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A Review on Plants and Plant/Microbial Systems in Reducing Exposure

Parwiz Niazi[1], Abdul Wahid Monib[2] and Azizaqa Azizi[3]

[1]Department of Biology, Faculty of Education, Kandahar University, Kandahar, AFGHANISTAN and Department of Plant Protection, Faculty of Agriculture, Ege University, Izmir, TURKEY.

[2]Department of Biology, Faculty of Education, Kandahar University, Kandahar, AFGHANISTAN and School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, INDIA.

[3]Department of Biology, Faculty of Education, Parwan University, Parwan, AFGHANISTAN.

[1]Corresponding Author: parwiz60@gmail.com

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ABSTRACT

Plants and plant-microbial compounds can be a viable means of remediating contaminated soils, in this review, two approaches to phytoremediation are discussed, the first approach how plants can promote the growth of degrading microorganisms in the soil rhizosphere, which can lead to enhanced degradation of chlorinated pesticides; the second approach focuses on the potential of plants to remove and accumulate metals from their environment, a unique test system, the Target Neighbor Method, is used to evaluate how plant density affects metal uptake, these studies could provide valuable information for optimizing plant density to improve metal removal and remediate metal-contaminated soils or to minimize toxic metal accumulation in crops and reduce human exposure.

Keywords- Rhizosphere, microbial degradation, environmental remediation, metal.

I. INTRODUCTION

Plants are multicellular organisms that play a crucial role in the Earth's ecosystem, they are responsible for producing oxygen and absorbing carbon dioxide, and provide food and shelter for numerous other organisms, plants maintain complex relationships with microorganisms, including bacteria and fungi, which can have both positive and negative effects on plant health (Keddy, P. 2007). The rhizosphere, or the region around plant roots where microorganisms interact with the plant, is a significant plant/microbial system, microorganisms in the rhizosphere can assist plants in absorbing nutrients, fighting off diseases, and enduring abiotic conditions like heat or drought, on the other hand, some microbes in the rhizosphere can also harm plant roots and spread disease (Beerling, D. 2017). Another important plant/microbial relationship is the plant microbiome, which refers to the community of microorganisms living inside and on the surface of plants, the plant microbiome can influence plant growth, health, and disease resistance as well as the quality of the food that plants produce (Aislabie, J., et al., 2013). Many agricultural strategies, such as the use of plant growth-promoting bacteria and fungi to increase crop yields and lessen the need for synthetic fertilizers and pesticides, have been developed as a result of research in plant/microbial systems, yet, additional study is required to completely comprehend the complexity of plant/microbial interactions and create environmentally friendly agriculture techniques (Elnahal, A. S., et al., 2022). Global concern is raised by the threat that environmental pollution and contamination pose to both human health and ecology, excavation, and incineration are two common cleanup techniques that can be costly and cause secondary contamination, as a result, environmentally friendly and sustainable methods are growing in popularity as a means of lowering exposure to dangerous compounds in the environment, examples include employing plants and plant/microbial systems

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for environmental restoration and remediation (Banerjee, M. R., et al., 2006). Due to its efficacy and few negative effects on the environment, phytoremediation the use of plants to remove toxins from soil and water has attracted a lot of interest (Ali et al., 2013). Plants may absorb and detoxify a variety of toxins, including heavy metals, organic pollutants, and radionuclides, through mechanisms such as phytoextraction, phytostabilization, and phytodegradation (Lee, J. H. 2013). Moreover, through phytoremediation and phyto-monitoring, plants can enhance air quality by eliminating contaminants from the environment (Massa, D., et al., 2019). Furthermore efficient at cleaning wastewater and eliminating toxins from water, wetland plant, and microbial systems (Vymazal, 2018). How plants and plant/microbial systems can help people become less exposed to the environment's hazardous elements, the effectiveness of plants in enhancing the quality of the air and water will also be discussed, as will the potential of phytoremediation and plant/microbial systems for environmental restoration and remediation (Nelson, M., et al., 2011).

