



IMPACT OF MICROPLASTIC AND LEAD TOXICITY ON THE TERRESTRIAL PLANTS: A CRITICAL REVIEW

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ABSTRACT

Microplastics pollution is a growing delinquent concern globally, as it is widely used at present on daily basis such as cutlery, commercial packaging, building insulation, medical equipment, toys, and other items used in the food sector. Environmental pollution of microplastics known to be mediated anthropogenically which is now becoming toxic to humans, animals and plants. Microplastics (<5mm) are responsible for uptake of potentially toxic elements in the soil which are responsible for many changes like physiochemical characteristics including enzymatic activity, plant growth and yield. One of the most perilous heavy metals that interfere with plant growth and development is the lead (*Pb*). Previous research showed that growing *Pb* concentrations in plants had an unfavourable effect on root, shoot, and new biomass, leaf growth development, and growth tolerance index. This review paper investigates the synergistic effects of microplastics and lead toxicity on plant. This review also highlights the possible environmental consequences by microplastics and lead contamination.

KEY WORDS: Microplastics, lead, bioaccumulation, synergistic effect, microplastics fate in soil and plants, remediation strategy

1. INTRODUCTION

The uncontrolled and large scale production of microplastics (MP) results in the microplastics pollution in the environment. A pioneering study on microplastics

occurred in 2004 they illustrated how common these tiny, microscopic pieces are in aquatic ecosystem [1]. The non-degradable waste from the hospital like syringe, plastic drips, plastic bags and the

recent pandemic increased the plastic waste like (mask and gloves) in the environment. Past research confirms the worldwide microplastics' presence in the marine environment, sediments, freshwater, groundwater, and soil [2]. Improper handling of plastic waste creates numerous environmental problems. MP can enter the environment directly or indirectly through primary emissions from the production of goods via secondary emission by degradation of plastic waste MP, which causes the release into the environment of a heterogeneous assortment of particle kinds, shapes, and sizes. Microplastics are the most commonly characterized as plastic granules that range in size from 100nm - 5mm. microplastics have been categorized into large microplastics (1-5mm) and small microplastics (0.3-1mm) [3]. Commercially accessible microplastics, according to Lin *et al.* (2018), some common plastics include polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), polystyrene (PS), polyurethane (PU), polyvinyl chloride (PVC), and polycarbonate (PC). They come in a variety of forms, colours and materials. The organisms that live in terrestrial and aquatic habitats may be threatened because of high and expanding pollution level of microplastics. In the aquaculture industry, the environment, and the goods microplastics is widespread that has a

drastic influence on aquatic environment, Microplastics that are introduced during the aquaculture process, such as through the deterioration and use in Plastic is used in product packaging, food, and fishing gear. Aquaculture habitats can become more acidic as a result of the degradation of microplastics that contain chlorine, such as PVC [4]. Microplastics will hinder the development and spread of aquaculture products, lower their likelihood of survival, and ultimately result in financial losses for the industry. Last but not least, these microplastics have a variety of negative consequences on human health as consumers of aquaculture products, such as well as lowering digestive enzyme activity and changing how the human digestive system absorbs nutrients [5]. Majority of microplastics used as in aquaculture that come directly from the land come from wastes close to the aquaculture environment. Microplastics will produce a lot of plastic garbage. From past research we examine that research on microplastics effect on aquatic ecosystem are several but the effect of microplastics on terrestrial ecosystem are limited, microplastics in the terrestrial environment microplastics in terrestrial ecosystems, such as agricultural farmlands, include greenhouse covers, plastic mulch films, solarisation films, plastic seed coatings, wastewater irrigation, landfills, atmospheric deposition, and

sewage sludge. Terrestrial ecosystems are under risk from microplastics in the soil. Anthropogenic pollutants may penetrate the ecosystem and alter the soil, putting soil fauna under stress. According to [6], one of the most significant issues for the preservation of biodiversity on a global scale is microplastics pollution. In a complex environmental matrix, such as soil and sludge (terrestrial environment), it is difficult to distinguish MPs, with the exception of water. Improperly disposed plastics ingested as a food by terrestrial biota, over time could be broken up by abrasion and erosion, resulting in a large number of MPs in the soil. Recent studies have looked on how MPs affect terrestrial organisms. They showed that as the MP concentration increasing in soil there is increased in the mortality rate, whereas the natality rate showed a divergent trend [7]. Microplastics affect the growth of the plants including vegetative growth and reproductive growth [8]. Reports explain the delay in sprouting in plants by microplastics, and microplastics affect the ecotoxicity and genotoxicity to plants [9]. In exposed plants presence of different microplastics induced distinct changes [10]. The alterations in the biophysical environment of the soil by microplastics may affect the plant reactions like germination, plant growth, genotoxicity *etc*, and substantial differences between plant

growth and its natural state suggest a possible danger to terrestrial ecosystems [11]. While using organic manures, sewage sludge as fertilizer, and plastic mulch to the agricultural soil, microplastics are in direct contact with the plants grown on agricultural soil [12]. Recent research has shown that root growth and seed germination are important factors to take into account when determining the direct effects of MPs on plants. Larger (100 nm–5 mm) microplastics particles have the potential to alter and/or disrupt soil structure, which could have an indirect negative impact on plants [13].

