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MORALITY BEFORE KNOWLEDGE

The application of zeolite in reducing green house gases in agriculture field

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ABSTRACT

Background: The addition of Zeolite 4A affected cumulative greenhouse emissions from rice. Zeolite 4A has been found to adsorb CH4 and CO2, reducing overall emissions. The combination of zeolite and fertilizer administration in one or two applications provided an anti-synergistic effect. **Methods:** The chemical fertilizers and sustained release organic fertilizers used were 16200, 4600 and 666, respectively, and the amount was 31.25 gm2. **Findings:** Higher fertilization stimulated harvesting, resulting in higher yields and higher proportions of good grain, but less efficient GHG reductions. The ratio of zeolite 4A to fertilizer should be higher than 3: 1 to reduce the increase in greenhouse gas emissions from the use of fertilizer. This treatment resulted in an emission reduction efficiency of 34.69% in proportion to 21.62 g CO2eq m2 g1 zeolite. **Conclusion:** In the current study, two applications, fertilizer and zeolite 4A, showed the best performance in reducing emissions. However, it is advisable to increase the ratio of zeolite to fertilizer. Similarly, sustained release organic fertilizers resulted in increased CH4 emissions due to the action of methanogens on organic matter. However, plant growth, good grain proportions, and total grain yields increased. Further research is recommended to investigate the optimal ratio of zeolite 4A to organic and synthetic fertilizers for rice cultivation.

KEYWORDS: agriculture; application; green house; zeolite.

1. Introduction

It seems like you've provided information on the greenhouse gas emissions from various sectors in a particular country, along with the percentages of total emissions attributed to each sector. Here's a breakdown of the information: Energy Sector (Emissions: 256.44 million tons of CO2eq), (Percentage of Total Emissions: 73.13%); Agriculture, Forestry, and Land Use (Emissions: 55.71 million tons of CO2eq), (Percentage of Total Emissions: 15.89%); Industrial Process and Product Use: (Emissions: 33.50 million tons of CO2eq), (Percentage of Total Emissions: 9.55%); and Waste Management Sector (Emissions: 5.03 million tons of CO2eq), Percentage of Total Emissions: 1.43%.

These figures provide a comprehensive overview of the major contributors to greenhouse gas emissions in the country, with the energy sector being the primary source. The data seems to be in line with global concerns about the impact of energy production on climate change. It suggests that efforts to reduce overall emissions should focus on measures within the energy sector, as well as addressing emissions from agriculture,

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forestry, land use, industrial processes, and waste management. This information can be valuable for policymakers, environmental organizations, and industries to develop targeted strategies for emission reduction and sustainable development.

It seems like you've provided information about how agriculture, forestry, and land use contribute to both carbon dioxide (CO2) emissions and the sequestration of greenhouse gases (GHGs). Here's a breakdown of the information you provided: CO2 Sequestration through Biomass Accumulation: (Agriculture, forestry, and land use play a role in binding CO2 through the accumulation of biomass), In 2012, forest areas and perennial plantations (such as oil palm, rubber, and fruit plantations) combined to accumulate 122.95 million tonnes of CO2eq (carbon dioxide equivalent); Net GHG Isolation: (After deducting emissions, this sector is responsible for the net GHG isolation of 67.25 million tonnes of CO2eq), This indicates that, overall, the sector has a positive impact on reducing the net release of greenhouse gases; GHG Emissions in Different Sectors: (Carbon dioxide (CO2) is identified as the largest greenhouse gas (GHG) emission in the energy sector), (Methane (CH4) dominates emissions from agriculture and livestock), (Nitrous oxide (N2O) dominates emissions related to soil management).

In summary, while the agriculture, forestry, and land use sector does contribute to GHG emissions, it also plays a crucial role in sequestering carbon through biomass accumulation. The net effect, as of 2012, is a positive impact on reducing overall greenhouse gas release. Additionally, the breakdown of GHG emissions in different sectors highlights the importance of addressing specific gases and sources to effectively mitigate climate change.

Your statement provides a comprehensive overview of the greenhouse gas (GHG) emissions associated with rice cultivation, particularly focusing on methane (CH4) and nitrous oxide (N2O) emissions. The major contributors to these emissions are flooded soils, organic and synthetic nitrogen fertilizers, and various agricultural practices. Here's a breakdown of the key points in your statement: Methane Emissions: (Mainly generated from anaerobic decomposition in flooded soils), (Factors contributing to methane emissions include floods, soil organic matter, designer stubble, anaerobic decomposition of straw, and the application of organic fertilizers), (Release of methane occurs during plantations and transplants, reaching approximately 48 g CH4 m2 at harvest); Nitrous Oxide Emissions: (Primarily associated with the use of nitrogen fertilizers), (Nitrous oxide is produced through nitrification and denitrification reactions), (Nitrification process involves the reduction of urea fertilizer in the soil to nitrates and nitrites, and then to ammonia, nitrogen, or nitrous oxide), (Nitrous oxide release occurs at a rate of approximately 1.6 g N2O m2 during growth and drainage, reaching a total of 476.8 g CO2 eq m2 at harvest); Overall GHG Emissions: (Greenhouse gas emissions from rice cultivation are highly dependent on water management and nitrogen fertilizer use), (The total GHG emissions for rice cultivation are estimated to be 1,676.8 g CO2 eq m2, with methane and nitrous oxide contributing significantly); and Impact of Emissions: (The statement emphasizes the environmental impact of rice cultivation, with emissions calculated in terms of carbon dioxide equivalent (CO2 eq) per unit of rice yield (kg CO2 eq kg1 rice).

