Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

Organic Waste Amendments and Their Effect on Heavy Metal Retention in Soil and Garlic

Muhammad Muneeb Hassan
Department of Chemistry, University of Agriculture Faisalabad
Email: haseebfsd567@gmail.com

Saima Batool
Department of Biochemistry, Bahauddin Zakariya, University (60800) Multan.
Email: saimabatooldmc@gmail.com

Dr. Adeel Hussain Chughtai
Institute of chemical sciences, Bahauddin Zakariya University, Multan (60800), Pakistan. Email: adeelhussain@bzu.edu.pk

Muhammad Ibrahim
Department of Biochemistry, Bahauddin Zakariya University (60800) Multan.
Email: ibrahimjam@bzu.edu.pk

Rana Wajid Ejaz
Department of chemistry, University of Sargodha Ex sub campus Bhakkar.
Email: wajidtub@gmail.com

Tayyaba Mushtaq
Department of Biochemistry, University of Agriculture, Faisalabad
Email: tayyabamushtaq169@gmail.com

Hassan Farooq
Institute of Soil and Environment Science, University of Agriculture Faisalabad
Email: hassanfarooq1591@gmail.com

Muhammad Amin
Department of Chemistry, University of Baltistan Skardu, Pakistan
Email: aminmehdi385@gmail.com

Sughra Yasin
Department of Zoology, University of Narowal
Email: sughrayasin789@gmail.com

Aamir Abbas
Department of Chemistry, University of Sargodha Ex sub campus Bhakkar
Email: aamirabbas5450@gmail.com

Abstract
A lot of money is spent on chemical fertilizers in South Asia, so organic fertilizers

Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

are being researched. This study was based on the effects of different types of organic wastes such as poultry waste, press soil, and farmyard manure on the mobility of heavy metals in soil and their accumulation in garlic, a commodity consumed by humans, and its health effects. protects Risks From the results, we observed that humus leads to the accumulation of some metals, including Zn, Cu, Fe and Co, while metals such as Mn, Cd, Cr and Pb are reduced. Sludge from the press raised Cd, Cr, Fe and Pb contents in garlic while poultry litter increased Zn and Cu. Farmyard manure affects cobalt, Co and Mn in soil in the following manner. The highest PLI was observed for copper with pressed soil and the highest HRI level for cadmium with pressed soil. Zinc, however, was the highest daily intake when poultry waste was used, and lead was the highest bioaccumulated in garlic grown in press soil. This study demonstrated that garlic grown in soil amended with contaminated organic manure is potentially harmful if eaten.

Keywords: Soil Pollution; Heavy Metal Contamination; Organic Waste Amendments; Garlic; Environmental Health Risk; Sustainable Agriculture

Introduction

Soil contamination by heavy metals is a problem of global concern and affects vegetable production (Aslam et al., 2024), particularly in urban areas (Abbas et al., 2023a; Zaib and Adnan, 2024; Zeeshan et al., 2023; Iftikhar et al., 2023). Due to various forces, both natural and man-made, the nature and quality of soil has degraded and the level of heavy metal pollution is high (Abbas et al., 2023b; Zaib, 2024a). High concentrations are lethal to soil and can be absorbed by vegetable crops and stored in edible parts (Osu et al., 2021; Afzal et al., 2023a; Zaib, 2024b). This addition degrades the nutritional value of vegetables by introducing heavy metals into the food chain (Shaukat and Ali, 2023), which is highly lethal for human consumption (Zeeshan et al. 2024a) and animal consumption (Afzal et al., 2023b). For the purpose of risk comparison, the amount of trace metals offered in vegetables can be equated to the daily vegetable intake of a person (Shrestha et al., 2019; Ali et al., 2023; Zaib et al., 2023r). High levels of toxic metals mean a greater chance of their accumulation in vegetables (Abah et al., 2019; Bayar et al., 2024). However, it is important to note that the highest concentrations of heavy metals can usually be found in the upper layers of contaminated soil, thus making it easier for plants to absorb toxic heavy metals (Zeeshan et al., 2023a), leading to health issues such as cardiovascular diseases (Zaib et al., 2023a; (Zubair et al., 2023a; Zeeshan et al 2023b), kidney problems (Zaib et al., 2023b; Zeeshan et al 2024b), nervous system disorders (Zubair et al., 2023b), and bone/joint diseases in consumers (Chang et al., 2013; Ge et al., 2024; Raza et al., 2023; Zeeshan et al 2023c).

