

ENHANCING SUGARCANE DEVELOPMENT AND INNATE IMMUNITY THROUGH INDIGENOUS COW DUNG ORGANIC CULTURE: A STUDY ON SOIL PH AND SOIL MOISTURE

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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 Daudpura village, which is situated around 15 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 (E₁, E₂, E₃, E₄ and E₅) and the control group (C₁ and C₂). We examined soil samples from the aforementioned research sites for two crucial markers, namely soil moisture and pH. 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, Soil Moisture, pH.

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. "Organic matter management in agriculture: a multidisciplinary approach to address climate change" by Lal (2021)^[1]. This review article discusses the role of organic matter management in mitigating climate

change, as well as its importance for soil health, food security, and sustainable agriculture.

Another study by Liu et al. (2020)^[2] evaluated the effect of different nutrient management practices on crop yield and soil carbon sequestration. The study found that combining organic and inorganic fertilizers with no-tillage management increased crop yield and soil carbon sequestration.

Yang et al. (2017)^[3] investigated the effects of long-term fertilizer application on soil fertility and crop yield. The study found that using a balanced nutrient management approach resulted in increased soil fertility, improved crop yield, and reduced nutrient loss.

Tiwari et al. (2015)^[4], the authors evaluated the impact of conservation tillage on soil carbon sequestration and

crop yield in India. The results showed that conservation tillage increased soil carbon sequestration and led to higher crop yields compared to conventional tillage. The authors suggested that conservation tillage could be an effective tool for mitigating climate change and enhancing food security in the region.

Bardgett *et al.* (2018)^[5] examines the relationship between soil biodiversity and ecosystem services, including soil fertility, carbon sequestration, and disease suppression. The authors discuss the importance of maintaining soil biodiversity for sustainable agriculture and highlight the need for further research to better understand the links between soil biodiversity and ecosystem services. Singh *et al.* (2019)^[6] studied the Impact of land use on soil microbial communities which discusses the impact of land use on soil microbial communities and their functions, including nutrient cycling, organic matter decomposition, and disease suppression.

Assessment of Soil Nutrient Status in Different Soil Series of Gobichettipalayam Taluk, Erode District, Tamil Nadu, India by Ramesh *et al.* (2018)^[7] evaluated the nutrient status of soils in different soil series in the Gobichettipalayam Taluk region of Tamil Nadu, India. The study analysed soil samples for various macro and micronutrients and found significant variations in nutrient levels among the different soil series, highlighting the importance of targeted soil testing and analysis. Comparison of Soil Testing Methods for Soil Nutrient Analysis in a Tea Growing Area of Southwestern China by Xiong *et al.* (2019)^[8] compared the effectiveness of different soil testing methods for soil nutrient analysis in a tea growing area of southwestern China. The study found that the Mehlich 3 method was the most effective for predicting soil nutrient availability and optimizing fertilizer application in the region. Hao *et al.* (2019)^[9] highlighted the application of machine learning techniques in soil analysis and modelling, including soil classification, soil fertility prediction, and soil nutrient management. The paper discussed the potential of machine learning to improve the accuracy and efficiency of soil analysis and modelling. New developments in soil testing for heavy metal contamination by Xue *et al.* (2018)^[10] discussed new developments in soil testing for heavy metal contamination, including X-ray fluorescence (XRF), atomic absorption spectroscopy (AAS), and inductively coupled plasma mass spectrometry (ICP-MS).

