Journal of Advances and Scholarly Researches in Allied Education
Vol. 17, Issue No. 2, October-2020, ISSN 2230-7540

Interaction of Earthworms and Microorganisms in the Detoxification of Metal Contaminants

Harbir Sharma[1]*, Dr. Asgar Singh[2]

[1] Research Scholar, Shri Krishna University, Chhatarpur M.P.

[2] Professor, Shri Krishna University, Chhatarpur M.P.

Abstract - Only a few of the numerous factors that contribute to heavy metal pollution in soil include emissions and waste from various industries, fertilizers, coal combustion residues, sewage, pesticides, and mine tailings. Heavy metals are more susceptible to direct and accidental exposure due to their characteristics, such as their rapid creation rates from human-made activities and their inability to be held in a single location. The majority of metals have been shown to be durable and do not degrade as a result of microbial or chemical action. In addition to reducing soil microbial activity and agricultural output, high levels of heavy metals also put human health at risk through the food chain.The most common heavy metal contaminants found in soil are lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel (Ni). Three of the most prevalent soil pollutants are cadmium (Cd), copper (Cu), and zinc (Zn). Consequently, the study's objective is to investigate how earthworms and microorganisms interact in the detoxification of heavy metal contaminants.

Keywords - Detoxification, Heavy Metal Contaminants, Earthworms, Cadmium, Copper, Zinc.

- X -

INTRODUCTION

Soil contamination from numerous hazardous components such as organic contaminants and heavy metals has grown considerably as a result of rapid industrialisation. Soil is the primary sink for a wide range of toxicants introduced into the environment. Emissions and wastes from various sectors, fertilisers, coal combustion leftovers, sewage, pesticides, and mine tailings are only a few of the numerous causes of contamination from heavy metals in soil. Heavy metals' features, such as quick creation rates from man-made activities and their failure to be held in a single location, make them more vulnerable to direct and inadvertent exposure. Most metals do not degrade due to microbial or chemical action, and they are proven to be long lasting.Elevated heavy metal levels not only reduce soil microbial activity and agricultural output, but also endanger human health via the food chain (Mclaughlin et al, 1999).

Lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel are the most frequent heavy metal pollutants detected in soil (Ni). Cadmium (Cd), copper (Cu), and zinc (Zn) are three of the most frequent soil contaminants. Cd is one of the top three heavy metal toxins, and it has no recognised biological purpose. Cadmium is known to influence numerous enzymes in the body. It is thought that the renal damage that causes proteinuria is caused by Cd negatively impacting enzymes responsible for protein reabsorption in kidney tubules. Cd may also induce bone demineralization, either directly through bone destruction or indirectly through renal failure. Excessive exposure to airborne Cd in the workplace may damage lung function and raise the risk of lung cancer (Bernard,2008).

Copper is the world's third most common metal. Copper is typically found in drinking water from Cu pipes as well as chemicals used to reduce algae development. Sources of airborne copper include particles from suspended soils, combustion sources, the production or processing of copper-containing goods, and mine tailings. Agriculture, sludge from publicly-owned treatment plants, and urban and industrial solid waste are the primary sources of emission. Copper is necessary for the body, but excessive amounts can cause anaemia, liver and kidney damage, and stomach and intestinal distress. Long-term copper exposure can result in headaches, nausea, dizziness, vomiting, and diarrhoea in addition to nose, mouth, and eye irritation.Wilson's illness is caused by chronic copper poisoning and is characterised by hepatic cirrhosis, brain impairment, renal failure, and copper accumulation in the cornea (Wuana and Okieimen, 2011).

Zinc is another trace element that is required. In comparison to other heavy metal ions, zinc is rather safe. It is necessary for the formation of complexes such as zinc fingers in DNA and as a component of biological enzymes. Long-term zinc exposure interferes with copper absorption in the body. Zinc is engaged in cell death in the brain and plays an important part in cytotoxic processes. Plants, invertebrates, and even vertebrate fish are particularly poisonous to free zinc ions in solution (Plum et al, 2010).

Heavy metal contamination causes severe harm and risks to humans and ecosystems through direct intake or contact with contaminated sites, the food chain, drinking contaminated ground water, reduction in food quality due to phyto-toxicity, and scarcity of land suitable for agriculture, resulting in food insecurity. As a result, heavy metal resistance is a general requirement of every live cell. Because of advances in science and technology, we may now use the potential of biological variety to remediate pollution, a process known as bioremediation.

