Research Title : The Study of microplastic types in soil in rice paddy fields (wet-season rice) that have been flooded during the monsoon season.

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Abstract

This study investigates the presence of various chemicals and microplastics in soil samples from five different locations, analyzing potential sources and types of contamination in the agricultural ecosystem. The temperatures and pH values at each sampling location were as follows: Hole 1 had a temperature of 27.2°C and a pH of 6.5; Hole 2 recorded a temperature of 28.4°C with a pH of 6.3 Hole 3 showed a temperature of 27.5°C and a pH of 6.1 Hole 4 had a temperature of 28.7°C and a pH of 6.0; and Hole 5 displayed a temperature of 28.2°C with a pH of 6.4. The analysis revealed the repeated presence of Polydimethylsiloxane (PDMS), a silicone compound, suggesting possible contamination by silicone across multiple samples. Kaolin, a clay mineral, and Chromium(VI) Oxide, a chromium compound, were identified at several sites. Notably, at Hole 3, microplastics such as Rayon Fiber, Niobium(V) Oxide, Tantalum(V) Oxide, and Cellulose were detected, indicating the potential presence of synthetic fibers and organic compounds. At Hole 4, several chemical compounds, including Gitan 770, EFKA 3236, and Guar, along with inorganic compounds like Bentonite and Ferric Hydroxide, were found. Additionally, compounds associated with high-temperature processes, such as Tetraallylsilane and Silicone Oil, High Temperature, were detected. The findings highlight significant contamination from silicone-based products, industrial chemicals, and microplastics, underscoring the need for further investigation into the environmental impact on the agricultural ecosystem.

Introduction

Rice farming in Thailand, particularly the traditional wet-season rice cultivation (napi), relies heavily on rainfall. The farming cycle begins in the early rainy season (approximately May to July) and harvesting takes place toward the end of the year (October to December). This system is deeply embedded in the livelihoods of Thai people, especially in the central, northern, and northeastern regions, which are large rice-growing areas. Wet-season rice farming is thus a crucial foundation of Thai agriculture and an integral part of the nation's economy and culture.

In recent years, the issue of microplastic contamination in agricultural ecosystems has gained significant attention, especially in flooded rice paddy fields, where water levels are continuously managed to support plant growth. Wet-season rice farming requires substantial amounts of water, resulting in prolonged water saturation in the fields. This has a variety of impacts, particularly on soil quality and the accumulation of microplastics in rice paddy areas. The contamination of microplastics in rice paddies can stem from multiple sources, such as agricultural plastics, plastic mulches, irrigation pipes, plastics in fertilizers or soil conditioners, runoff from rivers or irrigation canals, and airborne dust. There is a tendency for microplastics to accumulate from water sources that flow through these fields.

The accumulation of microplastics in rice paddies may affect soil quality, agricultural ecosystems, rice yield, and food safety, potentially leading to long-term health risks. Consequently, the research team recognizes the significant impact of this issue. The study of microplastic types in soils from rice fields that have been flooded during the monsoon season is crucial. This research will help identify the level of microplastic contamination in agricultural systems, which affects the ecosystem and soil quality. The findings will provide essential data for developing policies and strategies to manage plastic pollution in agriculture, helping to prevent environmental and food safety issues in the long term.

Objective

Study of microplastic types in soil of rice paddies (wet-season rice) that have been flooded during the monsoon season.

Research question

Do the types of microplastics found in the soil of rice fields (wet-season rice) that have been flooded during the monsoon season differ?

Hypothesis

The soil in rice fields (wet-season rice) that have been flooded during the monsoon season is contaminated with microplastics.