Chai *et al.* (2019)^[11] found that some methods, such as Mehlich3 and Bray P-1, produced more consistent results than others, and that the accuracy of the methods varied depending on the nutrient being measured. A review article published in the journal *Soil Use and Management* in 2020 discussed the importance of soil testing in sustainable soil management. Hannam *et al.* (2020)^[12] emphasized the need for regular soil testing to monitor soil health and nutrient levels, and also

discussed new technologies and techniques for soil analysis, such as hyperspectral imaging and soil DNA sequencing. A study published in the journal *Agriculture* in 2021 evaluated the accuracy of portable soil testing devices for measuring soil nitrogen, phosphorus, and potassium levels. Sarmadian *et al.* (2021)^[13] found that while the portable devices were less accurate than traditional laboratory analysis, they still provided useful information for making fertilizer recommendations in the field. In a study published in the journal *Geoderma* in 2022, Xu *et al.* (2022)^[14] evaluated the use of visible and near-infrared spectroscopy (VNIRS) for predicting soil organic carbon levels. The Rezaei *et al.* (2022)^[15] 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.

A Review of Soil Testing and Analysis Techniques for Precision Agriculture by Sarah *et al.* (2020)^[16] discussed different soil testing and analysis techniques used in precision agriculture. It covers topics such as soil sampling methods, soil nutrient analysis, and remote sensing techniques for soil analysis. Assessment of Soil Properties and Heavy Metal Contamination in Agricultural Soils Using Portable X-ray Fluorescence Spectroscopy by Gao *et al.* (2021)^[17] evaluated the use of portable X-ray fluorescence spectroscopy for assessing soil properties and heavy metal contamination in agricultural soils. Evaluation of Soil Health Indicators in Organic and Conventional Farming Systems by Dungait *et al.* (2022)^[18] evaluated soil health indicators in organic and conventional farming systems.

Singh *et al.* (2021)^[19] 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. Dhasarathan *et al.* (2020)^[20] 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. Kumar *et al.* (2021)^[21] 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. Ali *et al.* (2020)^[22] evaluated the effect of organic farming with cow dung on soil nutrient availability and the growth and immunity of wheat plants. A study by Sharma *et al.* (2021)^[23] 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. Hussain *et al.* (2022)^[24] 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. Yadav *et al.* (2022)^[25] 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.

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 (E₁, E₂, E₃, E₄ and E₅) and a control group (C₁ and C₂). 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 (E₁, E₂, E₃, E₄ and E₅) 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 (C₁ and C₂) 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 soil

moisture and pH. 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

Soil Moisture

Soil moisture is a critical factor for the successful cultivation of sugarcane. Sugarcane requires a sufficient and well-maintained soil moisture level throughout its growth stages to ensure optimal plant growth, development and high yields. The ideal soil moisture conditions for sugarcane involve providing adequate water while preventing water stress or waterlogging. Sugarcane plants have deep and extensive root systems, allowing them to access moisture from deeper soil layers. However, it is essential to ensure a consistent supply of water to the root zone, especially during critical growth stages. Irrigation plays a crucial role in managing soil moisture for sugarcane crops. Regular monitoring of soil moisture levels is necessary to maintain the optimal balance.

pH

The pH level of the soil plays a crucial role in sugarcane cultivation, as it directly influences nutrient availability, microbial activity, and overall plant growth and development. The pH scale ranges from 0 to 14, with values below 7 indicating acidic conditions, values above 7 indicating alkaline conditions, and a pH of 7 representing neutral soil. For sugarcane cultivation, the optimal pH range is typically between 6 and 7.5 which is slightly acidic to near-neutral. Within this range, the soil provides favorable conditions for nutrient uptake by the sugarcane plants. It allows for the efficient availability and absorption of essential macronutrients (nitrogen, phosphorus, and potassium) as well as micronutrients required for healthy growth. Acidic soils with a pH below 6 can present challenges for sugarcane cultivation. In such conditions, there may be increased solubility of certain toxic elements like aluminum and manganese, leading to their accumulation in the soil. This can hinder root development and nutrient uptake, resulting in stunted growth and reduced crop productivity. Lime application can be used to raise the pH of acidic soils and create a more favorable environment for sugarcane growth.

Chemical Analytical Data of the Seven Sampling Site from October 2021 to October 2022

Table 1.