To address the environmental challenges associated with rice cultivation, it may be crucial to explore and adopt sustainable agricultural practices, improve water management techniques, and develop efficient nitrogen fertilizer application strategies to minimize greenhouse gas emissions (Sa'adawisna & Putra, 2023).

Yes, you've provided an accurate description of some of the beneficial properties of zeolite in agriculture. Zeolites are natural or synthetic minerals with a porous structure and a high capacity for ion exchange. Here are some key points to elaborate on the uses of zeolite in agriculture: Nutrient Retention: Zeolites can adsorb and release nutrients, helping to prevent the leaching of essential minerals from the soil. This property is particularly useful in areas with high rainfall, where nutrients may be easily washed away; Cation Exchange Capacity (CEC): The high cation exchange capacity of zeolites allows them to hold onto and exchange positively charged ions (cations) such as potassium, calcium, and magnesium. This enhances the soil's ability to retain nutrients and make them available to plants; Water Retention: Zeolites' porous structure enables them to absorb and retain water, making them valuable in both water-scarce and waterlogged conditions. This can contribute to improved water management in agriculture; pH Buffering: Zeolites have a buffering capacity that helps stabilize soil pH. This is crucial for maintaining an optimal pH range for plant growth, as fluctuations in soil pH can affect nutrient availability; Fertilizer Carrier: Zeolites can be used as carriers for nitrogen (N) and potassium (K) fertilizers. This allows for controlled release of these nutrients over time, reducing the risk of nutrient runoff and improving their efficiency; Soil Structure Improvement: The addition of zeolites can enhance soil structure, promoting better aeration and root development. Improved soil structure also facilitates water infiltration and drainage; and Reduced Environmental Impact: By preventing nutrient leaching and enhancing nutrient efficiency, zeolites contribute to sustainable agriculture practices by reducing the environmental impact associated with fertilizer use (Putra et al., 2021).

It's worth noting that the specific benefits of using zeolites may vary depending on factors such as soil type, climate, and the crops being cultivated. Nonetheless, the properties you've highlighted make zeolites a valuable soil amendment in various agricultural settings.

2. Methods

The chemical fertilizers and sustained release organic fertilizers used were 16200, 4600 and 666, respectively, and the amount was 31.25 gm2. Rice (variety RD41) was cultivated with a seed yield of 15.625 g m2 and was harvested 105 days later. The harvested grains were then sun-dried for 3 days.

2.1 Properties of Zeolite

Zeolite 4A is an alkaline aluminosilicate, a sodium type with a zeolite type A crystal structure. The effective pore diameter is about 4, and the cation exchange capacity is large. It can effectively adsorb chemicals such as oxygen, nitrogen and carbon dioxide, cations such as NH4 +, K + and Ca2 +, and linear hydrocarbons such as methane. Table 1 shows the characteristics and characteristics of commercially available zeolite 4A.

2.2 Gas Analysis

The quality and quantity of CO2, CH4 and N2O were analyzed by gas chromatography (GC) using the Shimadzu 2014 model. The carrier gas used was helium gas, which was passed through a Unibeads CGC column. The injector, column, and thermal conductivity detector (TCD) temperatures were set to 150 ° C, 230 ° C, and 130 ° C, respectively. Sample chromatograms (Figure 2c) show CH4 and CO2 chromatograms at 3,370 and 5,843 minutes, respectively. The reduction in GHG emissions was determined in the form of reduced emission efficiency and percentage per gram of zeolite.

Table 1. Properties and characteristic of commercial zeolite 4A

Properties	Unit	Specificator
Diameter	mm	1.7
Bulk Density	g/cm^3	>0.72
Pore Diameter	A	4
Pore Volume	cm^3/g	0.45
Porosity	%	0.55
Crushing Strength	N	>35
Attrition	Wt%	7.35
Moisture	Wt%	<1
Adsorption	gH_2o 100g^1 zeolite	>22
Capacity	g methanol 100g^1 zeolite	>11

Cation Exchange Capacity (CEC)	meq 100g1 zeolite	738-797

3. Result and Discussion

The results show the effectiveness of zeolite 4A in adsorbing CH4 and CO2. The mineral structure can be adjusted to specifically adsorb various gases, which may further improve efficiency. Adsorption is carried out via a physicochemical mechanism, both CO2 and CH4 are adsorbed on the zeolite's porous matrix via the physical mechanism, and CO2 gas also reacts with the cations adsorbed on the zeolite as a chemical mechanism.

