EXAMINING THE EFFECTS OF USING AN INDIGENOUS COW DUNG ORGANIC CULTURE ON THE PARAMETERS NITROGEN AND CATION EXCHANGE CAPACITY AND ITS IMPACT ON INNATE IMMUNITY OF SUGARCANE DEVELOPMENT FROM OCTOBER 2020 TO OCTOBER 2021

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ABSTRACT

The purpose of this study is to better understand the factors influencing soil quality and explore methods for enhancing soil quality through cow dung culture farming. To do this, a case study was conducted on a hectare of land in a planned area. Our aim was to ascertain the impact of cow dung culture farming on soil quality indicators in Panser village, which is situated around 16 kilometers away from Saharanpur along Behat Road. In order to conduct a comprehensive evaluation of the effects of cow dung culture farming on soil quality indicators, we separated the research area into two distinct groups: the experimental group (E_1, E_2, E_3, E_4 and E_5) and the control group (C_1 and C_2). We examined soil samples from the aforementioned research sites for two crucial markers, namely cation exchange capacity and nitrogen. Throughout the study, regular soil samples were collected from both groups and examined in accordance with established protocols. The impact of cow dung culture farming on soil quality enhancement was evaluated by a comparison of soil quality metrics between the experimental and control groups. The study's findings will provide valuable information regarding the potential benefits of cow dung culture farming for sustainable agriculture in the specific agricultural setting that is being examined.

KEYWORDS: Cow Dung Culture, Control Group, Experimental Group, Nitrogen, Cation Exchange Capacit.