Experimental Method

3.1 Experiment step 1 Collect soil samples

1. Define the soil depth range as 10 cm.
2. Collect soil samples in containers free from contamination.

3.2 Experiment step 2 Measuring Soil Temperature

1. Pour approximately 250 milliliters of water at room temperature into a beaker (ensure the water level in the beaker is above 4 centimeters so that the sensor of the thermometer is submerged while calibrating).
2. Submerge both the standard thermometer and the digital thermometer into the water.
3. Wait for 2 minutes.
4. Read the temperature values from both the standard thermometer and the digital thermometer. If the temperature difference is less than 2 degrees Celsius, the thermometer is calibrated.
5. If the temperature difference is greater than 2 degrees Celsius, wait for another 2 minutes.
6. If the temperature difference still exceeds 2 degrees Celsius, adjust the screw at the bottom of the digital thermometer's dial with a wrench until the temperature readings from both thermometers are close to each other.

3.3 Experiment step 3 Measuring Soil Acidity and Alkalinity Using a pH Meter or pH Paper

1.Weigh 20 grams of dried and sieved soil sample and place it in a beaker.
2. Add 20 or 100 milliliters of distilled water to maintain a 1:1 soil-to-water ratio.
3. Stir the mixture using a glass rod for 30 seconds, then let it sit for 3 minutes. Repeat this process five times.
4. After stirring five times, allow the soil to settle until clear water appears at the top.
5. Dip pH paper or a calibrated pH probe into the clear water layer, avoiding soil particles at the bottom. Wait for the reading to stabilize, then record the pH value.

3.4 Experiment step 4 Prepare the samples

1. Dry the soil by air-drying or drying it in a hot air oven at 60°C for 20 hours to remove moisture.

2. Sieve the dry soil using a sieve to separate large particles and focus on small particles.

3. Remove organic substances using hydrogen peroxide (H_2O_2) to oxidize and eliminate organic matter.

3.5 Experiment step 5 Separate microplastics

1. Mix the soil with a saturated sodium chloride (NaCl) solution (density > 1.6 g/cm³).
2. Mix and allow heavier particles to settle while the lighter microplastics float to the surface.
3. Separate the floating particles and filter through a fine mesh or filter (e.g., 0.45 µm).
4. Place the residue on a filter paper and dry in an oven at 60°C for 2 hours.

3.6 Experiment step 6 Analyze microplastics

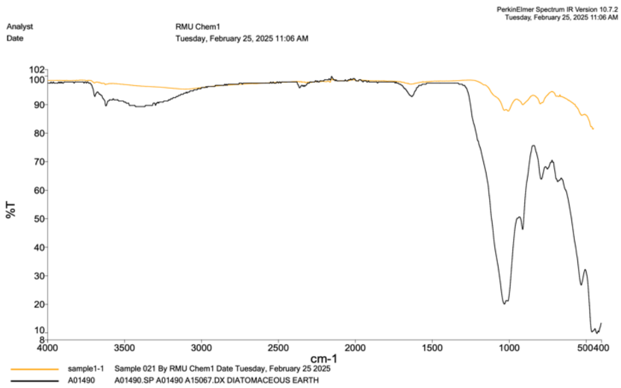
1. Analyze using FTIR (Fourier Transform Infrared Spectroscopy) to identify polymer types by detecting the infrared spectrum.

Materials and Equipment

1. Soil samples from the target area
2. Balance
3. Hydrogen peroxide (H_2O_2) solution, concentration
4. Saturated sodium chloride (NaCl) solution (density > 1.6 g/cm³)
5. Oven
6. FTIR (Fourier Transform Infrared Spectroscopy) machine
7. Needle-type or digital thermometer
8. Nail or guide rod, at least 12 centimeters long
9. Hammer
10. Plastic tubes for placing the thermometer during temperature measurement, 7 and 12 centimeters long
11. Standard calibration thermometer
12. Wrench for adjusting the thermometer dial
13. Clock
14. Data recording sheet for soil characteristic measurements