Site	Depth (Cm)	Soil Moisture					pH				
		October 2021	January 2022	April 2022	July 2022	October 2022	October 2021	January 2022	April 2022	July 2022	October 2022
E ₁	0-10	41%	43%	47%	49%	48%	6.45	6.48	6.41	6.45	6.49
	20-30	41%	44%	46%	47%	49%	6.39	6.34	6.39	6.46	6.46
	40-50	39%	41%	44%	47%	49%	6.38	6.29	6.38	6.41	6.48
	60-70	43%	40%	45%	40%	43%	6.35	6.31	6.41	6.45	6.45
E ₂	0-10	41%	44%	47%	44%	44%	6.36	6.26	6.39	6.40	6.47

	20-30	42%	42%	45%	46%	42%	6.39	6.27	6.36	6.46	6.44
	40-50	39%	46%	39%	40%	43%	6.42	6.37	6.37	6.43	6.42
	60-70	40%	43%	39%	47%	44%	6.39	6.29	6.38	6.39	6.46
E ₃	0-10	42%	43%	43%	39%	42%	6.37	6.32	6.39	6.44	6.47
	20-30	40%	42%	46%	47%	45%	6.39	6.34	6.34	6.41	6.49
	40-50	41%	45%	44%	49%	41%	6.38	6.38	6.37	6.45	6.38
	60-70	42%	39%	46%	43%	46%	6.40	6.37	6.39	6.38	6.42
E ₄	0-10	41%	39%	41%	41%	47%	6.41	6.32	6.34	6.39	6.41
	20-30	42%	41%	40%	44%	48%	6.45	6.30	6.36	6.38	6.45
	40-50	41%	46%	45%	46%	43%	6.36	6.33	6.36	6.37	6.46
	60-70	42%	38%	39%	44%	42%	6.37	6.27	6.38	6.39	6.47
E ₅	0-10	40%	39%	44%	42%	44%	6.39	6.29	6.34	6.38	6.39
	20-30	41%	45%	46%	45%	48%	6.38	6.31	6.37	6.40	6.41
	40-50	43%	41%	43%	39%	43%	6.40	6.27	6.36	6.42	6.40
	60-70	39%	43%	47%	46%	46%	6.44	6.29	6.38	6.42	6.43
C ₁	0-10	26%	25%	26%	27%	28%	5.78	5.80	5.81	5.77	5.82
	20-30	25%	26%	27%	29%	25%	5.68	5.81	5.79	5.81	5.78
	40-50	25%	25%	29%	27%	27%	5.76	5.84	5.87	5.82	5.75
	60-70	27%	28%	28%	24%	29%	5.77	5.88	5.82	5.80	5.73
C ₂	0-10	27%	27%	26%	28%	26%	5.69	6.15	5.84	5.79	5.69
	20-30	23%	28%	29%	26%	28%	5.73	5.91	5.82	5.77	5.53
	40-50	25%	26%	26%	28%	26%	5.75	5.88	5.84	5.77	5.76
	60-70	26%	27%	29%	27%	29%	5.77	5.89	5.82	5.75	5.77

RESULTS AND DISCUSSION

Result and Discussion of Soil Moisture in Experimental Groups and Control Groups from January 2022 to October 2022

The results of our soil moisture content analysis reveal intriguing trends in both the experimental and control groups over a three-year period, from October 2019 to October 2022. These investigations were conducted to assess the impact of indigenous cow dung organic culture compared to conventional farming practices, without the addition of cow dung, on soil moisture levels and their subsequent influence on the innate immunity system of sugarcane crops.

In the five experimental groups (E₁, E₂, E₃, E₄ and E₅) the soil moisture content exhibited significant variations. During the initial assessment period from October 2019 to October 2020, soil moisture content ranged from 22 % to 42 %. This wide range indicates fluctuating moisture levels, possibly due to variations in precipitation, irrigation practices, and the use of organic culture. Subsequently, from January 2021 to October 2021, the moisture content range narrowed to 30 % to 43 %, suggesting a trend towards improved moisture retention in the soil. The most substantial shift was observed during the final period, January 2022 to October 2022, where the moisture content ranged from 38 % to 49 %. This significant increase can be attributed to the consistent application of indigenous cow dung organic culture, which not only enriches the soil but also enhances its water-holding capacity.