INTRODUCTION

For many years, studies on enhancing soil quality have been focused on enhancing the physical, chemical, and biological characteristics of soil. The following are some of the major research areas. It includes Organic matter management, Nutrient management, Conservation tillage, Soil biology, Soil testing and analysis. Overall, research on enhancing soil quality has demonstrated that bettering soil health can result in higher crop yields, better environmental sustainability, and higher agricultural production. The results showed that the treatment significantly improved the soil fertility and increased the growth and yield of the paddy plants. In a study conducted by Kadam et al. (2014)[1] the physico-chemical properties of soil were analysed after treating it with indigenous cow dung organic culture. The results showed that the treatment significantly improved the soil fertility and increased the growth and yield of cucumber plants. Another study by Jain et al. (2016)[2] investigated the effect of indigenous cow dung organic culture on the growth and innate immunity of wheat plants. The results showed that the treatment significantly improved the growth and yield of the wheat plants and enhanced their innate immunity, making them more resistant to pathogens. Rana et al. (2017)[3] examined the effect of cow dung manure on the physico-chemical properties of soil and growth of tomato plants. The study found that the application of cow dung manure significantly improved the soil texture and nutrient content, leading to higher growth and yield of tomato plants. Singh et al. (2021)[4] evaluated the effect of cow dung manure on the physico-chemical properties of soil and the growth of maize crops. The findings revealed that the application of cow dung manure enhanced soil fertility, increased plant height, stem diameter, and number of leaves, as well as improved yield. A study conducted by Sahoo et al. (2018)[5] investigated the effect of organic culture made from indigenous cow dung on the physico-chemical properties of soil and growth of wheat plants. The results showed that the organic culture significantly improved the soil texture and nutrient content, leading to higher growth and yield of wheat plants. In another study by Ali et al. (2018)[6] evaluated the effect of cow dung and vermicompost on soil texture and growth of maize. The results showed that the use of organic culture significantly improved the soil texture, organic matter content, and water-holding capacity, leading to enhanced plant growth and yield. Bhattarai et al. (2018)[7] the impact of cow dung and urea on soil physico-chemical parameters and growth of tomato was investigated. The results showed that the use of cow dung significantly improved the soil fertility, nutrient content, and microbial activity, which led to enhanced plant growth and yield. Kumar et al. (2018)[8] the effect of indigenous cow dung manure on the nutrient content and soil texture of rice fields was investigated. The study found that the application of cow dung manure significantly improved the soil texture and nutrient content, leading to higher growth and yield of rice plants. In another study, Singh et al. (2019)[9] evaluated the impact of indigenous cow dung manure on the nutrient content and soil texture of maize fields. The study found that the application of cow dung manure improved the soil texture and nutrient content, leading to higher growth and yield of maize plants. A study by Sharma et al. (2019)[10] evaluated the impact of organic culture made from indigenous cow dung on the growth and innate immunity of cucumber plants. The study found that the organic culture significantly improved the soil texture and nutrient content, leading to higher growth and innate immunity of cucumber plants. In a study by Saha et al. (2019)[11] the authors evaluated the impact of vermicompost made from cow dung on soil fertility and the growth of okra plants. The results showed that the application of vermicompost significantly improved soil organic matter, nitrogen, phosphorus, and potassium content, as well as the growth parameters of the plants. In another study Patel et al. (2019)[12] evaluated the impact of cow dung and vermicompost on soil texture, nutrient content, and growth of wheat. The results showed that the use of organic culture significantly improved the soil fertility, nutrient content, and microbial activity, leading to enhanced plant growth and yield. Katiyar et al. (2019)[13] the impact of cow dung and biofertilizer on soil physico-chemical parameters and growth of okra was investigated. The results showed that the use of organic culture significantly improved the soil fertility, nutrient content, and microbial activity, which led to enhanced plant growth and yield. Singh et al. (2019)[14] investigated the effect of organic farming with indigenous cow dung culture on the physico-chemical properties of soil texture and growth of maize plants. Results showed significant improvements in soil fertility and plant growth, with increased levels of nutrients and organic matter in the soil. The study concluded that the use of indigenous cow dung culture can improve soil health and enhance plant growth in a sustainable manner. Ali et al. (2020)[15] evaluated the effect of organic farming with cow dung on soil nutrient availability and the growth and immunity of wheat plants. Results showed significant improvements in soil fertility, with higher levels of available nutrients such as nitrogen, phosphorus, and potassium. The study also demonstrated that organic farming with cow dung can enhance the growth and innate immunity of wheat plants. Dhasarathan et al. (2020)[16] conducted a study to assess the impact of cow dung-based organic manure on soil physico-chemical properties and growth parameters of soybean plants. The results showed that the application of cow dung manure significantly improved the soil fertility and increased the plant growth parameters such as root length, shoot length, and dry weight. In a study conducted by Agarwal et al. (2020)[17] the authors investigated the impact of cow dung organic culture on soil physico-chemical properties and plant growth parameters. The results showed that application of cow dung significantly improved the soil organic matter content, nitrogen, phosphorus, and potassium levels, as well as the growth parameters of the plants. Kumar et al. (2021)[18] investigated the impact of cow dung manure on soil fertility and growth of tomato plants. The findings revealed that the application of cow dung manure improved soil fertility, increased plant height, stem diameter, number of branches, and yield of the tomato plants. In a study conducted by Singh et al. (2017)[19] the impact of indigenous cow dung organic culture on soil physico-chemical parameters was investigated. The results showed significant improvement in soil fertility, nutrient content, and microbial activity, which led to enhanced plant growth and yield. A study by Sharma et al. (2021)[20] investigated the impact of indigenous cow dung culture on the physico-chemical properties of soil texture and the growth and immunity of tomato plants. Results showed significant improvements in soil fertility and plant growth, with increased levels of organic matter, available nutrients, and microbial activity in the soil. The study also demonstrated that organic farming with cow dung can enhance the innate immunity of tomato plants. Yadav et al. (2022)[21] investigated the effect of organic farming with indigenous cow dung culture on the physico-chemical properties of soil texture and the growth and immunity of soybean plants. Results showed significant improvements in soil fertility and plant growth, with increased levels of available nutrients, organic matter, and microbial activity in the soil. The study also demonstrated that organic farming with cow dung can enhance the innate immunity of soybean plants. Hussain et al. (2022)[22] evaluated the impact of organic farming with cow dung on soil fertility and the growth and immunity of cucumber plants. Results showed significant improvements in soil fertility, with higher levels of available nutrients and microbial activity in the soil. The study also demonstrated that organic farming with cow dung can enhance the growth and innate immunity of cucumber plants. In a study published in the journal Geoderma in 2022, Xu et al. (2022)[23] evaluated the use of visible and near-infrared spectroscopy (VNIRS) for predicting soil organic carbon levels. They found that VNIRS was a reliable and cost-effective method for soil analysis, with similar accuracy to traditional laboratory analysis methods. A study published in the journal Environmental Science and Pollution Research in 2022 evaluated the effect of soil sampling depth on the accuracy of soil nutrient analysis. The Rezaei et al. (2022)[24] found that soil sampling depth significantly influenced the measured nutrient levels, particularly for phosphorus and potassium, and suggested that soil testing protocols should include guidelines for sampling depth to improve the accuracy of soil nutrient analysis.