Lead is a widely used metal, from late sixties the systematic investigations of toxic physiological effects of Pb^{2+} is known on plants and other biological system (environment). The heavy metal Lead is regarded as harmful to the life forms including plants [14]. There is a lot of lead in the crust of the Earth and due to the distribution in earth crust; the occurrence of lead is more prominent in deep layers. Heavy metals were introduced to the upper layer of the soil by natural processes including erosion, earthquakes, volcanic eruptions, and industrial demand. Vehicle emissions also contributed to the release of metallic heavy into atmosphere. Metal smelting, Pb^{2+} -based paints, lead arsenate, pesticides, and phosphate fertilizers are the primary sources of lead contamination [14].

One of the most dangerous heavy metals, lead (*Pb*), is released into the environment primarily through the mining and smelting of lead ores, car exhaust, coal combustion, storage battery industry effluents, gasoline, and additives in pigments [15]. The amount of lead in the environment is quickly rising as a result of industrialisation and urbanization. owing to a rise use of fertilizers, heavier concentrations of heavy metals have also been introduced into non-polluted areas. Many fertilizers include lead, one of the most dangerous heavy metals, which plants can absorb and accumulate. Because it spreads easily and penetrates the food chain, it can be a threat to life. Because lead moves slowly, Plants and other organisms can readily absorb elemental and inorganic lead compounds because of their slow downward migration from soil to groundwater. Environmental dangers increase as lead concentrations rise due to its continuous use and non-biodegradable nature, lead is a potent environmental toxin, and the environment is harmful even at low concentrations. Lead is a heavy element that accumulates in different areas of plants and is not even necessary for them to survive. The morphological signs of lead toxicity include Chlorosis, root system discoloration, plant's undeveloped growth, quickly inhibited root growth. *Pb* slows down mineral nutrition, enzyme activity, and photosynthesis,

among other things [16]. *Pb* decreases root and shoot length, germination index, tolerance index, and dry mass of roots and shoots, which prevents seeds from germinating and stunts the growth of seedlings. High *Pb* concentration has significant negative effects on plants and induces cell membrane phytotoxicity. Because of high *Pb* concentration there is drop in flower production [17]. Due to all these processes, high levels of lead could interfere with a variety of plant functions, comprising the oxidative system, photosynthesis, respiration, mineral nutrient uptake, membrane construction and function, and gene expression [18].

MECHANISM OF BIOACUMULATION MICROPLASTIC

The first scientific reports of tiny fragments of plastic floating on the water's surface (called "nurdles") appeared since 1970s. MPs/NPs may build up in plants via either foliar or root uptake. The nature and inherent characteristics of MP have an impact on the propagation of microplastics, the location of the sources, and the complicated physical, chemical, and biological processes interact with one another of microplastics. According to Khalid *et al.* (2020), the movement of MPs primarily takes place due to bioturbation, preferred flow, soil fractures, and a variety of agricultural operations as ploughing, ditching, tilling, *etc.* MPs are present in

practically every habitat on earth, including the Polar regions, as a result of numerous natural processes such infiltration, river discharge, wind, ocean currents, and the movement of people and animals within and across ecosystems. In the aquatic ecology, MPs are present from surface waters to benthic zones. Formation of microplastics debris 80% in a marine environment contributed by the land based sources [19]. Plastics exposed at land-based sources (such as beaches) respond more favourably to the UV radiation breakdown mechanism. Plastic substance is adrift on the ocean; photo-degradation is likewise a less effective degradation mechanism. Low oxygen levels and temperature in aquatic environment [20]. The build-up of MPs in the environment has become a widespread issue because MPs may be found in all environmental components, species (such as the benthic fauna and fish), and basic

food items that are consumed on a daily basis and are essential to life, such salt and bagged tea, MPs pollution is spreading due to plastics used by tourist, industrial areas, sewage treatment plants also commonplace for microplastics are cities, tourist destinations, business districts, and sewage treatment facilities. Organic pollutants may enter the food chain through aquatic animals, especially those in marine settings, and pose a risk to human health there [21]. Pollutant deposition is accomplished by bioaccumulation inside an environment and increasing rapidly. Ingestion, bioaccumulation, and biomagnification are the three major mechanisms *via* trophic transfer of microplastics occur; the primary process for moving microplastics from a contaminated environment to an elevated trophic level *via* the food chain is trophic transfer [22] **Figure 1.**

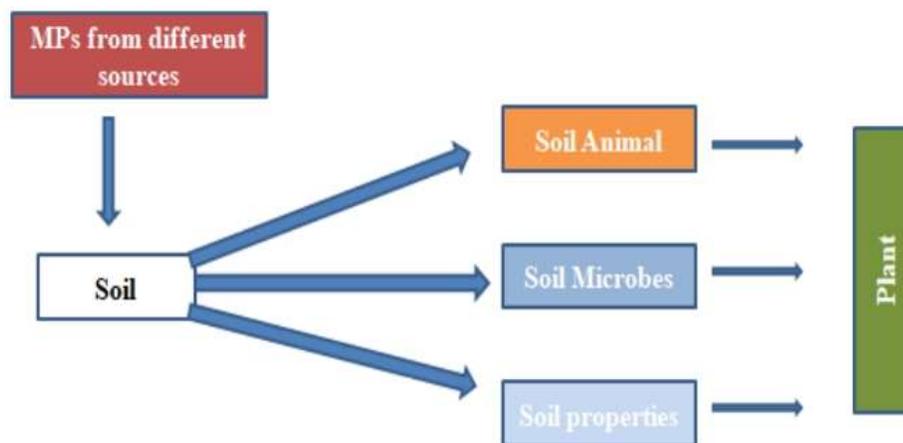


Figure 1: Microplastics impact on soil microbes [23]