Conversely, the control groups (C₁ and C₂) practicing conventional farming without cow dung, displayed minimal variation in soil moisture content. Over the

three-year span, the moisture content remained relatively stable, ranging between 23 % and 29 % during all assessment periods. This indicates that conventional farming practices alone had little impact on altering soil moisture levels. The absence of significant changes in the control groups underscores the importance of organic culture in enhancing soil moisture content, which can be vital for plant health and growth.

These findings have direct implications for the innate immunity system of sugarcane crops in both sets of groups. Soil moisture content plays a critical role in plant stress response and immune system activation. In the experimental groups, the improved moisture retention can contribute to better overall plant health and may stimulate a more robust innate immunity system. In contrast, the control groups, with their relatively unchanged moisture levels, may not provide the same favorable conditions for the development of a strong innate immunity system in sugarcane crops.

Result and Discussion of pH in Experimental Groups and Control Groups from January 2022 to October 2022:

The results of our soil pH analysis reveal notable variations in pH levels within the experimental and control groups over a three-year period, from October 2019 to October 2022. This study aimed to assess the impact of indigenous cow dung organic culture compared to conventional farming practices, without the addition of cow dung, on soil pH and its subsequent influence on the innate immunity system of sugarcane crops.

In the five experimental groups (E₁, E₂, E₃, E₄ and E₅)

the soil pH exhibited a consistent increasing trend over the study period. During the initial assessment period from October 2019 to October 2020, pH levels ranged from 5.32 to 6.38. Subsequently, from January 2021 to October 2021, pH levels increased further, with a range of 6.17 to 6.45. The most significant change was observed during the final period, from January 2022 to October 2022, where pH levels ranged from 6.26 to 6.49. This substantial increase in soil pH can be attributed to the consistent application of indigenous cow dung organic culture, which likely acted as a pH buffer and improved soil alkalinity.

Conversely, the control groups (C₁ and C₂) practicing conventional farming without cow dung, displayed relatively stable soil pH levels. Over the three-year span, pH levels remained consistent, ranging between 5.63 and 6.12 during the initial period and 5.53 to 6.15 during the final assessment period, from January 2022 to October

2022. This stability indicates that conventional farming practices alone had limited impact on altering soil pH levels. The absence of significant changes in the control groups underscores the importance of organic culture in influencing soil pH.

These findings have direct implications for the innate immunity system of sugarcane crops in both sets of groups. Soil pH plays a crucial role in nutrient availability and microbial activity, and changes in pH can impact plant health and immune responses. In the experimental groups, the observed increase in soil pH is likely to have a positive impact on the innate immunity system of sugarcane crops, making them more resilient to stressors. In contrast, the control groups, with their relatively stable pH levels, may not provide the same conducive environment for the development of a robust innate immunity system in sugarcane crops.