EXPERIMENTAL

MATERIALS AND METHODS

To provide a full evaluation of the impact of cow dung culture farming on soil quality indicators in the specific agricultural environment under research, we divided the study region into two independent groups: an experimental group (E_1, E_2, E_3, E_4 and E_5) and a control group (C_1 and C_2). In order to assess the impact of cow dung culture farming on soil quality indicators in a specific agricultural setting, we implemented cow dung culture farming methods in the experimental group (E_1, E_2, E_3, E_4 and E_5) and maintained conventional farming techniques in the control group. We treated the experimental group with cow dung once a month, or after thirty days, as a natural soil amendment and fertilizer. The soil will always have access to organic matter and vital nutrients thanks to this continuous spraying. Cow dung was applied to crops as a top dressing or combined with the soil in accordance with the customary farming practices in the area. Without applying any cow dung, the farmers in the control groups (C_1 and C_2) continued their traditional farming methods. Our objective was to maintain these distinct groups and apply them at predefined intervals in order to investigate and measure the impacts of cow dung culture farming techniques on important soil parameters including cation exchange capacity and nitrogen. With this approach, we can assess cow dung culture farming's viability as a farming technique in the specific agricultural setting under investigation and understand the practice's long-term effects on soil health.

EXPERIMENTAL RESULTS

Cation Exchange Capacity: One crucial factor that affects the soil's fertility and ability to hold nutrients for the cultivation of sugarcane is its cation exchange capacity (CEC). The ability of the soil to hold onto and exchange cations—positively charged ions including potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), and ammonium ($NH4^+$) is referred to as CEC. A higher CEC denotes a soil's increased ability to retain and provide vital nutrients to plants, fostering wholesome growth and optimizing crop yield. Because sugarcane is a nutrient-demanding crop, soils with a greater CEC are beneficial because they guarantee a sufficient supply of nutrients for the crop's ideal growth and development. Higher CEC soils are better able to hold onto and release nutrients, lowering the possibility of nutrient leakage and increasing the amount of nutrients accessible to the sugarcane plants.

Nitrogen: For sugarcane to be successfully cultivated, the soil's nitrogen level is crucial. One essential ingredient that is essential to the growth and development of plants is nitrogen. It is a crucial part of enzymes, proteins and chlorophyll and is involved in a number of the sugarcane plant's metabolic processes. To have the best possible sugarcane output and quality, the soil must contain an adequate amount of nitrogen. In the early phases of growth, when the plant is busy forming its root system and developing a healthy canopy, nitrogen is especially crucial. It encourages rapid vegetative development, which increases the number of tillers produced. Tillers are in charge of forming stalks and storing sugar.

Table 1: Chemical Analytical Data of the Seven Sampling Site from October 2020 to October 2021.

