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ASSESSMENT ON MICROPLASTIC CONTAMINATION FROM MULCHING AND NON-MULCHING FARMLAND IN SELANGOR, MALAYSIA

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Abstract

Introduction: *Emerging environmental contaminants known as microplastics (MPs) have recently attracted a growing amount of attention due to their ubiquitous distribution, high adsorption capability of impurities, high specific surface area, and physiological toxicity, which can remain in the environment for hundreds of years. Thus, this study aimed to characterize microplastics (MPs) and assess their association with varying soil depths and sampling sites, utilizing two distinct plant soil types for comparison.* ***Methods:*** *Soil samples were collected from different depths and various sampling sites within Tanjung Karang, Selangor. The abundance, color, size, shape, and polymer composition of the isolated MPs were analyzed using microscopic techniques and micro-Fourier Transform Infrared (FTIR) spectroscopy. Standard experimental protocols were followed, and one-way ANOVA test was conducted using SPSS.* ***Result and Discussion:*** *Mulched farmland had the most MPs abundance, 1650 particles/kg at 0-10 cm. However, non-mulched farmland had the lowest microplastic abundance at 336 particles/kg at 20-30 cm. This indicates that microplastics were substantially greater in mulched soils than in non-mulched soils. The Stereomicroscope Stemi 305, Zeiss, showed that 64% of films possessed the highest morphotypes, black colour of microplastics made up mostly about 59% of the total, and MPs were the most abundant with a size of <500 µm. ATR-FTIR found mostly polyethylene terephthalate (PET) and polypropylene (PP) polymers in these soils. Also, the abundance of microplastics in both farmlands gradually decreased as the depth of the soil increased.* ***Conclusion:*** *This investigation confirmed that microplastic composition and characteristics vary by agricultural land and soil depth.*

INTRODUCTION

In the modern era, plastic has become indispensable, with countless applications integrated into daily life. The escalating use of plastics is driven by their numerous advantages, such as durability, lightness, and longevity (1). The manufacturing and consumption of plastic have skyrocketed over the past 60 years, with 2018 seeing unprecedented levels of use. Nevertheless, there is still a significant amount of plastic being released into the environment due to the low recycling rate (2). Resistant to biodegradation, these polymers do not break down into smaller fragments and thus persist in the environment for extended periods, which previous research has identified as emerging environmental pollutants due to their physico-toxic effects, strong adsorption capacity, and widespread dispersion.

The term "microplastics" describes the ubiquitous and abundant plastics that are less than 5 millimetres wide. They travel through a wide variety of environments, from the sea to the land. There is evidence that these types of

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plastics can penetrate surface and groundwater systems after migrating through soil layers and becoming airborne (3-5). However, their exact mobility within terrestrial ecosystems is still undetermined. Consequently, MPs contamination has emerged as a significant environmental concern, with evidence suggesting substantially higher concentrations in terrestrial (soil) ecosystems compared to marine environments (6). The elevated abundance of MPs in terrestrial environments, as opposed to aquatic ecosystems, is fundamentally attributable to the prevalence of direct anthropogenic activities and the management and distribution modalities of plastic waste within land-based systems.

Microplastics enter agricultural soil through various pathways, including the application of plastic mulch, organic fertilizers, and wastewater irrigation (7). Plastic mulch, post-use, becomes brittle and fragments into microplastics under environmental stressors like UV radiation. Similarly, organic fertilizers, often contaminated with plastic waste, introduce microplastics into agricultural lands during application. Wastewater irrigation further exacerbates the issue, with microplastics accumulating in soil through the use of treated wastewater containing suspended particles (8).

Microplastic pollution has far-reaching consequences for soil physicochemical parameters, ecosystem health, and soil structure. Because of their interactions with soil organisms, microplastics can impede their development and sterility. Wind erosion and soil management activities can also contribute to atmospheric pollution and water contamination caused by microplastics in soil ecosystems (9-10). To protect both humans and the environment, it is essential to study agricultural soils for microplastic contamination and find ways to reduce it. While extensive research has explored various aspects of agricultural land management, including soil fertility, crop yield optimization, and water conservation techniques, a comprehensive and comparative understanding of the long-term impacts of mulching versus non-mulching practices remains an area warranting more focused investigation. Given the increasing imperative for sustainable agriculture, water resource efficiency, and soil health preservation in the face of climate change, an urgent of conduct a rigorous comparison of mulched and non-mulched agricultural land in Tanjung Karang, Selangor.