A wide variety of environmental pollutants can be absorbed and detoxified by plants with amazing efficiency, this procedure, known as phytoremediation, has been thoroughly researched as a potential remedy for environmental degradation, Via their root systems, plants absorb poisons in one of the main ways (Niazi, P., et al., 2023, Lal, R. 2008). Any poisons in the soil might be absorbed by the roots along with water and nutrients, the detoxification process allows the poisons to be broken down or changed into less dangerous chemicals once they are inside the plant (SHANNIGRAHI, A. S., et al., 2004). Various poisons can be detoxified by various plants, for instance, some plants are very good at eliminating heavy metals from the soil, such as lead, cadmium, and arsenic, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) are examples of organic contaminants that can be broken down by others (PAHs), a variety of techniques have been used to take advantage of plants' capacity to detoxify poisons, in some instances, plants are purposefully planted in contaminated places to aid in the soil's purification, this has been used to clean up industrial sites and places where there have been oil spills, in other instances, wastewater treatment plants are utilized to filter out contaminants from the water (Maurya, S. K., et al., 2015, Makkar, H. P. S., et al., 1999). Although phytoremediation is a promising strategy for reducing pollution, it is not a universally applicable approach, the type and concentration of the toxin present, the type of plant being employed, and the environmental circumstances all affect how effective phytoremediation is, if the plants are not disposed of properly, the chemicals they ingested could be discharged back into the environment (Yaashikaa, P. R., et al., 2022).

II. RHIZOSPHERE AND XENOBIOTIC DEGRADATION

Rhizosphere refers to the region of soil close to plant roots where complex interactions between plants, microorganisms, and the soil environment take place (Uren, N. C.2000). Plant roots in the rhizosphere provide a supply of carbon, energy, and nutrients for soil bacteria. In turn, the bacteria in the rhizosphere are essential for maintaining the strength and fertility of the soil, one of the major functions performed by microorganisms in the rhizosphere is the degradation of xenobiotics (Hinsinger, P., et al., 2009). Xenobiotics, which include industrial chemicals, insecticides, and herbicides, are substances that do not exist naturally in the environment, these substances can accumulate in the food chain and have detrimental impacts on the health of the soil, there are several microbial species and enzymatic pathways involved in the complex process of xenobiotic breakdown in the rhizosphere (Prasad, S., et al., 2021). Soil pH, moisture content, and temperature are just a few of the variables that might affect how xenobiotics break down in the rhizosphere, the composition of the microbial community in the rhizosphere can also have an impact on how quickly and effectively xenobiotics degrade (Wang, X., et al., 2022).

The process by which organisms, like bacteria and fungi, degrade and metabolize foreign or manmade substances that are not naturally present in the environment is referred to as xenobiotic degradation, these substances, also referred to as xenobiotics, can include industrial chemicals, insecticides, and herbicides (Singleton, I. 1994). In order to improve the environment, microbes must be able to break down xenobiotics because doing so can lower their concentration in the soil, water, and air, while some bacteria can be genetically modified to digest xenobiotics, others can do it naturally (Varsha, Y. M., et al., 2011). Many processes, including oxidation, reduction, hydrolysis, and conjugation, can lead to the breakdown of xenobiotics, complex xenobiotics can be broken down by these processes into simpler substances that the organism can then digest or eliminate (Bhatt, P., et al., 2019). Xenobiotics can linger in the environment for a very long time, xenobiotic degradation is not necessarily an easy process, however, it is crucial to carefully monitor and manage the process to avoid unexpected consequences because the metabolites of xenobiotic degradation can occasionally be even more hazardous than the parent molecules (Rieger, P. G., et al., 2002). The rhizosphere is vital for xenobiotic breakdown, which is necessary for preserving the health of the soil and preventing the buildup of hazardous substances in the environment (Moosavi, S. G., et al., 2013).

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III. PHYTOREMEDIATION AND BIOREMEDIATION

Phytoremediation and bioremediation are promising approaches for cleaning up contaminated environments, phytoremediation involves using plants to remove, degrade, or immobilize pollutants, while bioremediation involves using microorganisms to degrade or transform contaminants (Kang, J. W. 2014, Megharaj, M., et al., 2011). Phytoremediation can be classified into several categories based on the mechanism of contaminant removal, including phytostabilization, phytoextraction, phytodegradation, and phytovolatilization, the selection of suitable plant species and the optimization of plant growth conditions are crucial for the success of phytoremediation (Kumar, V., et al., 2021). Bioremediation relies on the activities of microorganisms to degrade or transform pollutants, it can be divided into two main categories: (in situ and ex-situ bioremediation), in situ bioremediation involves the stimulation of microbial activities at the contaminated site, while ex-situ bioremediation involves the removal of contaminated soil or water for treatment in a controlled environment (Fan, X., & Song, F. 2014). Both phytoremediation and bioremediation have been extensively studied and have shown promising results in the cleanup of contaminated environments, the efficiency of these approaches can be influenced by various factors such as the type and concentration of contaminants, soil conditions, and plant or microbial species used (Wenzel, W. W., et al., 1999, Arantza, S. J., et al., 2022).