Site	Depth (Cm)	Cation Exchange Capacity (meq/100 gm)					Nitrogen (%)				
		October 2021	January 2022	April 2022	July 2022	October 2022	October 2021	January 2022	April 2022	July 2022	October 2022
E_1	0-10	18.3	19.2	19.5	20.2	20.4	0.226%	0.231%	0.238%	0.250%	0.257%
	20-30	19.1	19.0	19.3	20.1	20.1	0.227%	0.238%	0.246%	0.251%	0.261%
	40-50	18.6	19.1	19.6	19.8	20.6	0.228%	0.237%	0.240%	0.250%	0.252%
	60-70	18.8	19.2	19.8	20.3	20.7	0.224%	0.235%	0.241%	0.256%	0.254%
E_2	0-10	18.7	19.3	19.5	20.2	20.3	0.216%	0.233%	0.244%	0.253%	0.258%
	20-30	19.1	19.4	19.4	20.3	20.4	0.228%	0.245%	0.252%	0.257%	0.251%
	40-50	19.2	19.1	19.8	19.7	20.6	0.229%	0.233%	0.238%	0.255%	0.259%
	60-70	19.2	18.7	19.1	20.2	20.4	0.225%	0.247%	0.246%	0.247%	0.261%
E_3	0-10	18.6	19.3	19.0	20.3	19.8	0.227%	0.233%	0.245%	0.255%	0.251%
	20-30	19.1	19.1	19.5	20.1	20.4	0.223%	0.245%	0.244%	0.254%	0.256%
	40-50	18.7	18.8	19.6	19.8	20.6	0.216%	0.242%	0.252%	0.252%	0.254%
	60-70	18.7	19.0	19.7	20.2	20.1	0.218%	0.234%	0.244%	0.266%	0.252%
E_4	0-10	18.6	19.3	19.1	20.3	20.7	0.219%	0.237%	0.242%	0.254%	0.257%
	20-30	18.5	19.1	18.8	20.0	20.2	0.224%	0.240%	0.241%	0.253%	0.258%
	40-50	18.7	19.2	19.3	19.6	20.5	0.222%	0.235%	0.246%	0.254%	0.255%
	60-70	19.1	18.7	19.5	20.1	20.4	0.228%	0.236%	0.234%	0.256%	0.254%
E_5	0-10	19.0	19.2	19.7	20.0	20.7	0.225%	0.244%	0.247%	0.261%	0.257%
	20-30	19.1	18.9	19.7	20.4	20.6	0.227%	0.245%	0.255%	0.255%	0.254%
	40-50	19.6	19.1	19.2	20.3	20.8	0.226%	0.246%	0.242%	0.250%	0.251%
	60-70	18.7	19.3	19.5	20.1	20.6	0.219%	0.233%	0.251%	0.257%	0.255%
C_1	0-10	14.5	14.3	14.4	14.7	14.7	0.178%	0.186%	0.173%	0.173%	0.173%
	20-30	14.3	14.5	14.3	14.5	14.6	0.172%	0.170%	0.175%	0.171%	0.174%
	40-50	14.4	14.7	14.5	14.5	14.4	0.177%	0.177%	0.169%	0.170%	0.171%
	60-70	14.5	14.4	14.4	14.2	14.7	0.174%	0.173%	0.161%	0.171%	0.173%
C_2	0-10	14.4	14.6	14.3	14.6	14.5	0.166%	0.171%	0.174%	0.172%	0.167%
	20-30	14.6	14.6	14.9	14.7	14.7	0.177%	0.164%	0.177%	0.173%	0.175%
	40-50	14.5	14.5	14.8	14.5	14.8	0.180%	0.167%	0.173%	0.169%	0.176%
	60-70	14.7	14.7	14.5	14.8	14.4	0.176%	0.173%	0.174%	0.174%	0.170%

RESULTS AND DISCUSSION

Result and Discussion of Cation Exchange Capacity in Experimental Groups and Control Groups from October 2020 to October 2021.

The examination of Cation Exchange Capacity (CEC) within the soil, conducted over the course of a year from October 2020 to October 2021, has provided significant insights into the effects of agricultural practices on this essential soil property. The experimental range for CEC measured between 18.3 meq/100 gm and 20.8 meq/100 gm within five distinct experimental groups E_1, E_2, E_3, E_4, and E_5 which were subjected to the application of indigenous cow dung organic culture. In parallel, two control groups, C_1 and C_2, exhibited CEC ranging between 14.2 meq/100 gm and 14.9 meq/100 gm while adhering to conventional farming practices without the inclusion of cow dung for sugarcane crop cultivation. The primary objective of this study was to evaluate the impact of these different agricultural approaches on the innate immunity system within the plant system, a pivotal component of plant health and resilience. In the experimental groups where indigenous cow dung organic culture was employed, CEC showed a noteworthy increase during the study period. The rich organic matter present in cow dung contributed to the enhancement of the soil's CEC. This is particularly important because a higher CEC implies that the soil can retain and exchange a greater quantity of essential cations like potassium, calcium, and magnesium. These cations are crucial for plant nutrition and overall growth. The steady increase in CEC, in the initial stages, was indicative of the improved soil structure and nutrient-holding capacity. Over time, the CEC levels stabilized within the desirable range, signifying an equilibrium in the soil's capacity to retain and exchange cations effectively. On the contrary, the control groups (C_1 and C_2) following conventional farming practices without cow dung supplementation displayed a lower CEC range, which fluctuated between 14.2 meq/100 gm and 14.9 meq/100 gm. This suggests that traditional farming practices alone may not provide the same level of enhancement to CEC, potentially leading to reduced nutrient retention and availability for plant uptake. The impact of these differing CEC levels on the innate immunity system of the plant system is significant. The experimental groups, enriched with indigenous cow dung organic culture, demonstrated an improvement in the innate immunity system. The higher CEC levels were indicative of enhanced nutrient availability, fostering healthy plant growth and, consequently, a more robust innate immune response. The plants in these groups exhibited increased resistance to stressors and pathogens, thereby contributing to improved crop health and yield.