METHODS

Soil Sample Collection

The study was carried out at two distinct agricultural sites in the Tanjung Karang area of Selangor: Farm A, representing mulching farmland, and Farm B, representing non-mulching farmland. From each of these chosen plots, soil samples were carefully collected at three specific depths: 0–10 cm, 10–20 cm, and 20–30 cm, using a stainless-steel ruler or calipers to ensure precision (11). To obtain a representative sample for each soil layer, three sub-samples were collected from a 25 x 25 cm square grid within each plot and then uniformly mixed to create a composite sample. In total, this sampling strategy yielded six composite soil samples, with three from each farmland. Approximately 2 kg of each composite sample was then securely packed into an aluminium box, with 500 grams allocated per depth. All collected soil samples were meticulously labeled and promptly transported to the laboratory to minimize any potential alterations before their pretreatment and subsequent analyses.

Microplastic Extraction and Isolation

Each composite soil sample underwent an initial pretreatment involving sieving through a 5 mm stainless steel sieve. This step was crucial for removing larger physical obstructions such as stones, significant plant material, and other macroscopic debris. Following this initial cleaning, the sieved soil samples were dried in an oven at a controlled temperature of 70°C for a duration of 24 hours to eliminate all moisture. The dried soil was then transferred into a beaker, ready for density separation. A saturated sodium chloride (NaCl) solution, precisely prepared to a density of 1.2 g/cm^3, was added to each beaker, and the mixture was thoroughly agitated. This mixture was then left undisturbed for 24 hours (12), allowing the lighter microplastic particles to float to the surface while heavier soil components settled at the bottom. After this separation period, the supernatant layer, visibly containing the buoyant microplastics, was carefully transferred to a clean beaker through a 20-μm filter, facilitated by a vacuum filtration system. To further purify the microplastic isolates, any remaining organic matter was digested. This was achieved by incubating the filtered solution with 50 mL of 30% hydrogen peroxide (H_2O_2) in a thermostatic oscillator at 60 °C for 24 hours, with continuous agitation at 150 RPM. As the final step in the isolation procedure, the digested solutions were filtered once more using a finer 0.45-μm filter. The filter membrane, now holding the concentrated microplastic particles, was gently moved to a clean petri dish using metallic tweezers after being rinsed with deionized filtered water. The petri dish was then covered and placed in a 50°C oven for 12 hours to ensure complete drying of the isolated microplastics.

Microplastic Characterization

Following the isolation process, the dried microplastic particles were subjected to a comprehensive analysis, encompassing their morphology, size, and color, primarily utilizing stereoscopic microscopy and image analysis techniques. The preliminary examination of the petri dishes was conducted using a 50-magnification stereoscopic microscope (Stereomicroscope Stemi 305, Zeiss) to visually inspect the microplastics on the filter membranes. High-resolution digital photographs of all observed particles were captured using a camera integrated with the microscope (Dino-Lite Edge/5MP, AM7915 Series). For morphological analysis, the microplastic particles were carefully categorized into distinct shapes, including foams, fibers, fragments, pellets, and films. Particle size was quantitatively determined using ImageJ software, and the particles were classified into predefined size categories: small (less than 1 mm), medium (1-3 mm), and large (3-5 mm). The colours of microplastics was also systematically recorded, distinguishing between transparent, translucent, white, black, and various other colored particles (13). The abundance of microplastic particles was quantified by counting using Dino Capture 2.0 software.

Microplastic Identification

For microplastic identification, a subset of the isolated microplastic particles was analyzed using Fourier Transform Infrared (ATR–FTIR) spectroscopy (14). Individual or aggregated microplastic particles, visually selected from the filter membranes, are gently placed onto the attenuated total reflectance (ATR) crystal of an FTIR spectrometer. Spectra were recorded in the wavenumber range of approximately 400 – 600 cm^{-1}, with a specified resolution of 4 cm^{-1} and 24 scans. OMNIC software (Thermo Fisher Scientific) was used to match sample spectra to polymer spectral databases to determine MPs' chemical compositions. Once similarity exceeded 70%, MPs were found to be identical to the polymer (15).

Quality Control

All procedures are consistently followed throughout the experimental work to prevent any contamination of the sample. All laboratory equipment was rinsed with distilled water and tightly wrapped in aluminum foil until needed. To protect samples and glassware from exposure to air, both were covered with aluminum foil during analysis and transportation.

Data Analysis

The one-way ANOVA was employed to assess the linear relationships between the abundance of microplastics across different soil depths in two distinct agricultural lands. All computations were performed using the Statistical Package for the Social Sciences (SPSS) software, version 27.0, with a 95% confidence level and a significance threshold of $p < 0.05$. Additionally, Microsoft Excel was utilized for data tabulation and graph visualization.