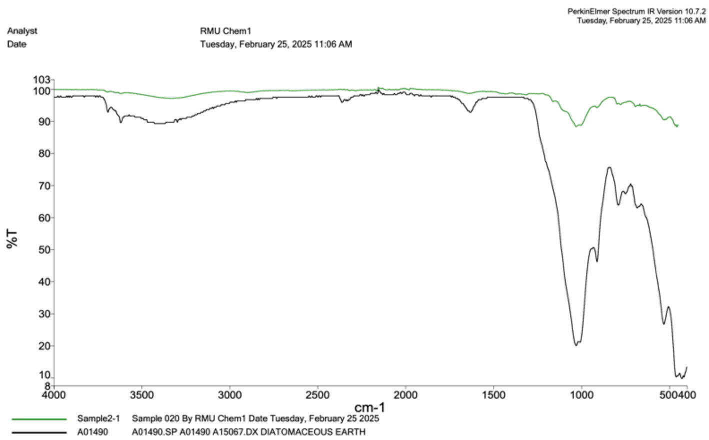
Results

Coordinates of hole 1 16.43640° N, 103.53306° E



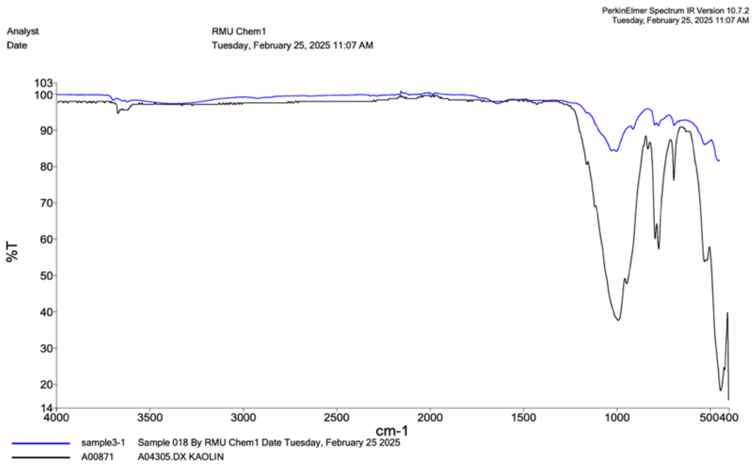
Has a temperature of 27.2 degrees Celsius and a pH value of 6.5 Polydimethylsiloxane (PDMS), a silicone possible contamination by silicone. Kaolin, a type of clay mineral while Chromium(VI) Oxide appeared as a chromium compound

Coordinates of hole 2 16.43629° N, 103.53281° E



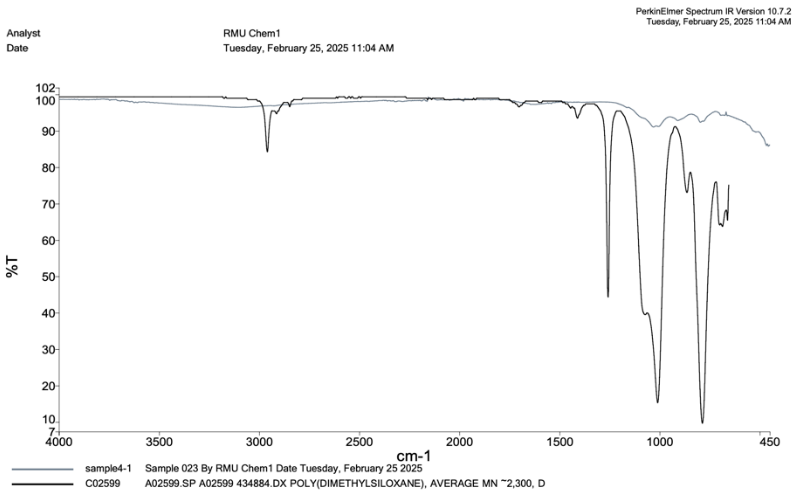
Has a temperature of 28.4 degrees Celsius and a pH value of 6.3 Polydimethylsiloxane (PDMS), a silicone compound, appeared multiple times in the list, suggesting possible contamination by silicone. Kaolin, a type of clay mineral, was observed in several instances, while Chromium(VI) Oxide appeared as a chromium

Coordinates of hole 3 16.43612° N, 103.53260° E



Has a temperature of 27.5 degrees Celsius and a pH value of 6.1 microplastics were identified as follows: Rayon Fiber appeared repeatedly, indicating the potential presence of rayon fibers in the sample. Niobium(V) Oxide was identified as a niobium compound, and Tantalum(V) Oxide was found as a tantalum compound. Additionally, Cellulose was detected.