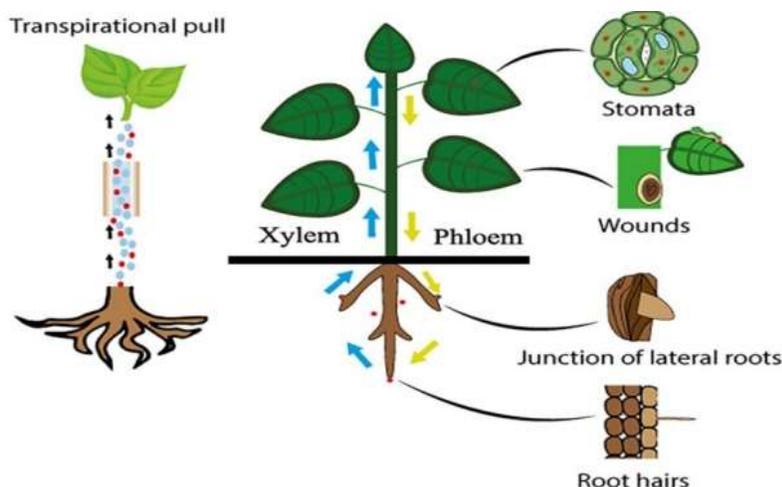


Figure 2: Routes for MPs to accumulate and move into plants [24]

TRANSFORMATION OF MICRO-PLASTIC FROM SOIL INTO THE PLANT SYSTEM

Soil properties change due to the presence of microplastic and this change in soil properties could be beneficial or non-beneficial for plants it all depends on the type of plant, although plants have the ability to grow in plastic polluted area. From past few Studies we examine that the possibility of accumulation of plastic from

plastic polluted soil is very because of plastic accumulation the plant is being affected either positively or negatively all based on the kind of plant [25, 26]. Microplastics enter the plant body through the root system, and by transpiration, the roots and stems are pulled up, bringing water and nutrients to the tops of the plants [27, 28]. **Figure 2, 3.**

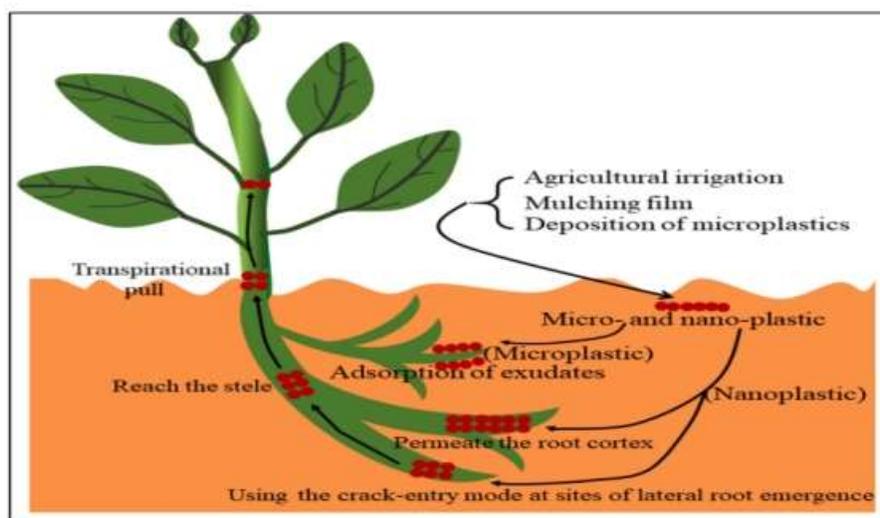


Figure 3: Pathways of microplastic entrance in plants [28]

2. MECHANISM OF BIOACCUMULATION OF LEAD

Soil and roots interference for the build-up of heavy metals contaminates food. In the roots of a variety of plant species adsorption of lead is observed, and the absorbed lead by the plants is accumulated in the roots, and areal part of the plants. Through cellular respiration from atmospheric air, *Pb* ions take up by the plants. From the external atmosphere lead directly absorbed by the soil and through soil lead directly enters into the plant system, and in the plant system nutrients uptake along with the lead cations occur directly from the well-developed root system to the plant aerial portions through xylem and phloem. Endoderm is the layer where the lead with nutrients uptake by plant system through

xylem vessel are unload. The vast surface area of plant leaves enables the cuticle and stomata to absorb metal ions from polluted air. In the end, the lead containing nutrients reaches the region of the plant's endodermis and forms a strong link with the plasma membrane and cell wall. Some cells, like endodermal cells, act as physical barriers to prevent lead from being transferred because the symplast and apoplast routes slow lead translocation. Only a small amount of lead was detected in plant components [29]. Because of these, root vegetables like carrots and sweet potatoes contain the highest percentage of lead, followed by leafy greens like lettuce and Swiss chard.

Figure 4.