RESULTS

The Abundance of Microplastics in Soils

Both mulched and non-mulched farmland had microplastics at varied soil levels. Figure 1 shows that mulched farmed soils had 74.5% (3,969 particles/kg) microplastics, while non-mulched soils had 25.5% (1,358 particles/kg). A prior study on China's farmlands indicated that mulched soils had far higher microplastic abundance than non-mulched soils (16).

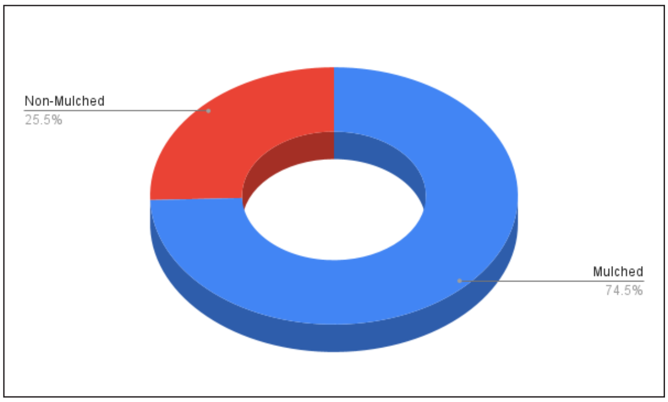


Figure 1. Comparison of Abundance Statistics Between Mulched and Non-Mulched Farmlands

The Morphotype of Microplastics

Figure 2 shows that MP morphotypes include film, fragment, fibres, and pellets at different farming soil types (mulch and non-mulching) and depths. Film, fragments, fibres, pellets, and foam are the most prevalent types on farmland. Meanwhile, films, fragments, and fibres are commonly discovered in non-mulched farmland.

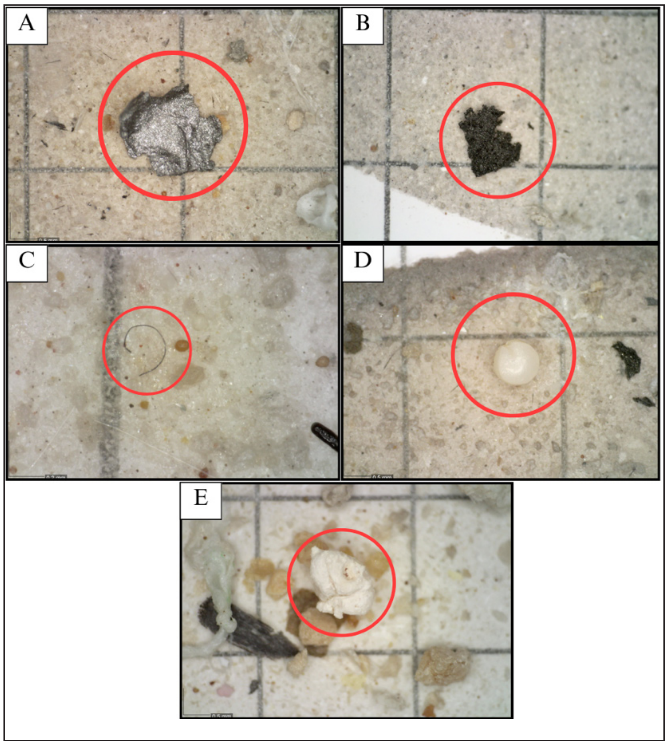
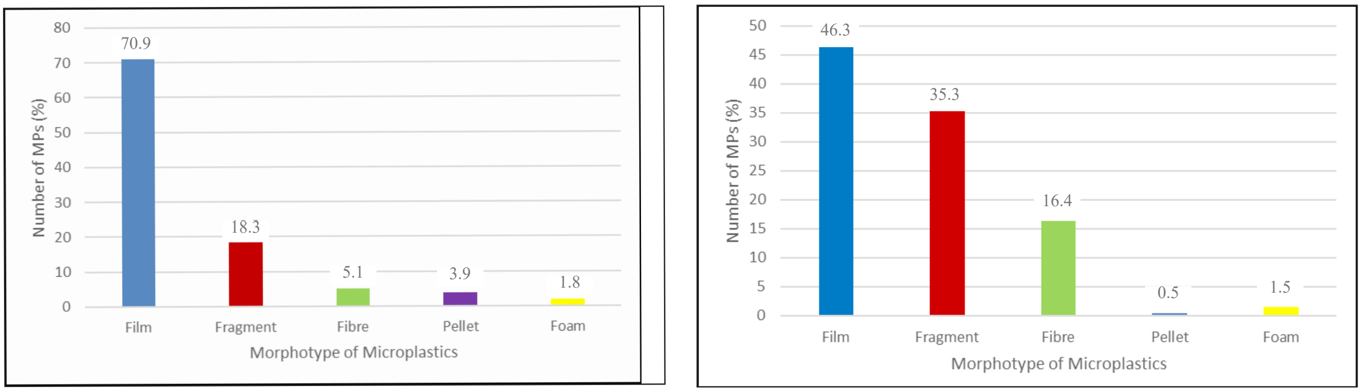