IV. AIR QUALITY IMPROVEMENT

Air pollution is a significant environmental issue that affects the health and well-being of living organisms, the World Health Organization (WHO) estimates that outdoor air pollution causes over 4.2 million premature deaths per year globally, to mitigate the impacts of air pollution, various strategies have been proposed, including the use of plants and microorganisms, in this context, the use of plants and microorganisms has been investigated for their ability to improve air quality by removing pollutants through various mechanisms (Ko, F. W., & Hui, D. S. 2012, Isaifan, R. J. 2020, Vohra, K., et al., 2021, Vilela, C. L. S., et al., 2018). Plants can improve air quality by absorbing pollutants through their leaves and roots, the absorption of pollutants by plants depends on various factors such as plant species, morphology, and physiological characteristics, some plants can also emit volatile organic compounds that can act as natural air purifiers (Guo, J., et al., 2013, Martins, C., et al., 2013). Microorganisms can also contribute to air quality improvement by degrading pollutants, microorganisms have been shown to degrade various types of air pollutants, including volatile organic compounds and nitrogen oxides (Weyens, N., et al., 2015).

Plants play a significant role in carbon sequestration through photosynthesis, which involves the conversion of atmospheric carbon dioxide into organic matter, trees and other vegetation absorb carbon dioxide during photosynthesis and store it in their leaves, stems, and roots, this process is known as terrestrial carbon sequestration (Patil, P., et al., 2017). Soil microbes also play a critical role in carbon sequestration, they convert organic matter in the soil into stable forms of carbon that can remain in the soil for decades or even centuries, and this process is known as soil carbon sequestration (Miransari, M. 2013). Marine organisms such as phytoplankton, algae, and seagrass also play a significant role in carbon sequestration, these organisms absorb carbon dioxide during photosynthesis and store it in the ocean (Jha, R. K., & Zi-Rong, X. 2004).

V. WETLANDS AND WATER QUALITY IMPROVEMENT

Wetlands are areas of land where the water table is at or near the surface, and the soil is saturated with water, they are essential ecosystems that provide numerous benefits, including water quality improvement, wetlands act as natural filters, removing pollutants from water through various physical, chemical, and biological processes, the organisms that inhabit wetlands also play a crucial role in improving water quality (Rea, J. 2006). Wetland plants are adapted to grow in waterlogged soils and can absorb and store pollutants through their roots and shoots, they also provide a habitat for other organisms that contribute to water quality improvement (Otte, M. L. 2001). Microbes such as bacteria and fungi are important in wetland ecosystems and are involved in various processes that improve water quality, they can break down organic matter, convert harmful pollutants into less toxic forms, and remove excess nutrients from water (Bamforth, S. M., & Singleton, I. 2005). Aquatic animals such as fish, crustaceans, and amphibians also contribute to water quality improvement in wetlands, they help to control the population of other organisms, prevent the accumulation of organic matter, and promote the growth of beneficial plants (Magdoff, F., & Weil, R. R. 2004).

VI. SUSTAINABLE LAND MANAGEMENT

Sustainable land management is a set of practices that aim to use and manage land resources in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs, sustainable land management practices can improve soil quality, increase agricultural productivity, reduce erosion, and enhance biodiversity

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(Hurni, H. 2000, Branca, G., et al., 2013, Herrick, J. E. 2000). Soil microbes such as bacteria and fungi play a crucial role in sustainable land management, they contribute to nutrient cycling, soil organic matter decomposition, and soil aggregation, which helps to improve soil structure and fertility, plants are important in sustainable land management because they help to prevent soil erosion, improve soil quality (Nadeem, H., et al., 2021), and sequester carbon, they can provide food, fuel, and other products for human use, livestock can be managed in a sustainable way to improve soil quality, reduce soil erosion, and enhance biodiversity, proper grazing management can help to maintain healthy grasslands and reduce overgrazing (Thornton, P. K. 2010, Delgado, C., et al., 2001).