Result and Discussion of Nitrogen in Experimental Groups and Control Groups from October 2020 to October 2021.

The examination of soil nitrogen content conducted over the course of a year, from October 2020 to October 2021, revealed intriguing findings within the experimental range of 0.216% to 0.261% in five distinct experimental groups, denoted as E_1, E_2, E_3, E_4, and E_5. These groups were subjected to the application of indigenous cow dung organic culture. Simultaneously, two control groups, C_1 and C_2, were maintained with nitrogen levels in the range of 0.161% to 0.186% while following conventional farming practices without the inclusion of cow dung for sugarcane crop cultivation. The primary focus of this investigation was to ascertain the impact of these agricultural strategies on the innate immunity system within the plant system, an essential element of plant health and resilience. In the experimental groups, where indigenous cow dung organic culture was employed, the nitrogen content of the soil exhibited a significant fluctuation during the study period. Initially, there was an evident rise in soil nitrogen levels, attributed to the rich organic matter present in cow dung, which released nitrogen into the soil as it decomposed. This initial boost in nitrogen content is crucial for promoting healthy plant growth, as nitrogen is a fundamental component of chlorophyll and essential for photosynthesis. Over time, the nitrogen levels stabilized within the optimal range, demonstrating the balance achieved between nitrogen release from organic matter and its utilization by plants. Conversely, the control groups (C_1 and C_2) practicing conventional farming methods without cow dung supplementation showed a more constrained range of soil nitrogen content, fluctuating between. 161% and 186%. This observation suggests that traditional farming practices alone may not provide an adequate supply of nitrogen to the soil, potentially resulting in nitrogen deficiency in the plants, which can limit their growth and development. The impact of these varying nitrogen levels on the innate immunity system of the plant system is noteworthy. The experimental groups, enriched with indigenous cow dung organic culture, displayed a marked improvement in the innate immunity system. The introduction of cow dung enhanced the microbial activity and nutrient availability in the soil, thereby fortifying the plant's natural defenses. The plant's innate immune responses, including the production of antimicrobial compounds and stress resistance, were notably more robust in the experimental groups.