Figure 2. Photograph of Morphotypes Characteristics of Microplastic Under the Stereomicroscopes: Film (A), Fragment (B), Fibre (C), Pellet (D), Foam (E)

Figure 3 shows films, fragments, fibres, foams, and pellets from mulched and non-mulched farmlands at different soil levels. In Figure 3(A), mulched farmland had the most films (70.9%), followed by fragments (18.3%), fibres (5.1%), pellets (3.9%), and foam (1.8%). Figure 3(B) shows that films made up 46.3% of microplastics in non-mulched farmland soils. Fragments came next at 35.3%, fibres 16.4%, pellets 0.5%, and foams 1.5%.

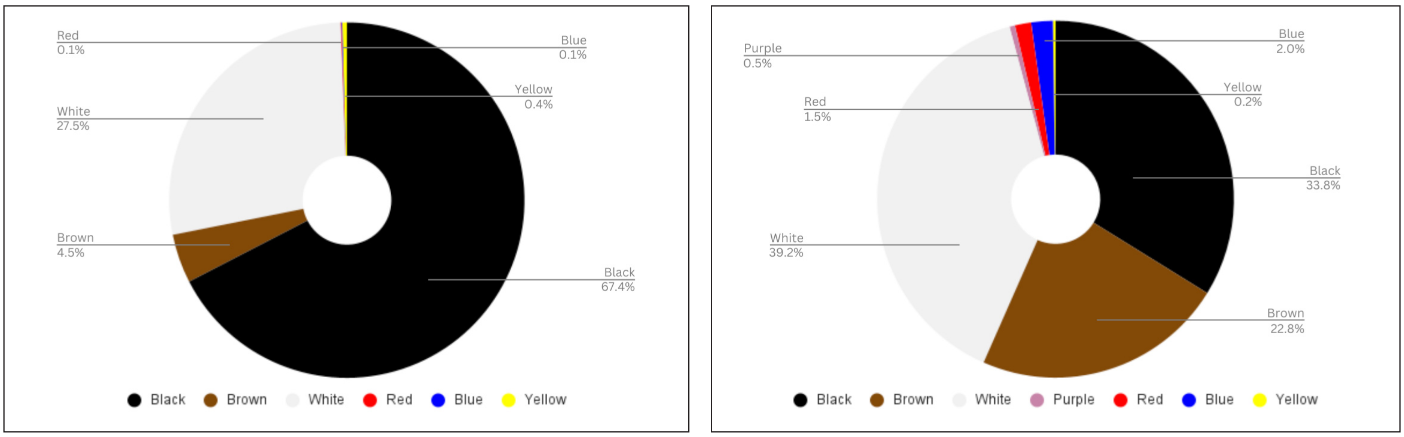


(A) (B)

Figure 3. Comparison on percentage of different morphotypes of microplastics from different farmlands: mulched farmland (A), non-mulched farmland (B)

The Colour of Microplastics

Overall, this research discovered seven different colours of MPs in the soils across mulched and non-mulched farmlands. Based on the data presented in Figure 4(A), 67.4% of the particles in mulched soils were black, 27.5% were white, and 4.5% were brown. Since the number that was discovered is extremely low, it reported a score of 0.4% for yellow, 0.1% for red, and blue colour. Within the context of non-mulched farmland which is based on Figure 4(B), the following were the corresponding percentages of MPs of each specified colour in descending scale which were white (39.2%), black (33.8%), brown (22.8%), blue (2.0%), red (1.5%), purple (0.5%) and yellow (0.2%).