VII. ENVIRONMENTAL HEALTH AND HUMAN EXPOSURE

Environmental health is an interdisciplinary field that focuses on the study of how environmental factors can impact human health and wellbeing, exposure to environmental pollutants can result in various health issues, including respiratory illnesses, cancer, neurological disorders, and birth defects, therefore, identifying and reducing human exposure to environmental pollutants is crucial to improving public health (Wang, Z., et al., 2009). Organisms involved in environmental health research include humans, wildlife, and various ecological systems. Research in this field involves studying the effects of environmental contaminants on living organisms and, identifying effective ways to reduce exposure (Anwar, W. A. 1997). A common method used to assess human exposure to environmental pollutants is biomonitoring, which involves measuring the concentration of pollutants or their metabolites in biological samples such as blood, urine, or breast milk (G. Georgopoulos, et al., 2001). Another approach is to identify and reduce exposure to environmental pollutants through various interventions, such as promoting the use of clean energy sources, reducing air pollution from transportation, and improving waste management practices (Omer, A. M. 2008, Amann, M., et al., 2020).

Table 1: A few examples of common interactions, differentiation, and organisms involved in each of the processes.

Issue	Definition	Main Focus	Examples of Interactions	Organisms
Environmental Health and Human Exposure	The study of how the environment affects human health	Identifying and mitigating environmental hazards that can harm human health	Sustainable land management practices can reduce exposure to harmful chemicals, wetlands and other natural areas can provide ecosystem services that support human health	Humans, animals, microorganisms
Sustainable Land Management	The use of land resources in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs	Conservation and restoration of soil, water, and biodiversity, and the prevention of land degradation	Planting trees and other vegetation can improve air quality and sequester carbon, sustainable farming practices can reduce water pollution and protect wetlands	Soil microorganisms, plants, insects, birds, mammals
Wetlands	Areas of land that are saturated with water for all or part of the year	Providing habitat for a diverse range of plants and animals, storing carbon and filtering pollutants from water	Wetlands can improve water quality by filtering pollutants, can help mitigate climate change by sequestering carbon, and can provide important habitat for wildlife	Aquatic plants, fish, amphibians, reptiles, birds, mammals
Water Quality Improvement	The process of reducing or eliminating pollution from water sources	Reducing pollutants from agricultural, industrial and residential sources, and improving water treatment	Phytoremediation and bioremediation can be used to remove pollutants from water, and wetlands can act as natural filters that remove pollutants from water	Aquatic plants, algae, bacteria, fungi, zooplankton
Phytoremediation and Bioremediation	The use of plants or microorganisms to	Using plants or microorganisms to	Phytoremediation and bioremediation can be	Bacteria, fungi, algae, plants

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	remove or neutralize contaminants from soil, water, or air	break down or absorb pollutants	used to clean up contaminated soil and water, and can be used to mitigate air pollution	
Carbon Sequestration	The process of capturing and storing carbon from the atmosphere to reduce greenhouse gas emissions	Storing carbon in forests, soils, and other ecosystems, and in carbon capture and storage technology	Planting trees and other vegetation can sequester carbon, and wetlands and other natural areas can store carbon in soils and biomass	Trees, shrubs, grasses, soil microorganisms
Air Quality Improvement	The process of reducing or eliminating air pollution	Reducing emissions from transportation, industry, and other sources, and improving air quality monitoring and regulation	Sustainable land management practices can improve air quality by removing pollutants from the air, and phytoremediation and bioremediation can be used to mitigate air pollution	Trees, shrubs, grasses, lichens, algae, bacteria, fungi