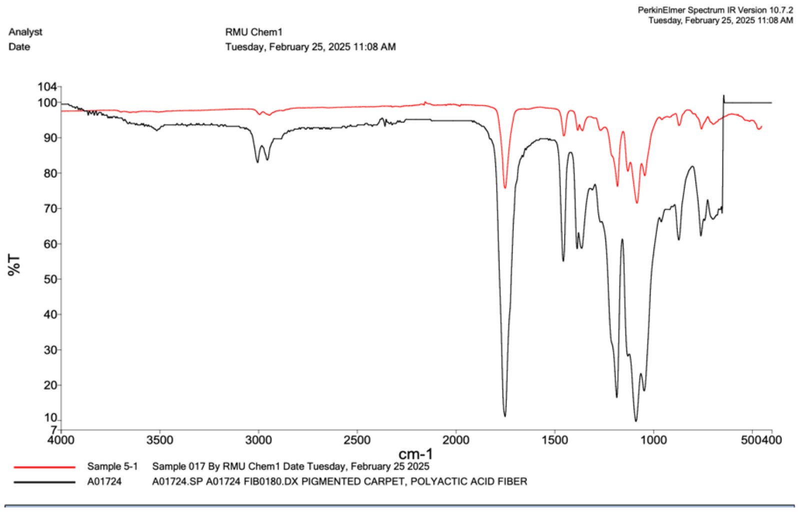
Coordinates of hole 4 16.43649° N, 103.53302° E



Has a temperature of 28.7 degrees Celsius and a pH value of 6.0 microplastics were identified as follows: Gitan 770 recorded the highest "Search Score" (0.592357), followed by EFKA 3236 and Guar , which are chemical compounds. Florisil , a commercial product name, and Methylthiophosphonic Dichloride were also identified. Bentonite Sample B and Ferric Hydroxide were detected as inorganic compounds, along with BYK 322 and Kaolin. Further, Tetraallylsilane , 5-Chloro-2-(Trichloromethyl)benzimidazole , 1,7-Dichloro-

Octamethyltrisiloxane, and Silicone Oil, High Temperature were also found, which are compounds associated with high-temperature processes and silicone-based products.

Coordinates of hole 5 16.43670° N, 103.53306° E



Has a temperature of 28.2 degrees Celsius and a pH value of 6.4 Polydimethylsiloxane (PDMS), a silicone compound, appeared multiple times in the list, suggesting possible contamination by silicone. Kaolin, a type of clay mineral, was observed in several instances, while Chromium(VI) Oxide appeared as a chromium

This analysis provides a comprehensive identification of various chemicals and microplastics present in the samples, highlighting the potential sources and types of contamination in the agricultural ecosystem.

Summary and Dicussion

This study provides a comprehensive analysis of chemical and microplastic contamination across five sampling sites. The data reveals a range of contaminants, including silicone-based compounds, clay minerals, and chromium compounds, highlighting potential sources of pollution within the agricultural ecosystem.

At all five coordinates, Polydimethylsiloxane (PDMS), a silicone compound, was detected multiple times, suggesting a possible widespread contamination from silicone-based products. The consistent presence of Kaolin, a type of clay mineral, across all sites further suggests that contamination could stem from natural mineral deposits or industrial activities involving clay materials. Chromium(VI) Oxide, a toxic chromium compound, was also identified at several locations, which may point to contamination from industrial or agricultural processes using chromium-based substances.