Organic materials like animal manure and sewage sludge (Zeeshan et al., 2023d) can improve the physical and chemical health of the soil (Zaib et al., 2023c). However, these materials can also have harmful substances that could affect human health, animals, and plants (Zaib et al., 2023d; Zeeshan et al., 2023e). Even so, using organic materials like farmyard manure (Zaib et al., 2023e; Zeeshan et al., 2024c), poultry waste (Zaib et al., 2024), and press mud (a

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

byproduct from sugarcane) can help improve the quality and profit of vegetables grown on polluted soils. This also helps reduce the negative effects of chemical fertilizers (Zaib et al., 2023f; Zeeshan et al., 2023f). Organic manures can reduce the movement and buildup of harmful metals in the soil, as well as their absorption by plants (Xi et al., 2016; Zaib et al., 2023g; Zeeshan et al., 2024d).
Garlic (Allium sativum L.) is a vegetable crop that contains many useful compounds. However, it is at risk of contamination by heavy metals due to human activities (Zaib et al., 2023h). In Pakistan's Sargodha region, which is a key farming area, organic materials like poultry waste, press mud, and farmyard manure are commonly used to improve soil fertility (Zaib et al., 2023i; Zeeshan et al., 2023g). Despite their widespread use, little research has been done to understand how these practices affect heavy metal levels in the soil (Chang et al., 2013; Abah et al., 2019; Zaib et al., 2023j).
Therefore, this study aims to: (a) evaluate the effects of poultry waste, press mud (Zaib et al., 2023k), and farmyard manure application on garlic growth (Zaib et al., 2023l), pollution load (Zaib et al., 2023m), and heavy metal accumulation in soil and the vegetable; (b) assess the human health risks from soil exposure and food consumption (Zaib et al., 2023n); (c) determine the risks posed by heavy metals from the organic manures (Zaib et al., 2023o); and (d) estimate the soil/vegetable contamination risk to public health from organic fertilizer applications (Zaib et al., 2023p). This will help bridge the gap in understanding the impacts of waste-derived organic amendments on heavy metal accumulation and associated health risks (Zaib et al., 2023q; Zeeshan et al 2024e).

Materials and Methods

Study Area

A pot experiment was set up to study how garlic grows in soil polluted with heavy metals. Different organic manures, such as farmyard manure, poultry waste, and sugarcane press mud, were used to improve the soil quality. Ten garlic seeds were planted in each pot filled with a mix of clay and loamy soil, and different treatments were applied. These treatments included: control (C), poultry waste (PW), farmyard manure (FYM), and press mud (PM). The pots were watered with tap water until the first compound leaf appeared. The experiment was done under conditions with an average daytime temperature of 25°C, nighttime temperature of 20°C, and 55–60% relative humidity. The organic manures were collected from the Sargodha region of Pakistan. Each treatment was repeated three times, making a total of 12 pots arranged in a completely randomized design (CRD). The soil in each pot was a mix of 50% organic manure and 50% loamy clay garden soil. Garlic plants were harvested twice during the experiment: the first harvest was 45 days after the seedlings appeared, and the second harvest, for bulbs, was done around 90 days later.

Sample Collection

- *Soil and Plant Sampling*
  Soil samples were collected randomly from the treated pots. These samples were dried, crushed, and passed through a 2 mm sieve. Then,

Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

they were sealed in plastic bags and kept in a freezer at -80°C for later analysis. Garlic samples were collected and cleaned by washing first with distilled water and then with diluted hydrochloric acid to remove dust and dirt. The plant samples were also washed with deionized water to remove any soil particles. After washing, the samples were crushed using a grinder and stored at -80°C for future testing. Before analysis, the samples were air-dried for four days and kept in sealed paper bags. They were then fully dried in an oven at 80°C for three days.