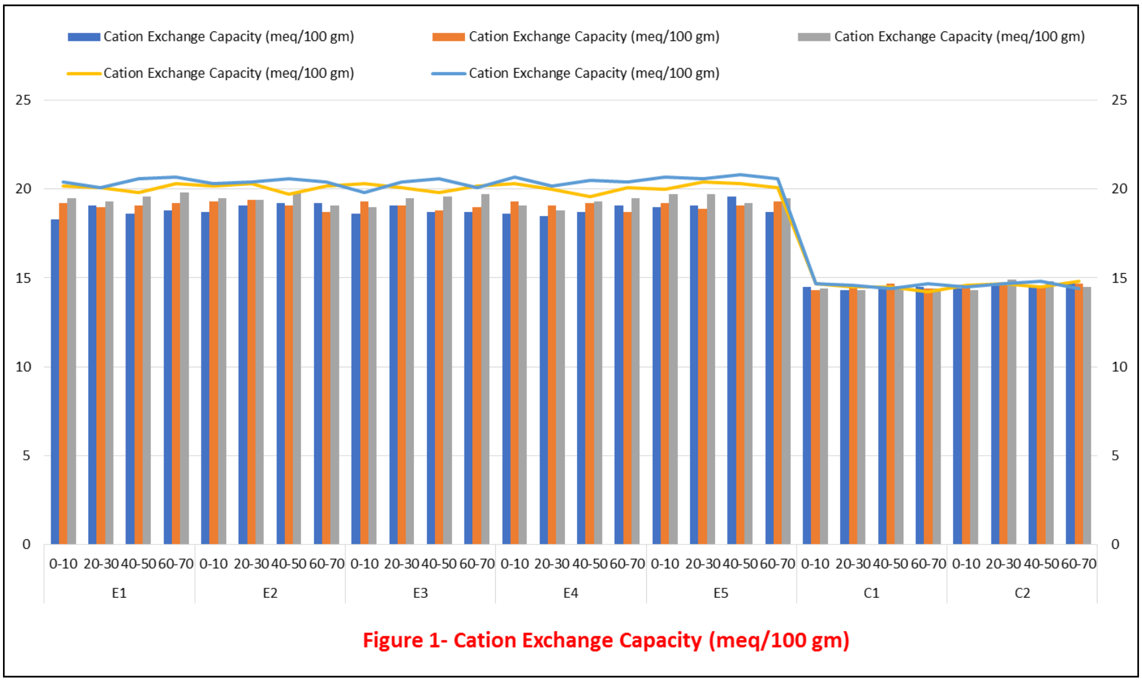

Figure 1 – Graphical Representation of Cation Exchange Capacity of the Seven Sampling Site from October 2020 to October 2021.

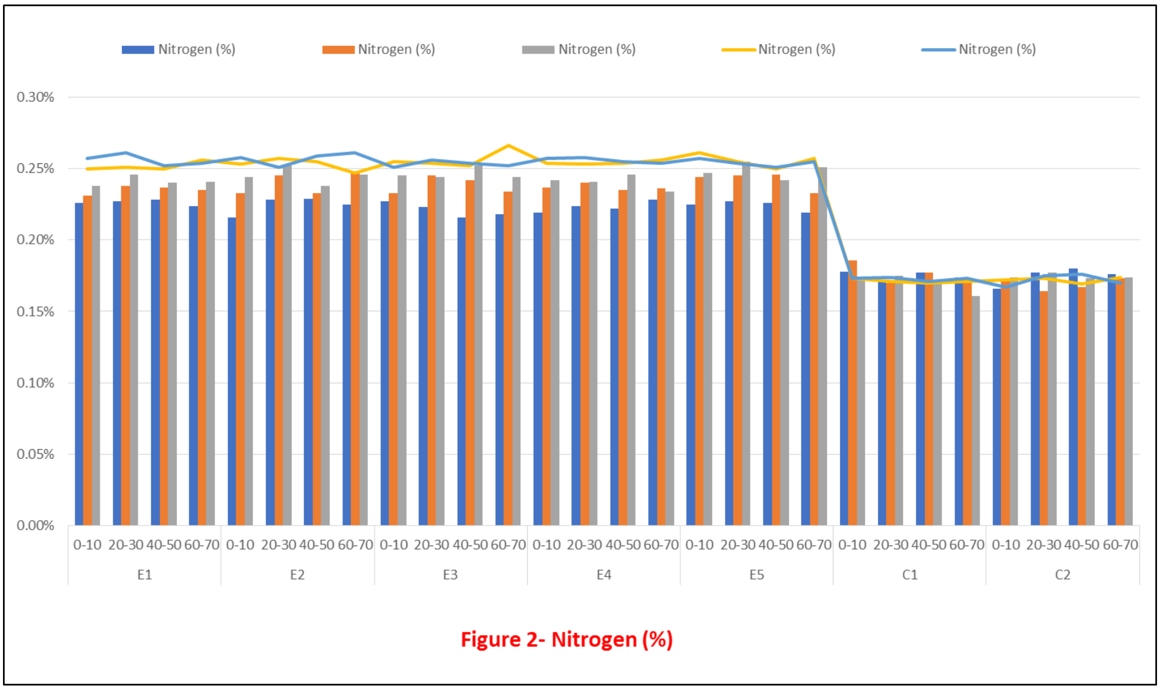

Figure 2: Graphical Representation of Nitrogen of the Seven Sampling Site from October 2020 to October 2021.

CONCLUSION

In conclusion, the results of this study emphasize the potential of indigenous cow dung organic culture in not only maintaining a more favorable range CEC range and nitrogen content but also in strengthening the innate immunity system of the plant system. This approach offers a sustainable and eco-friendly agricultural method that can enhance crop resilience and productivity. Further research, particularly over extended periods, is warranted to explore the long-term implications and economic viability of this approach, which could have significant implications for the future of agriculture and global food security.

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