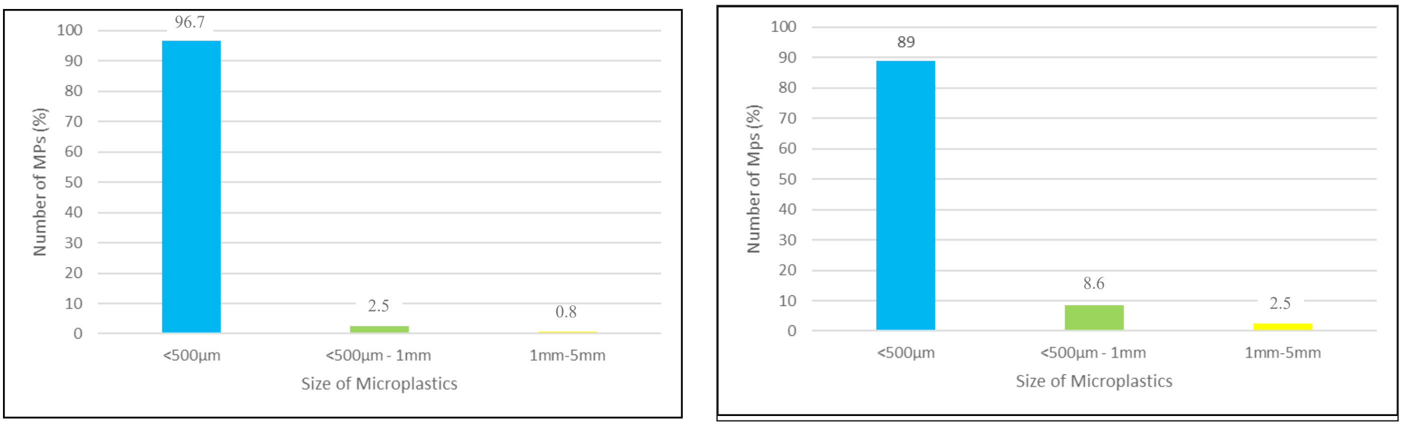


(A) (B)

Figure 4. Comparison on Percentage of Different Colour of Microplastics from Different Farmlands: Mulched Farmland (A), non-mulched farmland (B)

The Size of Microplastics

The study categorised plastic particles into three groups based on size, which were below 500 μm, between 500 μm and 1 mm, and those between 1 mm and 5 mm. Figure 5(A) shows that on mulched farmland, 96.7% of particles were less than 500 μm, 2.5% were 500 μm to 1 mm, and 0.8% were 1mm to 5 mm. Figure 5(B) shows that in non-mulched farmland, 89% of particles were less than 500 μm, 8.6% were between 500 μm and 1 mm, and 2.5% were between 1 mm and 5 mm. These findings are consistent with the previous study, which indicated that microplastic particles (MPs) smaller than 5 mm made up over 58% of agricultural soil MPs (11).

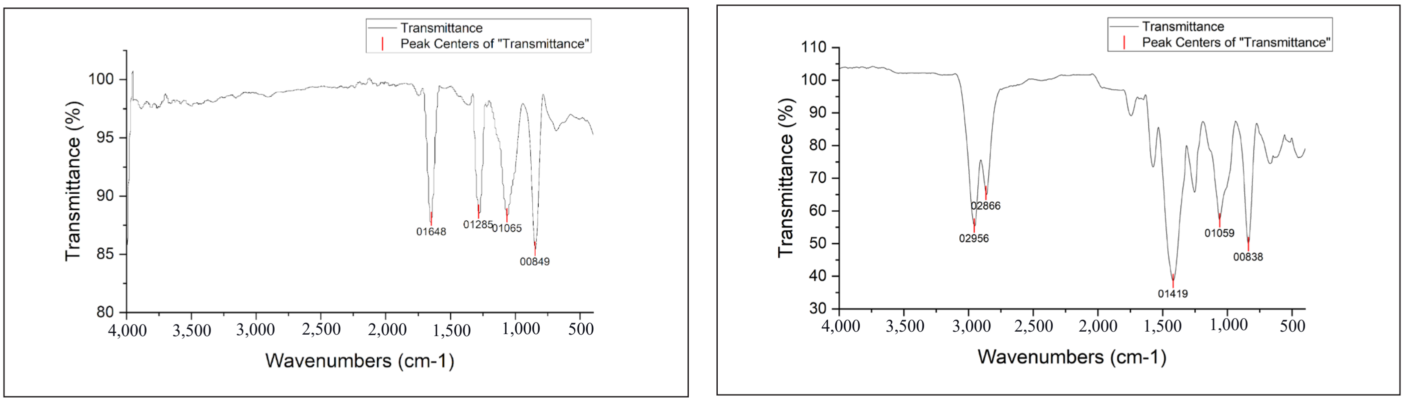


(A) (B)

Figure 5. Comparison on Percentage of Different Size of Microplastics from Different Farmlands: Mulched Farmland (A), non-mulched farmland (B)

The Polymer Composition of Microplastics

Polymers found by FTIR were PET and PP. As seen in Figure 6(A), PET produces high peaks near wavenumber regions 849 cm^{-1}, 1,065 cm^{-1}, 1,285 cm^{-1}, and 1,648 cm^{-1}. This research confirms previous findings on PET polymer composition in agricultural soil. Figure 6(B) reveals PP generates high peaks near wavenumber areas 838 cm^{-1}, 1,059 cm^{-1}, 1,419 cm^{-1}, 2,866 cm^{-1}, and 2,956 cm^{-1} (16). This study found PP essential due to its broad use in agriculture (17-18).