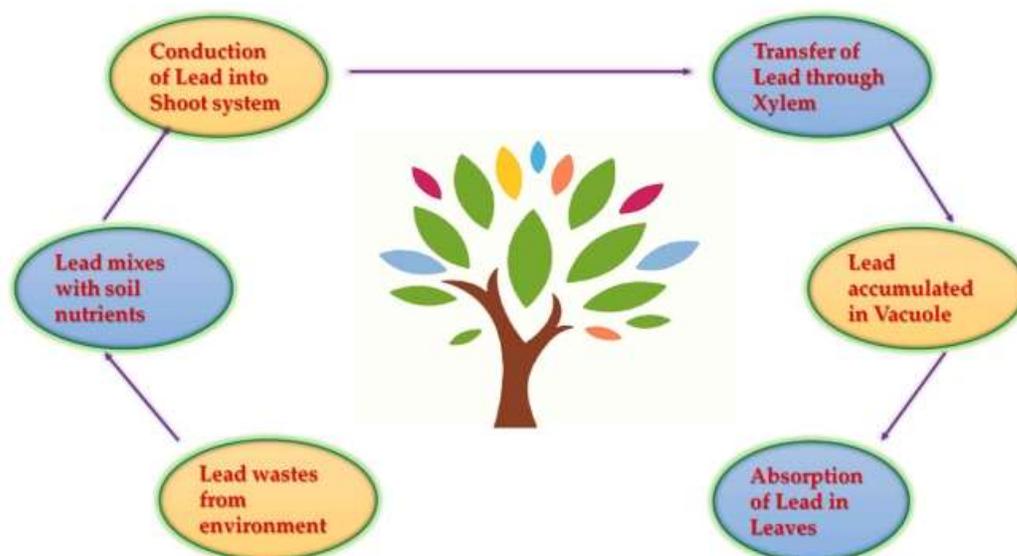


Fig. 4: Mechanism of soil-based lead uptake into plant systems [29]

3. IMPACT OF MICROPLASTICS ON PLANT SYSTEM

Microplastic contamination is a growing concern in the environment which affect the environment directly or indirectly. The effects of microplastic exposure on terrestrial plants can modify their physiology, community organization, and even their morphology. Microplastics indirectly affect the plant growth as it is the the physical contaminant of the soil. Microplastic indirectly effect on plant health because microplastics induced alteration in soil and microbial properties, Microplastic fibers improved soil aeration and decreased bulk density of soil [30], microplastics reduced the resistance of root penetration and increased the root growth. Microplastic restricts the seed pores, which directly affects plants, The microplastics either significantly reduce or entirely prevent water absorption by seed pores by sticking to their surface [31]. There is a decrease in the rate of plant germination

because microplastic physically blocks the seed pores [32]. Microplastic (MPs) impede the uptake of water and nutrients by blocking cell wall pores, which interferes with physiological activities. MPs also slow down the process of seed germination and root growth [33]. Microplastic may encourage the developments of plants which are draught tolerant in the plant species community because microplastic in the soil increase the water evaporation which could lead to more intense droughts [34]. Microplastic can either be taken up by the roots' surface or by the roots, fruits, and vegetables themselves, where it can then build up in their structures. Microplastic physically clogged the seed capsule pores, preventing the seeds from soaking up water, which delayed the germination of seeds exposed to it for as least 8 hours [35]. Microplastics affect both above ground and below ground yield, have damaging influence on plant development.

Table 1: Effect of microplastics on plants.

MICROPLASTIC	PLANT	EFFECTS	REFERENCE
PE Size: 3µm; Concentration: 0.0125 and 100mg ^l ⁻¹	<i>Maize</i>	The nitrogen content and growth of plants are significantly reduced, impairing the absorption of water and nutrient.	MA Urbina <i>et al.</i> , 2020
LDPE Size: 50-1000µm Concentration: 1% (w/w)	<i>Triticum Aestivum</i>	The development of the rhizosphere is impacted by a notable reduction in the overall biomass of plants.	Y Qi <i>et al.</i> , 2020
PS Size: 0.2, 1.0µm Concentration: 50mg ^l ⁻¹	<i>Lactuca Sativa</i>	PS can be taken up by lettuce roots and greatly enhanced, it can then move from the roots to the top of the soil, where it bulds up and disperses throughout the stems and leaves.	L Li <i>et al.</i> , 2019
PE Size: 0.023-0.88µm Concentration: 0.1, 1, 10 and 100mg/g	<i>Mug Bean</i>	Mug bean seedling development and water uptake are significantly inhibited at exposure concentration of 100mg/g.	YY Liu <i>et al.</i> , 2019

IMPACT OF LEAD ON PLANT SYSTEM

Lead has toxic effect on plants (morphologically, physiologically and biochemically), Lead toxicity's morphological visual signs include Immediately stopping root development, reduced plant growth, root system blackening, and chlorosis. There is bent in roots, swelling roots, shortening of roots, stubby roots after comes in contact with lead. Lead exposure causes plants to produce less photosynthetically. Lead ions cause plants to loss photosynthetic rate, which inhibits the Calvin cycle enzymes' activities, as well as CO₂ deficit because of stomatal closure. Lipid composition by thylakoid membrane change by the lead treatment in plant, reduction in the uptake of vital nutrients by plants, such as magnesium and iron when comes in contact with lead toxicity [36]. Plants react to *Pb* exposure in a variety of ways, for instance, by changing the volume and diameter of their roots and either producing or

inhibiting the growth of lateral roots. The plant produces an excess of reactive oxygen species (ROS), including superoxide radicals and hydrogen peroxide, as a result of lead exposure. As the lead toxicity increased in plants the growth of plant decreased as well the growth of leaf is also decreased that leads to the reduction of transpiration because the surface area of leaf reduced. Plasticity of plant cell wall reduces due to the presence of lead in plant and influences the cell turgor pressure. Lead toxicity in plants exhibit a well-known symptom on the inhibition of photosynthesis, and also affects the respiration of the plant. Lead exposure in the plants induces a disturbance or unbalanced cell division stages that leads to the production of unusual cells [37]. According to (WHO 1996) the threshold level of lead for agricultural soil is 50–300 $mg\ kg^{-1}$ while threshold level of lead for plant is 2 $mg\ kg^{-1}$ [38]. **Figure 5.**