- *Wet Digestion and Metal Testing*
  The wet digestion method was used for soil and plant samples. About 1 gram of air-dried soil or plant material was placed in a digestion flask. A mixture of concentrated acids (5 mL of HNO_3, $HClO_4$, and H_2SO_4 in a 5:1:1 ratio) was added. The mixture was left for 24 hours to ensure proper digestion. After cooling, the digested material was filtered using Whatman #42 filter paper.
- The concentration of metals in soil and garlic leaf samples was determined using an Atomic Absorption Spectrophotometer (AAS). The metals tested included cadmium (Cd), chromium (Cr), copper (Cu), cobalt (Co), iron (Fe), manganese (Mn), lead (Pb), and zinc (Zn). Standard European Commission methods were followed, and the detection limits were calculated using approved techniques.
- *Quality Control*
  - Equipment Calibration: Instruments were calibrated using standard reference values.
  - Deionized Water: Used throughout to prevent contamination.
  - Certified Reference Materials: SRM-2711 for soil and SRM NIST-1577b for garlic were used to ensure accurate results.
- Average recovery rates for soil and garlic are shown below:

Table 1: Recovery Rates

Metal	Soil Recovery (%)	Garlic Recovery (%)
Mn	92	109
Cr	98	97
Co	93	94
Cd	95	92
Pb	104	95
Cu	96	91
Zn	90	88

Pollution Load Index (PLI)

The Pollution Load Index (PLI) measures the level of contamination in soil. The formula used is:

$$\mathbf{PLI} = \frac{\text{Metal in soil sample}}{\text{Metal in reference sample}}$$

Bioconcentration Factor (BCF)

Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

The Bioconcentration Factor (BCF) shows how plants absorb metals from soil. The formula is:

$$\mathbf{BCF} = \frac{\text{Metal in plant tissues (mg/kg)}}{\text{Metal in soil (mg/kg)}}$$

Daily Intake of Metals (DIM)

The Daily Intake of Metals (DIM) helps assess health risks to consumers. It is calculated as:

$$\mathbf{DIM} = \frac{\text{Cmetal} \times \text{Dfood intake}}{\text{Baverage weight}}$$

Where:

- Cmetal = Metal concentration in grains
- Dfood intake = Daily vegetable intake (0.345 kg/person/day)
- Baverage weight = Average body weight

Health Risk Index (HRI)

The Health Risk Index (HRI) estimates risks from metals in food. It is calculated as:

$$\mathbf{HRI} = \frac{\text{DIM}}{\text{RfD}}$$

Where:

- RfD = Oral reference dose
- An HRI > 1 indicates a high health risk.

Statistical Analysis

The data was studied using SPSS software (version 20.0) to run ANOVA tests. Average values and standard errors were calculated in Microsoft Excel. For Principal Component Analysis (PCA) and Cluster Analysis, OriginPro 2021 software was used.

Results and Discussion

Metal Levels in Soil

Table 1 shows the levels of metals found in the soil. Different organic manures, like poultry waste, press mud, and farmyard manure, affected these metal levels in various ways. Metals like zinc (Zn), copper (Cu), iron (Fe), and cobalt (Co) increased, while manganese (Mn), cadmium (Cd), chromium (Cr), and lead (Pb) decreased.

Table 2: Heavy Metal Concentrations in Soil and Garlic (mg/kg)

Metal	Control	Poultry Waste	Press Mud	FYM	Permissible Limit
Cd	0.448	0.332	0.457	0.394	0.5
Co	0.537	0.455	0.562	0.488	1
Cr	0.135	0.146	0.779	0.189	50
Cu	1.222	1.310	1.251	1.254	20
Fe	0.179	0.126	0.108	0.141	10
Mn	1.868	5.682	5.682	0.720	1000

ISSN Online: 3007-3154
ISSN Print: 3007-3146
Vol. 2 No. 5 (December) (2024)

Pb	0.537	0.023	0.082	0.053	30
Zn	4.535	17.633	12.69	10.71	50

Table 3: Analysis of Variance (p-values)

Metal	**Soil (p-value)**	**Plant (p-value)**
Cd	0.005	0.003
Co	0.163	0.005
Cr	0.114	0.046
Cu	0.372	0.004
Pb	0.984	0.831
Fe	0.111	0.918
Mn	0.724	0.262
Zn	0.514	0.171

Key Insights

- Organic fertilizers improved soil quality and reduced heavy metal mobility.
- Higher soil pH immobilized metals, reducing their bioavailability.
- All treated pots showed metal levels below permissible limits, indicating safe soil quality.