(A) (B)

Figure 6. FTIR Spectra of the Representative Microplastic Found in Agricultural Farmland Samples: PET (A), PP (B)

The Distribution of Microplastic in Different Soil Depths

Figure 7 shows mulched farmland with average microplastic abundances of 1650, 1543, and 776 particles/kg at 0–10, 10–20, and 20–30 cm. The abundances in non-mulched farmland were 566, 456, and 336 particles/kg at the same soil depths. At 0-10 cm depth, mulched agricultural soils had the most microplastics (1650 particles/kg). However, non-mulched farmed soils had the lowest microplastic level at 336 particles/kg at 20-30 cm.

Microplastic vertical distributions were identical in mulched and non-mulched farms. Figure 8 shows that microplastics in the two farmed areas' soils decreased with depth. Surface (0 to 10 cm) and mid-layer (10 to 20 cm) soils had slightly greater microplastic levels than deeper soils (20-30 cm). Thus, One-Way ANOVA was used to compare soil depths in mulched and non-mulched farmland. Mulched farmlands had no significant difference between 0 to 10 cm and 10 to 20 cm (p = 0.999) and 20 to 30 cm (p = 0.133). The soil depths of 0 to 10 cm and 10 to 20 cm (p = 0.999) in non-mulched farmlands and 0 to 10 cm and 20 to 30 cm (p = 0.975) in mulched farmlands were not significantly different. Due to several reasons, the value was not statistically significant ($p > 0.05$). Moreover, a previous study found a similar trend, with the result that the quantity of MPs decreased with increasing soil depth, which is consistent with the results shown above (19).

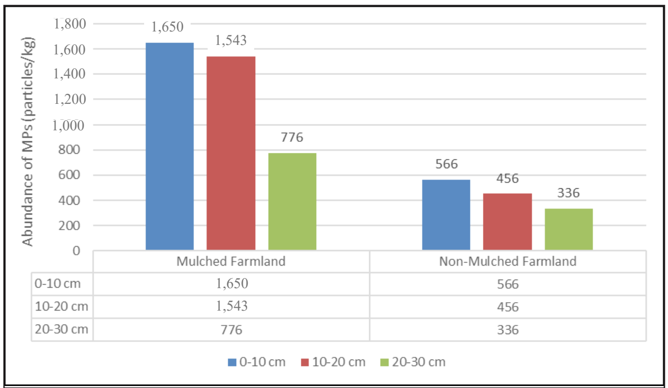


Figure 7. Abundance Statistics (particles/kg) of Microplastics at Different Soil Depths in Mulched and Non-Mulched Farmlands

DISCUSSION

During this study, microplastic abundance was much greater in mulched soils compared to non-mulched soils. It can likely be attributed to this noticeable difference in the use of plastic mulching. These thin films would be quickly damaged during cultivation and would be difficult to recycle (20). Loss of structural integrity and subsequent degradation of the remaining plastic mulch in the agricultural land could lead to the formation of microplastics from a variety of sizes of plastic residues. These plastics, as they deteriorated in agricultural soils, added a significant amount of microplastics to the soil, and some of these microplastics even remained in the crops (21). Plastic mulch films are among the most significant sources of microplastics. When exposed to light and mechanical forces, such as tillage practices, they break down into microplastics that infiltrate agricultural soils, especially in areas with low mulch film recovery rates. Consequently, microplastic fragments from these films can be easily detected and quantified in soil samples.

Other than that, non-mulched soils were also found to have microplastics, mostly in the form of fibres and films. Previous research suggested that plastic film mulch may not be the only element that contributes to the contamination of agricultural soils (19). Regardless of the use of film mulching, the sampling sites contained traces of agricultural film, fragmented fertilizer packaging bags, pesticide bottles, and plastic shopping bags, all of which could contribute to microplastic contamination. Additionally, fibrous microplastics may enter the soil through atmospheric deposition. Any of these factors could explain the presence of microplastics in non-mulched soils.

Additionally, both mulched and non-mulched farmland were located in wide-open environments. A previous research study stated that the input sources of microplastics that originated from the usage of farming-related means for cultivation were predominant and were not typically protected by polytunnels (14). As a result, the farmland was more susceptible to the effects of microplastics that were derived from atmospheric deposition, domestic wastes, and road traffic dust. Therefore, even though the farmland was not mulched, it still contains a wide range of MPs, which are caused by different sources of MPs, which might be among the contributing factors for the various characteristics found in MPs in both agricultural farmlands.