Statistical analysis shows that treatments with fertilizers show significantly different results for GHG emissions, both in terms of emission reductions and emissions. We found that controls were higher than all treatments in terms of both greenhouse gas emission efficiency and emission rates. SF, TTF, SROF. This indicates that Zeolite 4A acted as a gas absorber for control CH4 and CO2. On the other hand, when treating both SF and TTF fertilizer applications, Zeolite 4A adsorbs CH4 and CO2 gas in its pores, especially as nutrient absorbers such as ammonium and potassium. As a result, when treating SF and TTF, Zeolite 4A has sufficient active pores to exhibit superior performance in reducing GHG emissions compared to controls, especially in the case of double fertilization (TTF). There was no. Therefore, it was found that the reduction of greenhouse gas emissions was reduced (Farhaini et al., 2022).

From this, it can be concluded that zeolite 4A adsorbs not only CH4 and CO2 gas, but also nutrients from fertilizers, especially NH4 +, NO3 and K+. When zeolite adsorbs cations to the pore matrix, less CH4 and CO2 can be adsorbed because the pore volume is insufficient to adsorb both cations and gas together.

4. Conclusion

The addition Zeolite 4A affected cumulative greenhouse gas emissions from rice. Zeolite 4A has been found to adsorb CH4 and CO2, reducing overall emissions. The combination of zeolite and fertilizer administration in one or two applications provided an anti-synergistic effect. Higher fertilization stimulated harvesting, resulting in higher yields and higher proportions of good grain, but less efficient GHG reductions.

The ratio of zeolite 4A to fertilizer should be higher than 3: 1 to reduce the increase in greenhouse gas emissions from the use of fertilizer. This treatment resulted in an emission reduction efficiency of 34.69% in proportion to 21.62 g CO2eq m2 g1 zeolite. In the current study, two applications, fertilizer and zeolite 4A, showed the best performance in reducing emissions. However, it is advisable to increase the ratio of zeolite to fertilizer. Similarly, sustained release organic fertilizers resulted in increased CH4 emissions due to the action of methanogens on organic matter. However, plant growth, good grain proportions, and total grain yields increased. Further research is recommended to investigate the optimal ratio of zeolite 4A to organic and synthetic fertilizers for rice cultivation.

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References

AFTMT. (2020). Possibilities to Reduce Methane and Hydrogen Sulphide Emissions in Pig Farming By Application of Zeolite. 7, 23675888. https://aftmt.uni-ruse.bg/wp-content/uploads/2021/05/AFTMT_VII-1-2020-2.pdf

Applied Economics Research Center, Faculty of Economics, Kasetsart University. (2018) National Report No. 2 for UNFCCC, Office of Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment. https://unfccc.int/sites/default/files/resource/Thailand_BUR4_final_28122022.pdf

Composite. (2018). Natural Zeolite and Its Application in Concrete Composite Production. 165,101016. https://doi.org/10.1016/j.compositesb.2018.12.084

Dubey, S.K. (2019). Methane Emission and Rice Agriculture. Current Science. https://www.researchgate.net/publication/303670128_Methane_emission_and_rice_agriculture

Farhaini, A., Putra, B. K., & Aini, D. (2022). Reformasi Birokrasi dalam Pelayanan Publik Melalui Aplikasi Halodoc di Kota Mataram. Professional: Jurnal Komunikasi Dan Administrasi Publik, 9(1), 71–82. https://doi.org/10.37676/professional.v9i1.2416

ICSF. (2020). Sustainable low-carbon binders and concretes. 1, 06007. https://doi.org/10.1051/e3sconf/202016606007

Jobe, J. (2021). Natural Zeolite powder in cementitious composites and its application as heavy metal absorbents. 43, 103085. https://doi.org/10.1016/j.jobe.2021.103085

Milosevic, T., Milosevic, N. (2019). The effect of zeolite, organic and inorganic fertilizers on soil chemical properties, growth and biomass yield of apple trees. Plant, Soil and Environment. https://doi.org/10.17221/107/2009-PSE

Mungkung, R., Gheewala, S., Poovaroodom, N., Towprayoon, S. (2018). Carbon footprint and Carbon label of Rice. The Thailand Research Fund. https://www.researchgate.net/publication/276002290_Product_carbon_footprinting_and_labeling_in_Thailand_Experiences_from_an_exporting_nation

PNAS. (2021) Zeolite-like performnce for xylene isomer purification using polymer-derived carbon membranes. 1, 2022202118. https://doi.org/10.1073/pnas.2022202118

Putra, B. K., Dewi, R. M., Fadilah, Y. H., & Roziqin, A. (2021). Reformasi Birokrasi dalam Pelayanan Publik Melalui Mobile JKN di Kota Malang. Jurnal Ilmiah Publika, 9(1), 1–13. http://dx.doi.org/10.33603/publika.v9i1.5325

Sa'adawisna, D., & Putra, B. K. (2023). Political Education to Increase Beginner Voter Participation in the 2019 General Elections. Awang Long Law Review, 5(2), 419–431. https://doi.org/10.56301/awl.v5i2.716

Springer. (2020). Experimental investigation of the adsorption and desorption of cellulase enxymes on zeolite-beta for enzyme recycling applications. 1, 101007. https://doi.org/10.1007/s00449-020-02459-6

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