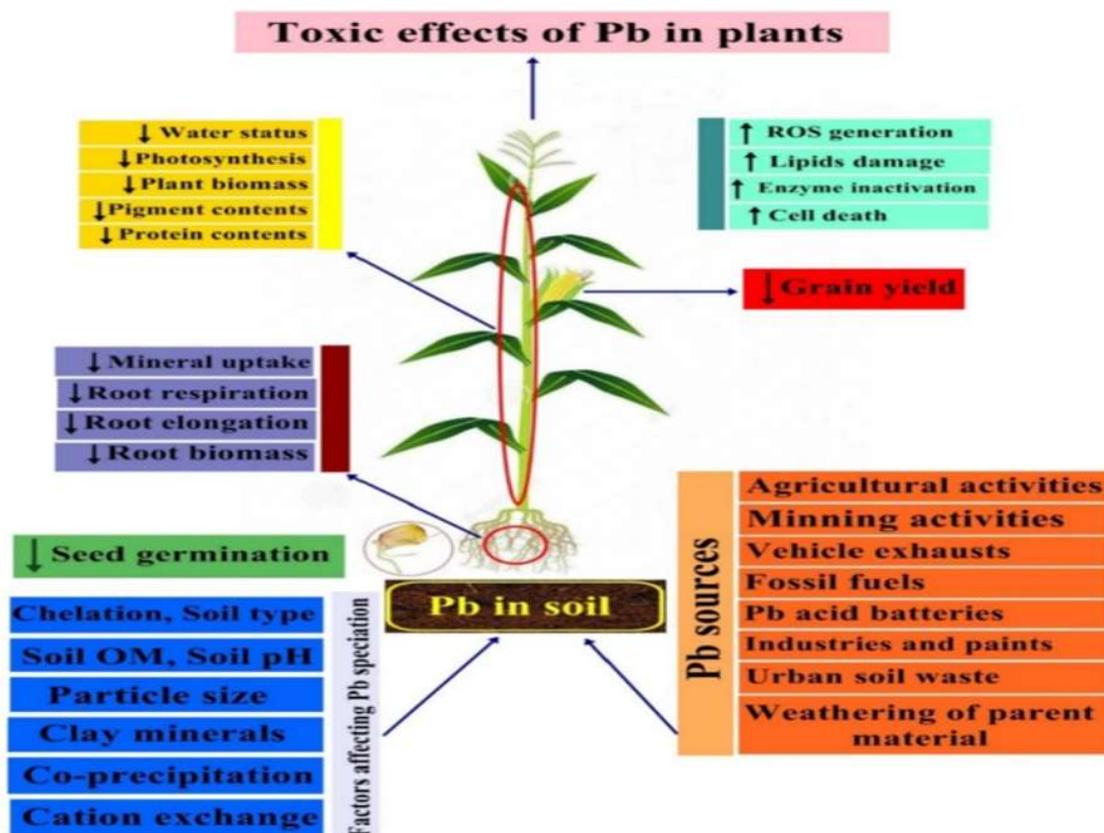


Figure 5: Potential *Pb* sources, variables influencing *Pb* speciation in soil, and harmful effects of *Pb* on plants [38]

4. SYNERGISTIC EFFECT OF LEAD AND MICROPLASTIC ON PLANT

Microplastics are the growing toxicity in the environment and their toxicity further increases as they come in contact with environmental pollutants like heavy metal pollutants in the environment. Heavy metals are transported through microplastics, which have a variety of physicochemical features that strongly influence their mobility [39]. Metals act as catalytic or reaction residues in plastics heavy, metals have a wide range of functions when present with plastics such as biocides, antimicrobial agents,

lubricants, and flame retardants. Bioaccumulation chances of toxicity increases while adsorption of heavy metal on microplastic occur, The bioaccumulation of the dangers that heavy metals pose and microplastic according to reports in terrestrial as well as aquatic environment (plants, animals and organisms). The toxicity of the microplastic and the heavy metals depends upon the contaminant type. Human activities modernization are the main origin of microplastic and heavy metals so these are mostly co occur in the same environment, The issue of microplastics is getting worse because they adsorb heavy metal from the

environment and are thought to be the vector for heavy metal in the environment. This process is spontaneous and continuing [40]. From a latest research it was about to know that lead toxicity aggravated by microplastic only on chlorophyll a and SOD activity, as a result lead alone or in a combined form with microplastic caused a serious toxic effect on physio-biochemical that appeared to be synergistic and species-

specific [41]. The interaction of heavy metals and microplastic facilitates when biofilms develop on the surface of microplastic and by this it may alter the morphological and physiological properties. Lead and microplastic may have a synergistic effect on plants, depending on the pollutant type and concentration.

Figure 6.