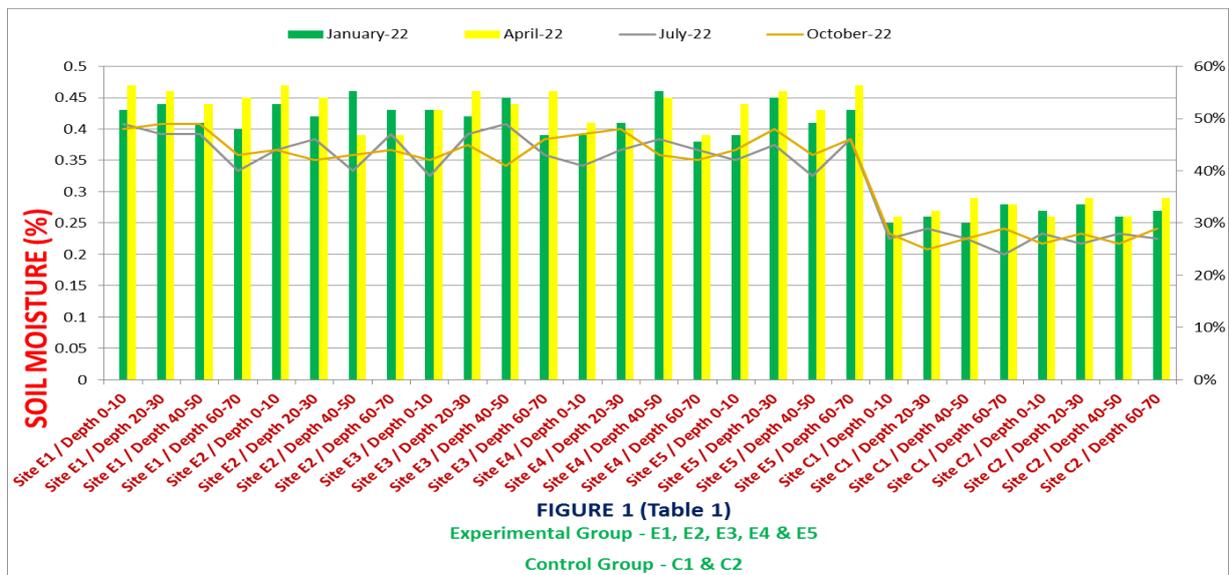


Figure 1 – Graphical Representation of Cation Exchange Capacity of the Seven Sampling Site from October 2020 to October 2021:

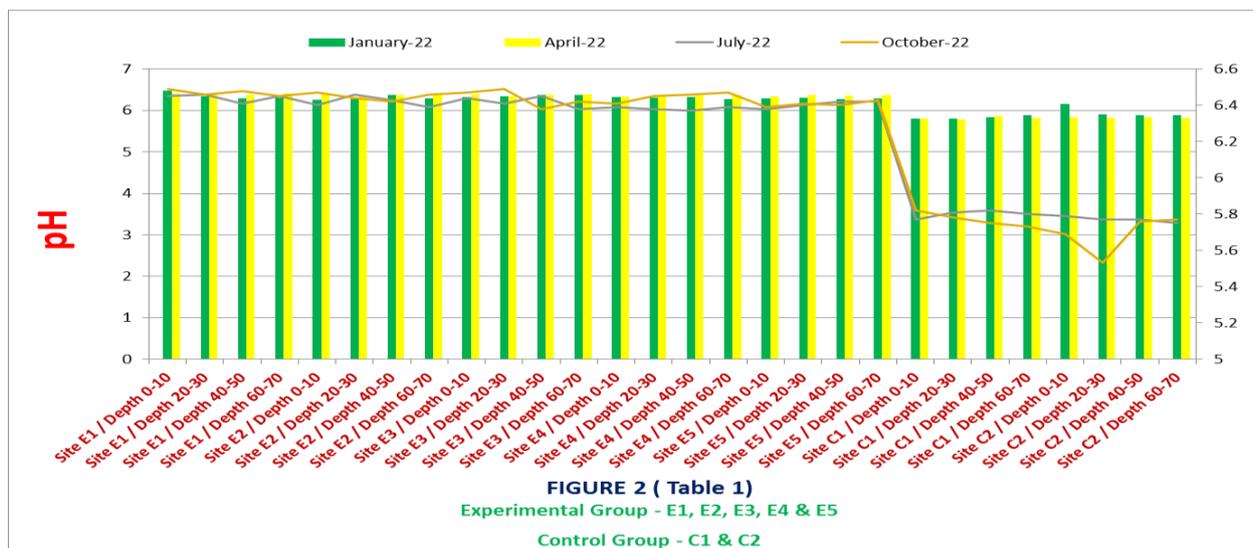


Figure 2: Graphical Representation of Nitrogen of the Seven Sampling Site from October 2020 to October 2021.

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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