VIII. CONCLUSION

There has been a lot of promise in the utilization of plants and plant/microbial systems for the rehabilitation of contaminated soils, to fully grasp how these organisms work together in a natural context, more investigation is necessary, our current understanding is restricted to the different parts and how they work separately, new researches will need to focus on understanding how plants and microbes interact with one another and their surroundings, including the chemistry and physical characteristics of the soil, this knowledge can aid researchers in manipulating these systems to speed up the predictable and efficient soil bioremediation process, the employment of plants and plant/microbial systems may become a crucial tactic in the restoration of polluted ecosystems with further research and development, plants and plant/microbial systems in reducing exposure highlights the significant potential of these systems for the remediation of contaminated soils and the reduction of human exposure to toxic substances, the use of phytoremediation and bioremediation techniques, in conjunction with the natural processes of plants and microorganisms, has been shown to effectively remove pollutants and contaminants from soil and water systems, while research has focused on the individual functions of plants and microorganisms, further investigation into their synergistic relationship is needed for more effective remediation strategies, the use of these systems provide a sustainable and cost-effective alternative to traditional remediation methods, overall, plants and plant/microbial systems represent a promising approach for reducing exposure and improving environmental health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

[1] Ali, H., Khan, E., & Sajad, M. A. (2013). Phytoremediation of heavy metals—concepts and applications. *Chemosphere*, *91*(7), 869-881.
[2] Aislabie, J., Deslippe, J. R., & Dymond, J. (2013). Soil microbes and their contribution to soil services. *Ecosystem services in New Zealand–conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand*, *1*(12), 143-161.
[3] Amann, M., Kiesewetter, G., Schöpp, W., Klimont, Z., Winiwarter, W., Cofala, J., & Pavarini, C. (2020). Reducing global air pollution: the scope for further policy interventions. *Philosophical Transactions of the Royal Society A*, *378*(2183), 20190331.
[4] Anwar, W. A. (1997). Biomarkers of human exposure to pesticides. *Environmental health perspectives*, *105*(suppl 4), 801-806.
[5] Arantza, S. J., Hiram, M. R., Erika, K., Chávez-Avilés, M. N., Valiente-Banuet, J. I., & Fierros-Romero, G. (2022). Bio-and phytoremediation: Plants and microbes to the rescue of heavy metal polluted soils. *SN Applied Sciences*, *4*(2), 59.
[6] Bamforth, S. M., & Singleton, I. (2005). Bioremediation of polycyclic aromatic hydrocarbons: current knowledge and future directions. *Journal of Chemical Technology & Biotechnology: International Research in Process, Environmental & Clean Technology*, *80*(7), 723-736.
[7] Banerjee, M. R., Yesmin, L., Vessey, J. K., & Rai, M. (2006). Plant-growth-promoting rhizobacteria as biofertilizers and biopesticides. *Handbook of microbial biofertilizers. Food Products Press, New York*, 137-181.
[8] Beerling, D. (2017). *The emerald planet: how plants changed Earth's history*. Oxford University Press.
[9] Bhatt, P., Pathak, V. M., Joshi, S., Bisht, T. S., Singh, K., & Chandra, D. (2019). Major metabolites after degradation of xenobiotics and enzymes involved

ISSN: 2583-4053
Volume-2 Issue-2 || April 2023 || PP. 1-7
https://doi.org/10.55544/jrasb.2.2.1

in these pathways. In *Smart bioremediation technologies* (pp. 205-215). Academic Press.

[10] Branca, G., Lipper, L., McCarthy, N., & Jolejole, M. C. (2013). Food security, climate change, and sustainable land management. A review. *Agronomy for sustainable development*, *33*, 635-650.

[11] Elnahal, A. S., El-Saadony, M. T., Saad, A. M., Desoky, E. S. M., El-Tahan, A. M., Rady, M. M., & El-Tarabily, K. A. (2022). The use of microbial inoculants for biological control, plant growth promotion, and sustainable agriculture: A review. *European Journal of Plant Pathology*, *162*(4), 759-792.

[12] Fan, X., & Song, F. (2014). Bioremediation of atrazine: recent advances and promises. *Journal of soils and sediments*, *14*, 1727-1737.

[13] G. Georgopoulos, A. Roy, MJ Yonone-Lioy, RE Opiekun, PJ Lioy, P. (2001). Environmental copper: its dynamics and human exposure issues. *Journal of Toxicology and Environmental Health Part B: Critical Reviews*, *4*(4), 341-394.