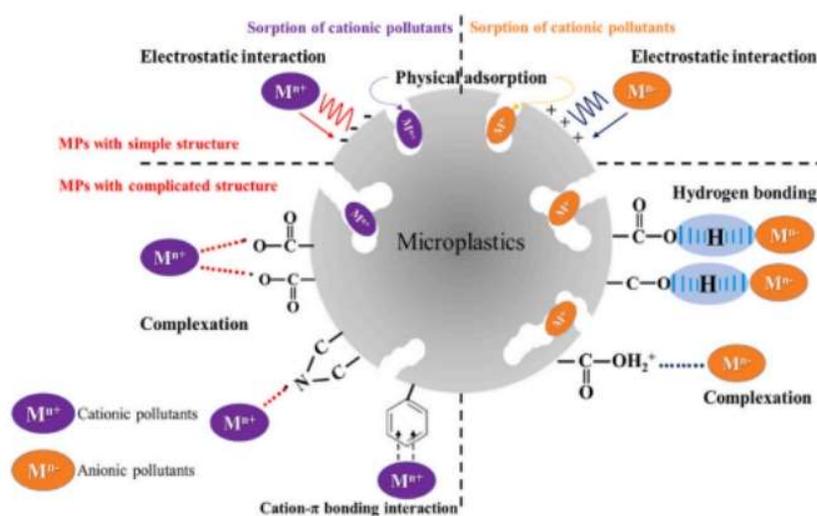


Fig. 6: Potential methods by which MPs absorb heavy metals [39]

Table 2: Combined effect of lead and microplastic on plant

S. NO.	CONTAMINANT	PLANT	CONCENTRATION	REMARKS	REFERENCE
1.	Lead + Microplastic	<i>M.aeruginosa</i>	$\geq 0.1 \text{ mg L}^{-1}$	significantly increased the growth rate	ShanWang <i>et al.</i> , 2021
2.	Lead + Microplastic	<i>M.aeruginosa</i>	0.5 mg L^{-1}	Growth rate was inhibited	ShanWang <i>et al.</i> , 2021
3.	Lead + Microplastic (PET)	<i>Triticum aestivum</i>	PET dosage is 1 g/20 mL. Pb: 0.31 ± 0.02 – $100.84 \pm 5.04 \text{ } \mu\text{g/L}$;	The change in root exudate.	Abbasi <i>et al.</i> , 2020
4.	Lead + Microplastic (PS)	<i>Dandelion Plant</i>	High concentration	Diminished the dandelion plant's capacity to fix carbon dioxide and prevented it from absorbing light by lowering the Chl level, which in turn reduced the dandelion plant's biomass.	Zhengguo Song <i>et al.</i> , 2023

5. IMPACT OF MICROPLASTIC AND LEAD ON SOIL- AGRO SYSTEM

From 1950s plastic had been used by humans in the form of plastic bottles, plastic bags and in other forms but plastic is not a recyclable product it is recycle in a very low percentage, which is mostly deposited on the landfill which is now become a concern topic in the form of microplastic. Microplastic has become a latest global concern because microplastic is a contaminant of ecosystem which is threat for the environment including humans, plants, and other life forms. There are many ways through which microplastic enters into the agricultural land and accumulate into the plants. Each year approximately 44000 to 300000 tons of

microplastic entered into the agroecosystem which is harmful for food productivity [42]. These plastics in the agroecosystem used to do modification soil temperature, control weeds, and used to reduction in the evapotranspiration and also decrease soil blemish of the products. The soil's physical and chemical traits, such as its bulk density, permeability, ability to hold water, aeration, microporosity, rooting, and nutrient immobilization. Plants and soil biota are affected by changes in the physiochemical qualities of the soil, albeit it is not always clear in which direction the effect will occur. And also on plant biomass there is negative, positive and no effects due to microplastics. **Figure 7, 8.**

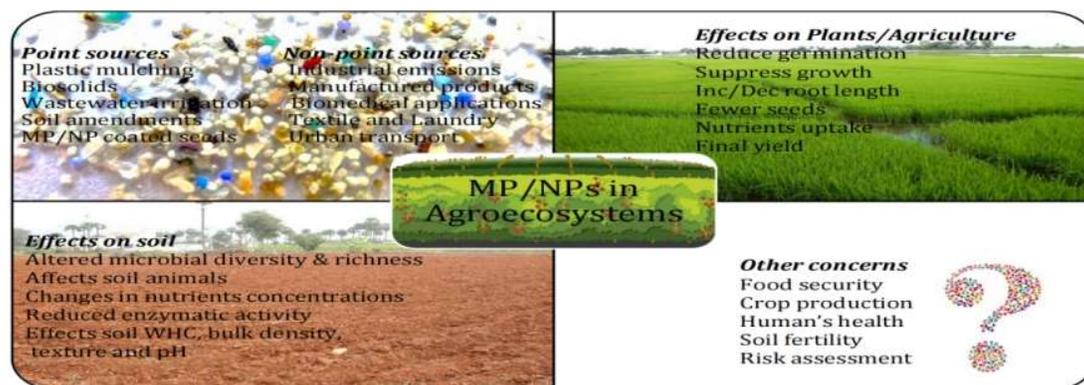


Figure 7: Sources of microplastics and nanoplastics in agroecosystems, effects on vegetation and agriculture, changes to soil properties, and effects on microbial communities, and key issues with these globally significant contaminants [42].