Earthworms are important organisms in terrestrial food webs. They are known as the "intestines of the earth" because they are responsible for organic matter decomposition, soil fertility improvement, and microbial activity augmentation. Pesticides, heavy metals, DDT, and PCBs, among other environmental toxins, can have varied harmful effects on earthworms (Eswaran et al. 2001). Earthworms have been employed as biological markers of pollution in the environment (Cooper and Roch, 2002). They are resistant to a wide range of chemical contaminants in soil, including heavy metals and organic pollutants, and may bioaccumulate them in their tissues (Dai et al, 2004; Nahmaniet al, 2007).Heavy metals are absorbed by earthworms by immobilisation in gut wall cells, storage in waste nodules produced within the body cavity, or excretion through calciferous glands. Some earthworm populations have been demonstrated to survive heavy metal concentrations much above the threshold amounts known to cause deadly effects (Stürzenbaumet al, 1999).

Earthworms ingest a tremendous amount of dirt, dispersing microorganisms.Earthworms have several intricate interactions with microbes. In their intestines, earthworms have millions of bacteria. They rely on microorganisms to produce degradative enzymes that degrade organic materials and fix nitrogen (Kumar et al, 2010). However, whether these bacteria hosted by earthworms play any meaningful part in the detoxification process is still unclear and yet to be discovered.

Microorganisms are good for bioremediation because they have enzymes that allow them to feed on environmental pollutants. Microorganisms have evolved numerous methods to withstand heavy metal stress as a result of the selective pressure from the metal in the growing environment. Toxic heavy metal tolerance and elimination have been researched in bacteria (Silver and Phung, 2005) and algae (Feng and Aldrich, 2004). Heavy metals can be removed from polluted fluids by microbes by bioaccumulation, precipitation, or biosorption. Heavy metal bioaccumulation is the retention and concentration of heavy metals by microorganisms. Heavy metal ions are carried from the outside to the interior of the microbial cell membrane, where they are concentrated.Heavy metal ions, particularly positively charged metal ions, are sequestered in bio sorption via metal adsorption to the negative ionic groups on cell surfaces (Terry and Stone, 2002; Akhtaret al., 2008; Liu et al., 2004; Malik, 2004).

Most microbes have specialised genes for tolerance to harmful heavy metal ions. Resistance genes are typically located on plasmids or chromosomes. Metal resistance determinants encoded by plasmids have been found to be inducible. Several genetic processes in bacteria aid in the maintenance of intracellular homeostasis of necessary metal ions as well as the acquisition of resistance to poisonous metals (Silver, 1996).Microorganisms gain metal resistance by one of two mechanisms: active metal refluxing to the cell's exterior or enzymatic detoxification, which changes the toxic chemical into a non-toxic or less toxic form (Mejáre and & Bülow, 2001).

Thus, metal tolerance/detoxification by bacteria has significant environmental and health ramifications. The immediate need is for creative and cost-effective solutions to cleanse contaminated surroundings, make them safe for human occupancy and consumption, and maintain the ecosystems that sustain life. Novel approaches that take use of microorganisms' capacity to reduce heavy metals to ecologically acceptable levels would be both economical and effective (Volesky and Holan, 1995).

Soil Pollution by Heavy Metals and Bioremediation

Heavy metal pollution of soils is quickly becoming one of the most serious environmental and human health threats. Heavy metals commonly found in soil include Ba, Cu, Cr, Co, Ni, and Zn (Krishna and Govil, 2007). Heavy metals can enter the soil through a variety of pathways, including pesticides, fertilisers, organic and inorganic amendments, mining, trash, and sludge residues (Capri and Trevisan, 2002). The variety and concentration of heavy metals in soil have steadily grown as geologic and human activities have increased, resulting in substantial environmental degradation (Su et al., 2014). Heavy metals do not dissolve or vanish from soil and might remain there for many years.