Conclusion

This study found that using different organic wastes like poultry waste, press mud, and farmyard manure can increase pollution in the soil and garlic. Organic materials caused more metals like zinc (Zn), copper (Cu), iron (Fe), and cobalt (Co) to build up, while manganese (Mn), cadmium (Cd), chromium (Cr), and lead (Pb) were found in smaller amounts in the soil. Adding press mud (PM) to the soil increased the levels of Cd, Cr, Fe, and Pb, while Cu and Zn built up in garlic. Farmyard manure (FYM) led to the appearance of cobalt (Co) and manganese (Mn). The metal levels in the soil were within safe limits, and the metal levels in garlic were also below the allowed limits. However, the health risk index for Cd and Pb was above 1, which means there could be health risks. This suggests that eating garlic grown in contaminated soil could be harmful. Future studies should look into the environmental effects of organic fertilizers, changes in soil health, and ways to improve soil quality.

References

Abah, H., Nwankwo, A., & Orgem, C. (2019). Waste management practices in selected poultry farms and its effect on the environment and human health in makurdi, nigeria. International Journal of Environment Agriculture and Biotechnology, 4(1), 121-127. https://doi.org/10.22161/ijeab/4.1.20

Abbas, R., Zaib, M., Haider, K., Abbasi, M.A.R., Haseeb, M., Hassan, M.B.K., Nawaz, M.M., Abbas, Z., Usama, M., Khalid, S. & Nasir, A.S. (2023a). Remediation of Heavy Metal Contaminated Sites by Application of Biochar: A Review with Future Prospects. *International Journal of Scientific Research and Engineering Development. 05(07),* 59-73.

Abbas, Z., Zaib, M., Bayar, J., & Sidra,. (2023b). Effects of Cover Crops on Soil Physical Properties: A Comprehensive Review. 05. 261-290.

Afzal, A., Zubair, H., Ali, U., Nawaz, M., Mansoor, A., Zaib, M., & Marium, A. (2023b). Mechanisms of Disease Resistance in Plants for Sustainable Agriculture. *Curr. Rese. Agri. Far. 4(5),* 1-13. DOI: http://dx.doi.org/10.18782/2582-7146.207

Afzal, A.H., Zubair, H., Abid, S., Shahzaib, M., Hassan, M., Khalid, S., Shoaib, M., Ahmad, A., Zaib, M. (2023a). Impacts of Water Logging on Soil Microbial Intentions and Mung Bean (*Vigna radiata* L.) Physiology. *Ind. J. Pure App. Biosci. 11(6),* 68-79. doi: http://dx.doi.org/10.18782/2582-2845.9036

Ali, S., Zaib, M., Zubair, H., Afzal, A., Zehra, E., Ashraf, M., Farooq, M., Ahmad, M., Asif, H. & Marium, A. (2023). Ecological Restoration of Degraded Lands. *Curr. Rese. Agri. Far. 4(4),* 25-34. DOI: http://dx.doi.org/10.18782/2582-7146.205

Aslam S, Mansoor M, Bano S, Zeeshan A, Ilyas A, Eman A, et al. Ethnoveterinary Study of Medicinal Plants of District Okara, Pakistan. Journal of Health and Rehabilitation Research. 2024; 4(2):963-970.

Bayar, Jalal & Ali, Nawab & Dong, Younsuk & Ahmed, Uzair & mehran anjum, Muhammad & Khan, Gul & Zaib, Muhammad & Jalal, Arshad & Ali, Rovaid. (2024). Biochar-based adsorption for heavy metal removal in water: a sustainable and cost-effective approach. Environmental Geochemistry and Health. 46. 428. 10.1007/s10653-024-02214-w.