Besides that, most of the microplastic particles in both farmlands consisted of films and fragments, which indicates the breakdown of several types of agricultural materials of plastics, including packaging items, seed bags, plastic woven bags, and agricultural equipment (20). Additionally, the previous studies reported that the usage of sludge from sewers and irrigation with wastewater have been considered to be the primary sources of fibres in agricultural soil due to their lightweight structure which are easily dispersed by wind or water movement also stated that there is a possibility that fiber-shaped MPs could be discharged from man-made clothes as well as from the use of fishing equipment and nets. The same applies to the foams, as they are very light in weight, and they could end up in agricultural land after being carried there by the wind from nearby household waste (22-23). Pellets, which have been utilized as exfoliants in a variety of personal care products, can originate from diffuse sources in water from rivers or be transported by aeolian processes, as they are present even when no industrial products are present. Mulch can create different temperature and moisture conditions, potentially influencing the degradation rates and fragmentation patterns of specific plastic types. For example, some plastics might break down into a foam-like structure under certain conditions.

Furthermore, the most prevalent colours of microplastics in both types of agricultural land (mulched and non-mulched) were black and white, followed by other colours of MPs, such as brown, purple, red, blue, and yellow. According to previous research, the variety of colours that might be found in microplastics is also an indicator of the variety of sources of pollution (24). There are a wide variety of sources from which white and transparent microplastics can be derived. Some of these sources include plastic packing materials, plastic film, and plastic bags (25). Furthermore, polychromatic microplastics have the potential to change colour through weathering and discoloration when exposed to water, light, and heat, resulting in the formation of white microplastics (26). Additionally, the black colour of the MPs may be a result of the utilization of tyre wear or dark shade nets, both of which continually accumulate and penetrate agricultural soil by irrigation with sewage sludge or surface runoff.

Previous research mentioned that multicoloured microplastics can come from a variety of sources, including colourful plastic goods, apparel, packaging, and cosmetics that people use regularly (27-28). Over time, they may break down by minerals from the soil and end up stained with the typical brown and black colours of soil. Also, a previous study showed that the surface colour of MPs can be altered from white to yellow or black, which means the colour would become more intense as the amount of time spent in exposure to the elements was increased (26). Since the causes of pollution were both complicated and broad, the various distribution of the plastic colours offered a significant challenge to the regulation of the food safety authority.

Furthermore, the decrease in the size of MPs was followed by an increase in the percentage of total MPs abundance, which aligns with the previous findings (29). This tendency might be explained by the fact that microplastics (MPs) of smaller sizes are more likely to be carried to lower soil layers due to ultraviolet (UV) radiation, soil organisms, and farming activities (30). For instance, earthworms have a tendency to consume MPs of smaller sizes, which they then excrete into deeper soil pathways in their excrement (31).

Additionally, small-sized MPs can easily seep into deeper soil layers through tiny holes and cracks, while larger MPs tend to remain on the surface. Simulation studies indicate that lower-density MPs are more likely to be transported by surface runoff when small soil pores are present but can infiltrate deeper layers when larger soil pores are available (32-33). The transportation of microplastics by runoff from the surface is influenced by the dimensions and mass of the microplastic particles (34). Consequently, polymers that have less soil mineral contamination have a high tendency to float (35). Moreover, the migration process is more effortless for smaller particles due to the reduced probability of becoming physically trapped in the surface vegetation or soil layer. Therefore, this showed that larger MPs tended to settle at the soil's surface, while smaller MPs tended to settle at the soil's deeper layers (36).

Moreover, PET is the most common in this study. PET, which is a type of polyester, is similar to the fabric used for clothes (37). Some examples of synthetic fibres that are frequently used in clothes and other products are microfiber, polyester, nylon, spandex, and rayon. This means that the vast majority of the PET that is produced around the world is used for these synthetic fibres (38). Even though PET materials are not frequently used in agricultural production, they are nonetheless present in farmland that is suitable for agricultural development. This is because PET is mostly utilised in the textile industry (39). Furthermore, it is present in significant concentrations in irrigation water, which is known to have high quantities of plastic fibres that are formed by laundry (40). Therefore, agricultural irrigation water may serve as a key pathway for fiber microplastics to enter the farmland. Additionally, both dry and wet atmospheric deposition are potential sources of fiber microplastics in the soil. According to this, the high level of mobility along roads, the large diffusion area and the enormous volume of traffic may all contribute to the presence of a high abundance of PET in the soils that are adjacent to the roads (41). From this point of view, road traffic dust may be a significant contributor to the presence of PET in open-field soils.

In addition, the results of this research agree with the previous findings which also indicated that PP was a prominent component due to its wide application in agriculture (42-43). The previous studies also indicate that even though PP can withstand biodegradation, its lengthy polyolefin chains make it vulnerable to abiotic degradation (44). So, factors related to the environment can cause PP plastics to degrade into MPs. Because PP's chemical bonds have a lower bond dissociation energy, the polymer was more likely to break down when exposed to ultraviolet (UV) light than other polymers like PS and PE (45).