Most metals are required in trace amounts in the soil for activities such as plant absorption. Increasing heavy metal emissions into the environment represent a serious hazard for all creatures. Plants grown in heavy metal polluted soils grow, perform, and produce less (Chibuike and Obiora, 2014). Contamination by heavy metals can alter the qualitative and quantitative functioning of soil ecosystems by disrupting the activities of soil fauna and can lead to contamination of the terrestrial food chain via heavy metal transfer to soil fauna predators. Metal pollution of soil has a direct impact on microorganism populations by affecting abiotic factors such as temperature and humidity. Reduced pollution raises the temperature of the environment, allowing for a rise in the diversity of thermophilic species (Grzés, 2009). The relative toxicity of the metals (on a g g1 soil basis) declined in the sequence Cd > Cu > Zn > Pb when the impacts of Cd, Cu, Zn, and Pb on soil microorganisms and soil processes that were mediated by microbes were examined (Baath, 1989). Metals, both essential and non-essential, can alter the specificity of enzymes, damage cell membranes, impair cellular function, and even damage DNA at high doses.They have been connected to birth deformities, cancer, skin sores, retardation resulting in impairments, kidney and liver damage, and a variety of other health issues (Järup, 2003).

To cleanse contaminated environments, make them safe for human occupancy and consumption, and safeguard the functioning of the ecosystems that support life, new and cost-effective solutions must be developed. Because of advances in science and technology, we may now use the potential of biological variety for pollution cleanup, a process known as bioremediation.

Metal solubility, absorption characteristics, transport qualities, and toxicity are all affected by bioremediation (Malik, 2004). Solubilization of heavy metal pollutants in bioremediation provides a method of removal from the solid material. Heavy metal ions are reduced by enzymes in some microbial species; the reduced form of heavy metal ions is highly insoluble and precipitates out of solution. Other bacteria can mobilise heavy metals by autotrophic and heterotrophic leaching, resulting in volatilization and the dissolution of insoluble metal complexes (Malik, 2004). Heavy metal contamination has obvious eco-toxicological repercussions since it is highly bio-available and tends to bio-accumulate in the soil. Understanding the mechanics of these heavy metal trafficking channels inside terrestrial invertebrates such as the earthworm is therefore deemed critical.

Effect of Heavy Metals on Earthworms

Soil invertebrates, such as earthworms, reflect soil chemical pollution because they have direct contact with soil pore water or food exposure, as opposed to many vertebrates that are exposed indirectly through the food chain (Kammenga et al., 2000). A primary avenue for contaminant absorption is through the earthworm's skin, which is highly water permeable (Jajer et al., 2003; Vijver et al., 2005). Earthworms consume a lot of dirt and are constantly exposed to toxins through their digestive tract (Morgan et al., 2004). When earthworms live in heavy metal contaminated areas, metals accumulate in the posterior alimentary canal, which includes the gut (Andre et al., 2009).

Earthworms are an important component of soil function and play a vital part in chemical element conversions. Insecticides, heavy metals, and lipophilic organic micropollutants including polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCB) may all be removed from soil by earthworms (Contreras-Ramos et. al, 2006). Earthworms can bio-accumulate significant amounts of metals, especially heavy metals, in their tissues without having any negative effects on their physiology, according to Hartenstein et al. (1981), even when the metals are essentially non-bioavailable. According to studies, heavy metals including cadmium (Cd), mercury (Hg), lead (Pb), copper (Cu), manganese (Mn), calcium (Ca), iron (Fe), and zinc (Fe) may be absorbed and bioaccumulated by earthworms (Zn).

They may consume and accumulate exceptionally high levels of zinc (Zn) and cadmium (Cd). Cadmium is quite mobile and may easily be absorbed into earthworm soft and non-calcareous tissues. When the effects of uranium on earthworms were studied, no death or weight loss were seen, although cytotoxic and genetic effects were observed with low natural uranium concentrations (Giovanetti et al., 2010). Cadmium has been shown to produce physiological changes in earthworms, including bioaccumulation (Stürzenbaum et al., 2004), a minor weight loss (Burgos et al., 2005), and the formation of oxidative DNA damage (Nakashima et al,2008). Heavy metals were discovered to have a greater impact on Eisenia fetida life cycle characteristics such as cocoon creation and hatching rate than survival or weight change (Nahmani et al.2007).