Chang, C., Yu, H., Chen, J., Li, F., Zhang, H., & Liu, C. (2013). Accumulation of heavy metals in leaf vegetables from agricultural soils and associated potential health risks in the pearl river delta, south china. Environmental Monitoring and Assessment, 186(3), 1547-1560. https://doi.org/10.1007/s10661-013-3472-0

Ge, Shiji & Zhiqiang, Jiao & Gao, Chenyang & Zaib, Muhammad & Ruan, Xinling & Wang, Yangyang. (2024). Potential Health Risks for Long-Term Stays in Underground Parking Garages: Implications of Polycyclic Aromatic Hydrocarbons in Surface Dust. Indoor Air. 2024. 5527710. 10.1155/2024/5527710.

Iftikhar A, Aijaz N, Farooq R, Aslam S, Zeeshan A, Munir M, et al. Beneficial Role of Phosphate Solubilizing Bacteria (PSB) In Enhancing Soil Fertility Through A Variety of Actions on Plants Growth and Ecological Perspective: An Updated Review. Journal of Xi'an Petroleum Institute (Natural Science Edition). 2023; 19(9):520-547.

Osu, S., Udosen, I., & Udofia, G. (2021). Remediation of crude oil contaminated soil, using organic supplement: effects on growth and heavy metal uptake in cassava (manihot esculenta crantz). Journal of Applied Sciences and Environmental Management, 25(1), 5-14. https://doi.org/10.4314/jasem.v25i1.1

Raza, Irfan & Zubair, Muhammad & Zaib, Muhammad & Khalil, Muhammad Hamza & Haidar, Ali & Sikandar, Asma & Abbas, Muhammad Qamer & Javed, Ahsan & Liaqat, Muhammad & Ain, Arisha & Nafees, Muhammad

Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 2 No. 5 (December) (2024)

& Ashfaq, Muhammad. (2023). Precision Nutrient Application Techniques to Improve Soil Fertility and Crop Yield: A Review with Future Prospect. International Research Journal of Education and Technology. 05. 109-123.

Shaukat S, Zeeshan A. Application of Floating Wetland for Treatment of Paper Mill Wastewater. Journal of Plantarum. 2023; 5(1):69-86.

Shrestha, P., Bellitürk, K., & Görres, J. (2019). Phytoremediation of heavy metal-contaminated soil by switchgrass: a comparative study utilizing different composts and coir fiber on pollution remediation, plant productivity, and nutrient leaching. International Journal of Environmental Research and Public Health, 16(7), 1261. https://doi.org/10.3390/ijerph16071261

Xi, Z., Xu, Y., Ma, B., & Wang, S. (2016). Evolution of heavy metal contents in the soil of protected vegetable fields and its environmental quality evaluation in yongnian county of hebei province in china. World Journal of Engineering, 13(3), 258-265. https://doi.org/10.1108/wje-06-2016-035

Zaib, M. & Adnan, M. (2024). Phytoremediation: A Comprehensive Look at Soil Decontamination Techniques. *International Journal of Contemporary Issues in Social Sciences. 3(1),* 998-1029.

Zaib, M. (2024a). Biofortification: Bridging the Nutrient Gap in Chinese Agricultural Practices. *International Journal of Contemporary Issues in Social Sciences. 3(1),* 902-911.

Zaib, M. (2024b). Boron Nutrient for Sustainability of Plant Growth and Soil Health: A Review with Future Prospects. *International Journal of Contemporary Issues in Social Sciences. 3(1),* 912-931.

Zaib, M., Abbas, Q., Hussain, M., Mumtaz, S., Khalid, M., Raza, I., Abbas, S., Danish, M., Abbas, R., Muhammad, N. & Bano, S. (2023a). Micronutrients and Their significance in Agriculture: A Mini Review with Future Prospects Corresponding Author address. *International Research Journal of Education and Technology. 05(04),* 234-252.

Zaib, M., Aryan, M. & Ullah, H. (2023b). Innovative Inorganic Pollutant Bioremediation Approaches for Industrial Wastewater Treatment: A Review. *International Journal of Scientific Research and Engineering Development. 6(4),* 1294-1304

Zaib, M., Aryan, M., Khaliq, A., Haider, K., Ahmad, S., Zeeshan, A., Haq, U., Ahmad, U., Akbar, H. & Zubair, H. (2023c). Essential Insights for Effective Environmental Management and Human Well-being: Strategies for Remediation in Soil-Plant- Environment Systems. *Journal of Asian Development Studies.12(03),* 1-17.