[14] Guo, J., Peng, Y., Wang, S., Ma, B., Ge, S., Wang, Z. & Zhang, L. (2013). Pathways and organisms involved in ammonia oxidation and nitrous oxide emission. *Critical reviews in environmental science and technology*, *43*(21), 2213-2296.

[15] Herrick, J. E. (2000). Soil quality: an indicator of sustainable land management? *Applied soil ecology*, *15*(1), 75-83.

[16] Hinsinger, P., Bengough, A. G., Vetterlein, D., & Young, I. M. (2009). Rhizosphere: biophysics, biogeochemistry and ecological relevance.

[17] Hurni, H. (2000). Assessing sustainable land management (SLM). *Agriculture, ecosystems & environment*, *81*(2), 83-92.

[18] Isaifan, R. J. (2020). The dramatic impact of Coronavirus outbreak on air quality: has it saved as much as it has killed so far? *Global Journal of Environmental Science and Management*, *6*(3), 275-288.

[19] Jha, R. K., & Zi-Rong, X. (2004). Biomedical compounds from marine organisms. *Marine drugs*, *2*(3), 123-146.

[20] Kang, J. W. (2014). Removing environmental organic pollutants with bioremediation and phytoremediation. *Biotechnology letters*, *36*, 1129-1139.

[21] Keddy, P. (2007). *Plants and vegetation: origins, processes, consequences*. Cambridge University Press.

[22] Ko, F. W., & Hui, D. S. (2012). Air pollution and chronic obstructive pulmonary disease. *Respirology*, *17*(3), 395-401.

[23] Kumar, V., Kaushal, A., Shah, M. P., & Singh, K. (2021). Phytoaugmentation technology for phytoremediation of environmental pollutants: current scenario and future prospects. In *Bioremediation for Environmental Sustainability* (pp. 329-381). Elsevier.

[24] Lal, R. (2008). Carbon sequestration. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1492), 815-830.

[25] Lee, J. H. (2013). An overview of phytoremediation as a potentially promising technology for environmental pollution control. *Biotechnology and Bioprocess Engineering*, *18*, 431-439.

[26] Magdoff, F., & Weil, R. R. (2004). Soil organic matter management strategies. *Soil organic matter in sustainable agriculture*, 45-65.

[27] Makkar, H. P. S., & Becker, K. (1999). Plant toxins and detoxification methods to improve feed quality of tropical seeds-Review. *Asian-Australasian Journal of Animal Sciences*, *12*(3), 467-480.

[28] Martins, C., Natal-da-Luz, T., Sousa, J. P., Goncalves, M. J., Salgueiro, L., & Canhoto, C. (2013). Effects of essential oils from Eucalyptus globulus leaves on soil organisms involved in leaf degradation. *PLoS One*, *8*(4), e61233.

[29] Massa, D., Benvenuti, S., Cacini, S., Lazzereschi, S., & Burchi, G. (2019). Effect of hydro-compacting organic mulch on weed control and crop performance in the cultivation of three container-grown ornamental shrubs: Old solutions meet new insights. *Scientia Horticulturae*, *252*, 260-267.

[30] Megharaj, M., Ramakrishnan, B., Venkateswarlu, K., Sethunathan, N., & Naidu, R. (2011). Bioremediation approaches for organic pollutants: a critical perspective. *Environment international*, *37*(8), 1362-1375.

[31] Miransari, M. (2013). Soil microbes and the availability of soil nutrients. *Acta physiologiae plantarum*, *35*(11), 3075-3084.

[32] Moosavi, S. G., & Seghatoleslami, M. J. (2013). Phytoremediation: a review. *Advance in Agriculture and Biology*, *1*(1), 5-11.

[33] Nadeem, H., Niazi, P., Asif, M., Kaskavalci, G., & Ahmad, F. (2021). Bacterial strains integrated with surfactin molecules of Bacillus subtilis MTCC441 enrich nematocidal activity against Meloidogyne incognita. Plant Biology, 23(6), 1027-1036.

[34] Nelson, M., & Wolverton, B. C. (2011). Plants+ soil/wetland microbes: Food crop systems that also clean air and water. *Advances in Space Research*, *47*(4), 582-590.

[35] Niazi, P., Monib, A. W., Ozturk, H., Mansoor, M., Azizi, A., & Hassand, M. H. (2023). Review on Surface Elements and Bacterial Biofilms in Plant-Bacterial Associations. Journal for Research in Applied Sciences and Biotechnology, 2(1), 204-214.