Earthworm Interaction with Microbes

Earthworms have a digestive system that includes a throat, oesophagus, and gizzard, as well as an anterior intestine that secretes enzymes and a posterior intestine that absorbs nutrition. The number of microorganisms increases up to 1000 fold during digestion. Furlong et al. (2002) discovered that several soil microorganisms (e.g., Pseudomonas sp. and Firmicutes sp.) multiply as they move through the digestive tract of L. rubellus. Microorganisms have been reported to offer sustenance for earthworms. Earthworms and microbes work together to break down organic materials into water-soluble aggregates.

According to studies, the total number of bacteria and actinomycetes in earthworms is significantly higher than in surrounding soil. In contrast, several other data indicate that the number grew from the front to the posterior parts of the earthworm stomach (Wan Wong, 2004;). The enormous rise in the number of microorganisms in the earthworm stomach was ascribed to the large amount of water and mucus secreted in their gut. Actinomycetes nocardia, Oerskovia, and Streptomyces species, as well as bacteria such as Vibrio species, are preferentially stimulated during transit through the earthworm stomach. By expanding the surface area of organic particles, earthworms indirectly boost microbial bulk, activity, and nutrient mobilisation (Emmerling and Paulsch, 2001).They feed on a big amount of soil organic matter and create a large number of biogenic structures. They control the activities of microorganisms and other smaller invertebrates in their 'functional domains,' which are defined as the total of biogenic structures in soil and the organisms that occupy them (Lavelle et al., 1994). Earthworms rely heavily on microbes for nutrition; they encourage microbial activity in decaying organic matter by fragmenting it and inoculating it with bacteria. Earthworms have a large impact on the organisation of soil bacterial populations. Earthworms were observed to diminish the size of the injected population of Pseudomonas sp. and hence the Atrazine-degrading genetic potential in typical soil (Kersante et al., 2006).The ability of the bacteria in the earthworm's stomach to survive microbial or worm-derived digestive enzymes, intestinal mucus, and bacteriostatic substances is critical to their survival (Brown, 1995). Selective feeding methods have been discovered in many earthworm species, where some microorganisms are consumed preferentially while others are rejected (Neilson et al., 2003). Food preference studies using *D. octaedra, A. caliginosa*, and *Octolasion tyrtaeum* Savigny revealed that these earthworms favoured organic matter infected with various actinomycete species over a control (Jayasinghe et al., 2009).While *Steptomyces lipmanii* was responsible for 90% of the actinomycete, Vibrio species accounted for 73% of the microorganisms found in *Eisenia lucens'* intestine. Fungi such as *Aspergillus fumigatus and Pencillium rogueforti* were common in *Nicodrilus caliginosa's* digestive system.

The purpose of this study is to look at the interaction between the endogeic earthworm *Pontoscolex corethrurus* and its gut microflora in the absorption of heavy metals from polluted soil samples. Endogeic earthworms were chosen for the study because they reside and eat in the mineral soil layers. As a result, these earthworms are constantly in touch with polluted soil and are immediately affected by the presence of metal contaminants in the soil. This research will assist to describe the bacteria found in earthworm guts that participate in the uptake/detoxification of heavy metal contaminants. This knowledge may then be applied to field research to improve the efficacy of soil bioremediation.

CONCLUSION

Due to their properties, such as their high generation rates from human-made activities and their inability to be kept in a fixed spot, heavy metals are more sensitive to direct and unintentional exposure. Most metals have been found to be strong and resistant to chemical or microbiological deterioration. High levels of heavy metals not only decrease soil microbial activity and agricultural productivity but also put human health at risk through the food chain.Emissions and waste from various sectors, fertilizers, coal combustion residues, sewage, pesticides, and mine tailings are only a few of the many elements that cause heavy metal toxicity in soil. Lead (Pb), chromium (Cr), arsenic (As), zinc (Zn), cadmium (Cd), copper (Cu), mercury (Hg), and nickel are the most prevalent heavy metal pollutants detected in soil (Ni). Therefore, it may be said that cadmium (Cd), copper (Cu), and zinc are three of the most common soil contaminants (Zn).