In addition to these substances, microplastics were identified at Hole 3 and Hole 4, with Rayon Fiber, Niobium(V) Oxide, and Tantalum(V) Oxide found in Hole 3, and a variety of chemical compounds including Gitan 770, EFKA 3236, and Guar in Hole 4. The identification of microplastics, particularly synthetic fibers, and inorganic compounds suggests that the contamination could be linked to both synthetic textile production and industrial activities that utilize chemicals and high-temperature processes. The presence of high-temperature-related compounds such as Tetraallylsilane and Silicone Oil at Hole 4 indicates that the area may be exposed to pollutants from industrial operations involving silicone-based materials. The temperature and pH values of the samples ranged from 27.2°C to 28.7°C, with pH values between 6.0 and 6.5. These values are typical of neutral to slightly acidic soils, which could influence the mobility and persistence of the identified contaminants in the environment.

Overall, the analysis highlights the complex nature of contamination in agricultural ecosystems, where both natural and industrial pollutants are present. The findings emphasize the need for further research into the sources of these contaminants and the long-term environmental and health impacts they may pose. Effective strategies for mitigating contamination and protecting soil quality are essential for sustainable agricultural practices.

Discuss the esults of the experiment

The results of this experiment provide a detailed insight into the types of contaminants present at various sampling locations and their potential sources in the agricultural ecosystem. The identification of several chemicals, silicone-based compounds, microplastics, and inorganic minerals reveals significant contamination from both natural and anthropogenic sources.

At all five coordinates, the most notable finding was the repeated presence of Polydimethylsiloxane (PDMS), a silicone compound, which appeared consistently in the samples. This suggests the possibility of widespread contamination by silicone-based products, commonly used in industrial applications and agricultural processes. PDMS is a highly stable compound, and its persistence in the environment can lead to long-term contamination of soil and water, potentially impacting plant growth and soil health.
In addition to PDMS, Kaolin, a naturally occurring clay mineral, was detected in most samples. Kaolin is often used in industrial applications, including agriculture as a pesticide carrier or filler. Its presence across all sampling sites indicates that industrial and agricultural

activities could be contributing to its dispersion in the environment. However, the detection of Chromium(VI) Oxide, a toxic chromium compound, at multiple locations suggests the potential involvement of industrial processes, particularly those associated with chromium-based chemicals. Chromium(VI) compounds are known for their toxicity and environmental persistence, raising concerns about their impact on the soil ecosystem and plant health.

The results from Hole 3 and Hole 4 revealed the presence of microplastics , including Rayon Fiber, which points to potential contamination from synthetic textiles or other plastic-based products. Rayon fibers are commonly used in clothing and industrial applications, and their breakdown in the environment can contribute to microplastic pollution. Niobium(V) Oxide and Tantalum(V) Oxide , identified in Hole 3, are compounds associated with metal processing and high-tech industries, suggesting that industrial emissions could be a source of these contaminants. The detection of Cellulose , a biodegradable compound, further supports the presence of organic materials in the samples, potentially from plant material or microbial activity.

At Hole 4, several chemicals such as Gitan 770, EFKA 3236, and Guar were detected. These compounds are typically associated with chemical manufacturing, and their presence indicates the possible influence of chemical runoff from industrial or agricultural sources. The identification of Florisil, Methylthiophosphonic Dichloride, and compounds associated with high-temperature processes such as Tetraallylsilane and Silicone Oil, High Temperature suggests that the region may be subject to contamination from industrial activities that use silicone-based products and other high-temperature chemical processes.

Finally, the temperature and pH values recorded at the sampling sites (ranging from 27.2°C to 28.7°C and pH values between 6.0 and 6.5) suggest that the soil conditions are generally neutral to slightly acidic. These conditions are favorable for the persistence of many chemical compounds, including both silicone-based substances and inorganic minerals, which may remain in the environment for extended periods and potentially affect soil quality and biodiversity.

In conclusion, the findings of this study highlight the complex interaction of industrial pollutants, natural minerals, and microplastics in agricultural ecosystems. The identification of silicone compounds, inorganic materials, and chemical pollutants suggests that agricultural soils may be subject to multiple sources of contamination. Further research is needed to assess the long-term environmental and ecological impacts of these contaminants, particularly regarding their bioaccumulation in the food chain and their effects on soil health and plant growth.

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