Zaib, M., Farooq, U., Adnan, M., Abbas, Z., Haider, K., Khan, N., Abbas, R., Nasir, A., Sidra., Muhay-Ul-Din, M., Farooq, T., & Muhammad, A. (2023d). Optimization water stress in crop plants, implications for sustainable agriculture: current and future prospects. *Journal of Environmental & Agricultural Sciences. 25 (1&2),* 37-50.

Zaib, M., Farooq, U., Adnan, M., Sajjad, S., Abbas, Z., Haider, K., Khan, N., Abbas, R. & Nasir, A. (2023e). Remediation of Saline Soils by Application of Biochar: A Review. *Journal of Agriculture and Environmental*

Sciences. 24(3&4), 29-36.

Zaib, M., Hassan, M.M., Haseeb, M.H. & Zeeshan, A. (2024). Soil Microbes and Human Health: A Comprehensive Review. *International Journal of Contemporary Issues in Social Sciences. 3(1),* 939-951.

Zaib, M., Ibrahim, M., Aryan, M., Mustafa, R., Zubair, M., Mumtaz, S. & Hussain, T. (2023f). Long-Term Efficacy of Biochar-Based Immobilization for Remediation of Heavy Metal-Contaminated Soil and Environmental Factors Impacting Remediation Performance. *International Journal of Scientific Research and Engineering Development. 06(05),* 58-72.

Zaib, M., Raza, I., Zubair, M., Arif, Z., Mumtaz, M., Abbas, M.Q., Javed, A., Salman, S., Sikandar, A., Kashif, M., Muneeb, M. & Uzair, M. (2023g). Nano-Enabled Soil Amendments for Improved Soil Structure and Water Holding Capacity: An In-depth Review. *International Research Journal of Education and Technology. 05(08),* 344-357.

Zaib, M., Sandhu, M., Zar, M., Ghani, U., Rehman, A., Musharraf, M., Zubair, M., Abbas, R. & Raza, I. (2023h). A Brief Review on Plant Growth Promoting Rhizobacteria (PGPR): A Key Role in Plant Growth. *International Research Journal of Education and Technology. 05(07),* 104-126.

Zaib, M., Zeeshan, A., Akram, H., Amjad, W., Aslam, S. & Qasim, S. (2023i). Impact of Climate Change on Crop Physiology and Adaptation Strategies: A Review. *International Research Journal of Education and Technology. 05(08),* 15-38.

Zaib, M., Zeeshan, A., Akram, H., Amjad, W., Bano, S., Aslam, S., Qasim, S., Faiz, S., Nazar, A. & Nazim, F. (2023j). Innovative Approaches Utilizing Plant-Based Techniques for Soil An In-depth Review. *International Research Journal of Education and Technology. 05(08)*, 319-330.

Zaib, M., Zeeshan, A., Akram, H., Amjad, W., Bano, S., Aslam, S., Qasim, S., Faiz, S., Nazar, A. & Nazim, F. (2023k). Innovative Approaches Utilizing Plant-Based Techniques for Soil Conservation: An In-depth Review. *International Research Journal of Education and Technology. 05(08)*, 319-330.

Zaib, M., Zeeshan, A., Akram, H., Hameed, S., Wakeel, A., Qasim, S. & Aslam, S. (2023l). Soil Contamination and Human Health: Exploring the Heavy Metal Landscape: A Comprehensive Review. *Journal of Health and Rehabilitation Research. 3(2),* 351-356. DOI: 10.61919/jhrr.v3i2.123

Zaib, M., Zeeshan, A., Aslam, S., Bano, S., Ilyas, A., Abbas, Z., Nazar, A. & Mumtaz, S. (2023m). Drought Stress and Plants Production: A Review with Future Prospects. *International Journal of Scientific Research and Engineering Development. 06(04)*, 1278-1293.