REFERENCES

1. Akhtar, N., Iqbal, M., Zafar, S. I., & Iqbal, J. (2008). Biosorption characteristics of unicellular green alga Chlorella sorokiniana immobilized in loofa sponge for removal of Cr (III). *Journal of Environmental Sciences*, *20*(2), 231-239.
2. Andre, J., Charnock, J., Stürzenbaum, S. R., Kille, P., Morgan, A. J., & Hodson, M. E. (2009). Metal speciation in field populations of earthworms with multi-generational exposure to metalliferous soils: cell fractionation and high energy synchrotron analyses. *Environmental Science and Technology*, *43*(17), 6822-6829.
3. Bernard, A. (2008). Cadmium & its adverse effects on human health. *Indian Journal of Medical Research*, *128*(4), 557.
4. Burgos, M. G., Winters, C., Stürzenbaum, S. R., Randerson, P. F., Kille, P., & Morgan, A. J. (2005). Cu and Cd effects on the earthworm Lumbricus rubellus in the laboratory: multivariate statistical analysis of relationships between exposure, biomarkers, and ecologically relevant parameters. *Environmental science & technology*, *39*(6), 1757-1763.
5. Capri, E., & Trevisan, M. (Eds.). (2002). *I metalli pesanti di origine agricola nei suoli e nelle acque sotterranee* (No. 2479). Pitagora.
6. Chibuike, G. U., & Obiora, S. C. (2014). Heavy metal polluted soils: effect on plants and bioremediation methods. *Applied and environmental soil science*, *2014*.
7. Cooper, E. L., & Roch, P. (2003). Earthworm immunity: a model of immune competence: The 7th international symposium on earthworm ecology· Cardiff·

Wales· 2002. *Pedobiologia*, *47*(5-6), 676-688.
8. Dai, J., Becquer, T., Rouiller, J. H., Reversat, G., Bernhard-Reversat, F., Nahmani, J., & Lavelle, P. (2004). Heavy metal accumulation by two earthworm species and its relationship to total and DTPA-extractable metals in soils. *Soil Biology and Biochemistry*, *36*(1), 91-98.
9. Eswaran, H., Lal, R., & Reich, P. F. (2001). Land degradation. An overview conference on land degradation and desertification. In *Proceedings 2nd International Conference on Land Degradation and Desertification*.
10. Feng, D., & Aldrich, C. (2004). Adsorption of heavy metals by biomaterials derived from the marine alga Ecklonia maxima. *Hydrometallurgy*, *73*(1-2), 1-10.
11. Giovanetti, A., Fesenko, S., Cozzella, M. L., Asencio, L. D., & Sansone, U. (2010). Bioaccumulation and biological effects in the earthworm Eisenia fetida exposed to natural and depleted uranium. *Journal of Environmental Radioactivity*, *101*(6), 509-516.
12. Grześ, I. M. (2009). Ant species richness and evenness increase along a metal pollution gradient in the Bolesław zinc smelter area. *Pedobiologia*, *53*(1), 65-73.
13. Jager, T., Fleuren, R. H., Hogendoorn, E. A., & De Korte, G. (2003). Elucidating the routes of exposure for organic chemicals in the earthworm, Eisenia andrei (Oligochaeta). *Environmental science & technology*, *37*(15), 3399-3404.
14. Järup, L. (2003). Hazards of heavy metal contamination. *British medical bulletin*, *68*(1), 167-182.
15. Jayasinghe, B. D., & Parkinson, D. (2009). Earthworms as the vectors of actinomycetes antagonistic to litter decomposer fungi. *Applied Soil Ecology*, *43*(1), 1-10.
16. Kammenga, J. E., Dallinger, R., Donker, M. H., Kohler, H. R., Simonsen, V., Triebskorn, R., & Weeks, J. M. (2000). Biomarkers in terrestrial invertebrates for ecotoxicological soil risk assessment. *Reviews of Environmental Contamination and Toxicology*, *164*, 93-148.
17. Kersanté, A., Martin-Laurent, F., Soulas, G., & Binet, F. (2006). Interactions of earthworms with atrazine-degrading bacteria in an agricultural soil. *FEMS microbiology ecology*, *57*(2), 192-205.
18. Krishna, A. K., & Govil, P. K. (2007). Soil contamination due to heavy metals from an industrial area of Surat, Gujarat, Western India. *Environmental monitoring and assessment*, *124*(1), 263-275.
19. Kumar, R., Singh, B. L., Deepshikha, V., & Shweta. (2010). Enzyme activities and microflora of earthworm gut and vermireactors as indicators of the stabilization of waste degradation process. *Bioremediation journal*, *14*(3), 150-157.
20. Liu, H. L., Chen, B. Y., Lan, Y. W., & Cheng, Y. C. (2004). Biosorption of Zn (II) and Cu (II) by the indigenous Thiobacillus thiooxidans. *Chemical Engineering Journal*, *97*(2-3), 195-201.
21. Malik, A. (2004). Metal bioremediation through growing cells. *Environment international*, *30*(2), 261-278.
22. McLaughlin, M. J., & Singh, B. R. (1999). Cadmium in soils and plants. In *Cadmium in soils and plants* (pp. 1-9). Springer, Dordrecht.
23. Mejáre, M., & Bülow, L. (2001). Metal-binding proteins and peptides in bioremediation and phytoremediation of heavy metals. *TRENDS in Biotechnology*, *19*(2), 67-73.
24. Nahmani, J., Hodson, M. E., & Black, S. (2007). A review of studies performed to assess metal uptake by earthworms. *Environmental pollution*, *145*(2), 402-424.
25. Nahmani, J., Hodson, M. E., & Black, S. (2007). Effects of metals on life cycle parameters of the earthworm Eisenia fetida exposed to field-contaminated, metal-polluted soils. *Environmental pollution*, *149*(1), 44-58.
26. Nakashima, T., Okada, T., Asahi, J., Yamashita, A., Kawai, K., Kasai, H., ... & Hirano, T. (2008). 8-Hydroxydeoxyguanosine generated in the earthworm Eisenia fetida grown in metal-containing soil. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, *654*(2), 138-144.
27. Neilson, R., & Boag, B. (2003). Feeding preferences of some earthworm species common to upland pastures in Scotland. *Pedobiologia*, *47*(1), 1-8.
28. Plum, L. M., Rink, L., & Haase, H. (2010). The essential toxin: impact of zinc on human health. *International journal of environmental research and public health*, *7*(4), 1342-1365.
29. Raja, C. E., & Selvam, G. S. (2009). Plasmid profile and curing analysis of Pseudomonas aeruginosa as metal resistant. *International Journal of Environmental Science & Technology*, *6*(2), 259-266.
30. Silver, S., & Phung, L. T. (1996). Bacterial heavy metal resistance: new surprises. *Annual review of microbiology*, *50*(1), 753-789.
31. Silver, S., & Phung, L. T. (2005). Genes and enzymes involved in bacterial oxidation and reduction of inorganic