Through the anthropogenic activities like the use of (fertilizers, organic manures, industrial waste, municipal wastes, and irrigation) trace elements specially heavy metals enters into an agroecosystem, And

because of the accumulation of heavy metals in the soil the soil functions get restricted like cause toxicity to the plant which contaminate the food chain [43]. Lead behaviour in the soil is responsible for

the lead uptake in the plant and the lead behaviour include its fluidity and saturation, speciation, and accessibility. Leafy vegetables grown in a lead contaminated soil accumulated the high concentration of lead which is spreading in the food web which create numerous risks to human health [44]. From the external atmosphere lead directly absorbed by the soil and through soil lead directly enters into the plant system, and in the the plant system nutrients uptake along with the lead cations occur directly from the well-developed root system to the plant's aerial portions through xylem and phloem. Due to the anthropogenic activities lead released into the soil due to which soil becomes contaminated and because of lead the microorganism in the soil get affected by which soil fertility affected such as high or low temperatures, acidity, salinity, and

chemical pollution which results into the loss in crop production [45]. From past few research it has been reported that lead has a strong effect on the morphology and physiology of the seed due to stomatal closure lead induced deficiency of CO_2 in the root, prevention in the uptake of essential elements which is necessary for the plant growth, it inhibit germination, elongation of root, inhibit in the development of seed, chlorophyll production, decrease in the content of water and protein, slow down the growth of plant. Increased lipid peroxidation, activation of the glutathione (GSH) ascorbate cycle, superoxide dismutase (SOD), guaiacol peroxidase (POD), and ascorbate peroxidase (APX) all contribute to the inhibition of seedling growth in lead-contaminated soil.



Figure 8: Overview of the effects of contamination with heavy metals effects on agriculture and the environment [45]

6. PLANT SCIENCE, MICRO AND NANOPLASTIC, S FATE IN SOIL AND PLANTS

The effects of MNPs on soil systems and plant crops have gone unreported, despite the fact that they may gather up in plant roots and detrimentally impact terrestrial environments. There is little knowledge of the fate, environment, and ecology of MNPs in terrestrial ecosystems [46], in part because it is difficult to identify and measure MNPs in different soil samples. Farming methods, runoff, unlawful direct destruction, and fragmentation of larger plastic trash some of the environmental factors that might leach MPs. Then, direct and indirect sources are separated from these sources. MPs come from fragmentation rather than runoff, which is a direct source. MNPs need to migrate up the food chain from the soil to plants and then to other living beings in order to do this, microorganisms attached to MNPs can act as a conduit [47]. According to preliminary

evidence, soil characteristics, plant performance, and microbial activities are all impacted by MPs appearing in soil. Plants and food crops have a significant potential to interact with MPs and NPs because they form the foundation of food web. The deleterious effects of MPs/NPs on plants (such as disrupted growth, poor seed germination, and altered gene expression) are evident and can mostly be linked to oxidative stress and cytogenotoxicity [48]. According to [49], the top layer of soil is where the majority of MNPs in the agroecosystem are deposited and then move vertically to subsequent soil layers. Additionally, surface MNPs are vulnerable to being transported to new areas by wind, water, and flood - a process known as horizontal transfer of MNPs. Similar to this, human activities including composting, sewage sludge distribution, and irrigations help to spread MNPs horizontally, usually as a result of agricultural operations [50].

Figure 9.

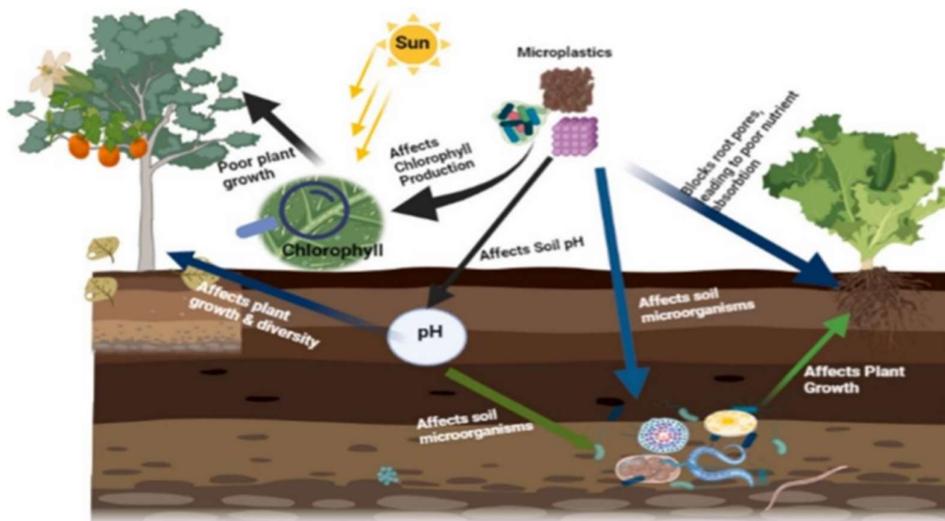


Figure 9: MNPs' presence, movement, and eventual destiny in agroecosystems. MNPs are dispersed both horizontally and vertically in agroecosystems, impacting soil biota, nutrient cycling, and plant variety. This poses serious ecological dangers [50].