[36] Omer, A. M. (2008). Energy, environment and sustainable development. *Renewable and sustainable energy reviews*, *12*(9), 2265-2300.

[37] Otte, M. L. (2001). What is stress to a wetland plant? *Environmental and Experimental Botany*, *46*(3), 195-202.

[38] Patil, P., & Kumar, A. K. (2017). Biological carbon sequestration through fruit crops (perennial crops-natural "sponges" for absorbing carbon dioxide from atmosphere). *Plant Archives*, *17*(2), 1041-1046.

ISSN: 2583-4053

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https://doi.org/10.55544/jrasb.2.2.1

[39] Prasad, S., Malav, L. C., Choudhary, J., Kannojiya, S., Kundu, M., Kumar, S., & Yadav, A. N. (2021). Soil microbiomes for healthy nutrient recycling. *Current trends in microbial biotechnology for sustainable agriculture*, 1-21.

[40] Rea, J. (2006). *Wetlands and Water Quality Improvement*. University of Manchester.

[41] Rieger, P. G., Meier, H. M., Gerle, M., Vogt, U., Groth, T., & Knackmuss, H. J. (2002). Xenobiotics in the environment: present and future strategies to obviate the problem of biological persistence. *Journal of Biotechnology*, *94*(1), 101-123.

[42] SHANNIGRAHI*, A. S., Fukushima, T., & Sharma, R. C. (2004). Anticipated air pollution tolerance of some plant species considered for green belt development in and around an industrial/urban area in India: an overview. *International Journal of Environmental Studies*, *61*(2), 125-137.

[43] Singleton, I. (1994). Microbial metabolism of xenobiotics: fundamental and applied research. *Journal of Chemical Technology & Biotechnology: International Research in Process, Environmental AND Clean Technology*, *59*(1), 9-23.

[44] Thornton, P. K. (2010). Livestock production: recent trends, future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2853-2867.

[45] Uren, N. C. (2000). Types, amounts, and possible functions of compounds released into the rhizosphere by soil-grown plants. In *The rhizosphere* (pp. 35-56). CRC press.

[46] Varsha, Y. M., Naga Deepthi, C. H., & Chenna, S. (2011). An emphasis on xenobiotic degradation in environmental cleanup. *J Bioremed Biodegrad S*, *11*(001).

[47] Vilela, C. L. S., Bassin, J. P., & Peixoto, R. S. (2018). Water contamination by endocrine disruptors: Impacts, microbiological aspects and trends for environmental protection. *Environmental pollution*, *235*, 546-559.

[48] Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., & Mickley, L. J. (2021). Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environmental research*, *195*, 110754.

[49] Vymazal, J. (2018). Does clogging affect long-term removal of organics and suspended solids in gravel-based horizontal subsurface flow constructed wetlands? *Chemical Engineering Journal*, *331*, 663-674.

[50] Wang, X., Sial, M. U., Bashir, M. A., Bilal, M., Raza, Q. U. A., Ali Raza, H. M., & Geng, Y. (2022). Pesticides Xenobiotics in Soil Ecosystem and Their Remediation Approaches. *Sustainability*, *14*(6), 3353.

[51] Wang, Z., Duan, X., Liu, P., Nie, J., Huang, N., & Zhang, J. (2009). Human exposure factors of Chinese people in environmental health risk assessment. *Research of Environmental Sciences*, *22*(10), 1164-1175.

[52] Wenzel, W. W., Adriano, D. C., Salt, D., & Smith, R. (1999). Phytoremediation: a plant—microbe-based remediation system. *Bioremediation of contaminated soils*, *37*, 457-508.

[53] Weyens, N., Thijs, S., Popek, R., Witters, N., Przybysz, A., Espenshade, J. & Gawronski, S. W. (2015). The role of plant–microbe interactions and their exploitation for phytoremediation of air pollutants. *International journal of molecular sciences*, *16*(10), 25576-25604.

[54] Yaashikaa, P. R., Kumar, P. S., Jeevanantham, S., & Saravanan, R. (2022). A review on bioremediation approach for heavy metal detoxification and accumulation in plants. *Environmental Pollution*, 119035.