arsenic. *Applied and environmental microbiology*, *71*(2), 599-608.
32. Stürzenbaum, S. R., Kille, P., & Morgan, A. J. (1998). Heavy metal-induced molecular responses in the earthworm, Lumbricus rubellus genetic fingerprinting by directed differential display. *Applied Soil Ecology*, *9*(1-3), 495-500.
33. Su, C. (2014). A review on heavy metal contamination in the soil worldwide: Situation, impact and remediation techniques. *Environmental Skeptics and Critics*, *3*(2), 24.
34. Terry, P. A., & Stone, W. (2002). Biosorption of cadmium and copper contaminated water by Scenedesmus abundans. *Chemosphere*, *47*(3), 249-255.
35. Vijver, M. G., Vink, J. P., Miermans, C. J., & van Gestel, C. A. (2003). Oral sealing using glue: a new method to distinguish between intestinal and dermal uptake of metals in earthworms. *Soil Biology and Biochemistry*, *35*(1), 125-132.
36. Volesky, B., & Holan, Z. R. (1995). Biosorption of heavy metals. *Biotechnology progress*, *11*(3), 235-250.
37. Wan, J. H., & Wong, M. H. (2004). Effects of earthworm activity and P-solubilizing bacteria on P availability in soil. *Journal of Plant Nutrition and Soil Science*, *167*(2), 209-213.
38. Wuana, R. A., & Okieimen, F. E. (2011). Heavy metals in contaminated soils: a review of sources, chemistry, risks and best available strategies for remediation. *International Scholarly Research Notices*, *2011*.

Corresponding Author

Harbir Sharma*

Research Scholar, Shri Krishna University, Chhatarpur M.P.