7. REMEDIATION STRATEGY OF MICROPLASTIC, NANOPLASTIC AND LEAD

The management and elimination of plastic trash (macro, micro, and nano) among the most significant issues facing the entire planet. Plastic garbage that has not been treated causes a wide range of issues for all living things. Larger plastic trash can be recycled mechanically, bodily, or thermochemically; it can also be reused; burned; and other things; nevertheless the greatest challenge is dealing with micro- and nanoplastics. [51]. Microplastic pollution on soil is a serious issue nowadays because it continuously spreading in environment due to anthropogenic activities which is harmful for plants, animals and humans due to its rotation in the food web. To control microplastic pollution it is mandatory to do remediation

strategy. The source of microplastic from where the microplastic pollution generate, first step we have to do the reduction in the source, the use of biodegradable polymers instead of plastic polymers it is the primary and very initiative step to control plastic pollution and control the source of microplastic. To control the soil microplastic pollution it should be necessary to reduce the agricultural plastic films [52]. To reduce plastic pollution, the government should take rigorous action and outlaw single-use plastics like plastic shopping bags, water bottles, and other goods made of plastic. Instead, it should concentrate on a recycling system, technical method (new techniques) should be made use for determining and measuring variables of microplastics and nanoplastics to degrade the plastic waste, there should be substitute for plastic which is

environmentally friendly and for this government should take a step to promote environmental friendly products [53].

Table 3: Remediation Strategies [51]

S. No.	REMEDICATION STRATEGIES	WORKING
1.	Photocatalysis	Prior to being released into the environment, wastewater plastic is treated using photocatalysis.
2.	Adsorption on biochar	Organic and inorganic contaminants can be captured by Biochar by adhering to its surface.
3.	Flocculation	In this method, polymers—natural or synthetic—are used to settle unstable particles in water by interacting with a particular flocculant and creating massive microflocks.
4.	Bio remediation method	Plastic trash is degraded by microbial action in bioremediation.
5.	Eco- corona formation	The manner that MNPs interact with organisms alters as a result of the biomolecule called corona that they create when they absorb macromolecules from nature.
6.	Electrospun membrane	A straightforward and scalable protocol was used to create a unique membrane that provided an effective method for lowering MNPs.
7.	Filtration	A membrane-covered disc sand or pulverized filter is used for filtering as part of the tertiary process of managing MNPs litter in a WWTP, among other processes.

Lead is the toxic heavy metal found in the earth crust naturally occurring and by human activities, Its excess use result in the environmental contamination. This careless in situ remediation, in situ harsh soil limited measures, and in situ or ex situ harsh soil devastating actions are three methods for cleaning up metal-contaminated soil. At the early of year 2007 (USEPA 2007) classified the new remediation technology for

contaminated soil source control (i) and containment measures (ii). These technologies involve in situ treatment for pollutant from soil without excavation or soil removal. Source control involves the use of in situ and ex situ remediation methods to address contaminated sources. Ex situ treatment involves moving, excavating, or removing contaminated soil from the site or subsurface [54].

Table 4: Techniques for heavy-metal - contaminated soils remediation [54]

S. No.	CATEOGRY	RECOVERY TECHNOLOGIES
1	Isolation	Capping underlying barriers
2	Immobilization	The consolidation and instability Vitrification Chemical therapy
3	Toxicity and/or Mobility Reduction Physical separation	Chemical therapy walls with permeable treatments Biological treatment bioaccumulation, Phytoremediation, Bioleaching, Biochemical processes
4	Extraction	Soil washing, Pyrometallurgical extraction, and Electrokinetic treatment

REMEDICATION OF HEAVY METAL BY CHEMICAL AND BIOLOGICAL APPROACH

This approach to heavy metal removal from wastewater is economical and environmentally responsible. Due to its reduced environmental impact, this combination of chemical and biological treatment is common [55].

REMEDICATION OF HEAVY METAL BY PHYTOBIAL APPROACH

For the elimination of heavy metals from soil Utilization of plants which is cost effective as well as environmentally friendly. Heavy metals are extracted from the soil & water by both plants and microorganisms. As compared to other costly technologies phytobial remediation is more effective technology, It is also an in situ treatment technology [55].

CHELATING AGENTS

Chelating agents are organic and inorganic compounds, these agents binds to heavy metals and create chelates used to treat excessively high level of these metals from the contaminated site. **Figure 10.**

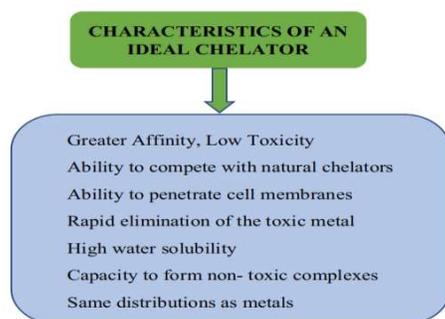


Figure 10: Perfect chelating agent characteristics for a better chelation of heavy metals [55].

8. CONCLUSION

From this review we conclude that the synergistic effect of microplastics and lead has shown phytotoxicity. The hazardous effect of microplastics and lead keeps increasing continuously in the environment due to anthropogenic activities. This spread in the aquatic ecosystem and agroecosystem directly or indirectly affects the aquatic life and terrestrial life. In this review we studied the bioaccumulation of microplastics and lead toxicity in the environment which affect the whole ecosystem, effect of microplastics on plant, effect of lead on plants and synergistic effect of plants with some previous studied research papers. As per in this review we studied the toxic effect of lead and microplastics on environment. It also included the studies on the remediation strategy and the future perspectives. In literature numerous studies explored on the effect of microplastics on aquatic environment but there is still a research gap in the study on the impact of microplastics on the terrestrial environment. The future perspective on the research of microplastics impacts on the terrestrial environment is unrevealed and new strategies to be adopted on its amelioration.

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