For instance, despite plastic mulching, it was possible to find residue from plastic bags and PP bottles used for agrochemicals and fertilisers in the fields of the research locations. These items likely played an important role in causing soil fragments to accumulate. Soil microplastics (MPs) can accumulate in agricultural soils due to improper or inadequate disposal of agricultural fertilisers, agrochemical containers (including bags and bottles), and agricultural packaging film (46). Microplastic levels in the soils of both mulched and non-mulched farmland declined with increasing depth, indicating that the two types of farmlands had identical vertical microplastic distributions. The results of this study can be compared to those of a previous study that indicates microplastics were evenly dispersed over the entire tillage layer, possibly as a result of mechanical factors or frequent crop rotation (47). Additionally, traditional tillage makes it possible for MPs to migrate to depths of 20-30 cm in the soil or even deeper, whereas rotation management or little tillage causes them to remain in the topsoil (48). These findings addressing the vertical distribution of microplastics could be caused by factors such as the depth of the samples taken, runoff, crop rotation, leaching, or mechanical and biological disturbances. These contaminants can eventually move to deeper soils when exposed to external forces, increasing the ecological danger.

Also, the previous research mentioned that ploughing the soil in mulched farmlands occurs twice yearly and in non-mulched farmlands once a year during planting in China, which could lead to the vertical movement of microplastics from the topsoil to the bottom soil in those sampling sites (49). This demonstrates that microplastics are dispersed throughout the agricultural area by soil ploughing, which indicates that there are more plastics at the surface and fewer particles deeper down. Moreover, soil tillage may result in the creation of a plough sole beneath the cultivation area. This solid layer poses a challenge for earthworms and roots to get through by their roots (50). It is anticipated that rigid fragments will be dispersed as agricultural equipment edges to penetrate the soil, whereas films will be gathered and carried away at ease (51). Further, they also added that as agricultural engines go over the ground, they vibrate it, which can cause big particles like gravels to rise to the top and microplastics of all sizes to migrate downward more easily (52). According to this theory, the decrease in abundance with soil depth might be explained by particles migrating vertically towards the surface.

Other than that, the study provided evidence that cultivation promotes the vertical movement of microplastics (MPs) in agricultural soils (53). Bioturbation is an additional component that facilitates the mobility of microplastics in soils (54). For instance, it was reported that pellets sunk to a depth of 10 cm within 21 days due to the activity of earthworms. Besides, with prolonged use of composts containing sludge polluted with microplastics (MPs), earthworms might consume and carry MPs to the lower layers of soil. Therefore, the agricultural methods such as cultivation and the presence of soil animals like earthworms can have a significant impact on the long-term fate and distribution of microplastics (MPs).

CONCLUSION

This study discovered microplastics in mulched and non-mulched agricultural land at 0-10 cm, 10-20 cm, and 20-30 cm soil depths. Microplastics were observed in mulched soils and were substantially greater than in non-mulched soils. Mulched farming soils had 3,969 particles/kg, while non-mulched agriculture soils had 1,358. Both of the agricultural areas' soils had fewer microplastics as they got deeper. The average microplastic abundances in mulched farmland were 1,650, 1,543, and 776 particles/kg at 0–10 cm, 10–20 cm, and 20–30 cm. The abundances in non-mulched cropland were 566, 456, and 336 particles/kg at the same soil depths. Therefore, it is acceptable to conclude this study that the number of microplastics that were discovered is influenced by the soils of different farmland areas.

This study also studied MP morphotypes, colours, and sizes. Film, fragment, fibre, pellet, and foam were found as morphotypes. With 64% MPs, the film had the highest morphotypes. Black microplastics made about 59% of the total. Most microplastics were less than 0.5μm in size, and their abundance increased with soil depth. This points out that microplastics with a smaller size tend to move into the deeper layers of the soil.

Both farms have mostly PET and PP types of MPs. These pollutants come from water irrigation, improper fertiliser disposal, and pesticide bags and bottles. Finally, this study considerably increases our understanding of plastic pollution's effects in Tanjung Karang, Selangor. This reveals that microplastic amounts, composition, characteristics, and polymers vary by agricultural land type. Also, the level of microplastics in the soils was gradually decreased as the depth of the soil increased, although there was no significant difference due to reasons that have been stated above.

AUTHORS' CONTRIBUTION

MFZ: Writing-Original draft preparation. NASF: Methodology, Data Analysis. NWR: Data validation, Writing-Reviewing and Editing. MP: Writing-Reviewing and Editing. SRMY: Conceptualization, Methodology, Original draft preparation.

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