Zaib, M., Zubair, H., Afzal, A., Naseem, M., Maryam, D., Batool, S., Raza, S., Umar, M., Marium, A. & Tariq, H. (2023n). Biofortification for Enhancement of Micronutrient Contents in Cereals. *Ind. J. Pure App. Biosci. 11(6),* 53-67. DOI: http://dx.doi.org/10.18782/2582-2845.9035

Zaib, M., Zubair, H., Akbar, H., Zahra, M., Ali, U., Afzal, A., & Marium, A. (2023o). Emerging Trends in Biofortification for Microelement Enrichment in Crop Edibles: Implications for Health. *Curr. Rese. Agri.*

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 2 No. 5 (December) (2024)

Far. 4(4), 15-24.

Zaib, M., Zubair, M., Aryan, M., Abdullah, M., Manzoor, S., Masood, F. & Saeed, S. (2023p). A Review on Challenges and Opportunities of Fertilizer Use Efficiency and Their Role in Sustainable Agriculture with Future Prospects and Recommendations. *Curr. Rese. Agri. Far. 4(4)*, 1-14. doi: http://dx.doi.org/10.18782/2582-7146.201

Zaib, M., Zubair, M., Mumtaz, S., Shaheen, C., Muqaddas, A., Sarwar, R., Noman, M., Irfan, M., Aman, Z., Hanan, A. & Sajid, S. (2023q). Trace Elements Behavior in Salt-Affected Soils: A Review. *International Journal of Scientific Research and Engineering Development. 06(05)*, 73-81.

Zaib, M., Zubair, M., Rani, M., Nawaz, S., Haider, W., Shafiq, M., Cheema, Q., Shabbir, U., Nawaz, H. & Noor, M (2023r). In-Situ Remediation Strategies to Treat Polluted Water: A Review. *International Research Journal of Education and Technology. 05(08)*, 331-343.

Zeeshan A, Abbas M, Qasim S, Nawaz L, Najam M, Waqas M, Zubair M, et al. Addressing Nutrient Deficiencies Through Zinc Biofortification. Emerging Trends in Sustainable Agriculture. 2024a; 95-146.

Zeeshan A, Akram H, Ilyas A, Niaz S, Nazar A, Shakeel Y. Solanum Nigrum Linn: An Analysis of the Therapeutic Properties of Plant. Journal of Pure and Applied Agriculture. 2023a; 8(4):1-10.

Zeeshan A, Akram H, Nasir A, Manzoor S. Historical Significance and Modern Applications of Turmeric (Curcuma Longa) in Traditional Medicine and Beyond. International Research Journal of Educational Technology. 2023b; 5(11):113-123.

Zeeshan A, Akram H, Nazar A, Shoukat A, Pearl C, Nazim F, et al. Medicinal Importance of Ginger (Zingiber Officinale): A Systematic Review. GU Journal of Phytosciences. 2024b; 4(1):331-342.

Zeeshan A, Akram H, Qasim S, Naseer A, Nazar F, Rafique O. The Healing Touch of Foeniculum Vulgare Mill. (Fennel): A Review on Its Medicinal Value and Health Benefits. Journal of Health and Rehabilitation Research. 2023c; 3(2):793-800.

Zeeshan A, Amjad W, Akram H, Mobeen N, Qasim S, Naseer A, et al. Assessment of Nursery Administration and Identification of Ornamental Plant Species: A Case Study of Tehsil Pattoki (Pakistan). Journal of Asian Development Studies. 2023d; 12(4):468-480.

Zeeshan A, Amjad W, Faiz S, Noor M, Akram W, Yameen I, et al. Medicinal Importance of Solanum Nigrum Linn; A Review. Journal of Plant and Environment. 2023e; 5(2):181-189.

Zeeshan A, Amjad W, Masood M, Akram W, Yameen I, Mansoor M, et al. Neem's Bioactive Marvels: A Therapeutic Review. Journal of Health and Rehabilitation Research. 2024c; 4(1):185-195.

Zeeshan A, Hafeez UB, Abdullah M, Saeed S, Tariq MH, Abbas M, et al. The Controversy Surrounding Water Use and Its Implications for Crop Production: A Review with Current and Future Directions. International Research Journal of Educational Technology. 2023f; 5(10):336-351.

Zeeshan A, Munir MA, Sadia S. Unlocking the Promise of the "Miracle Tree": A

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

Review on Therapeutic Applications and Phytochemistry of Moringa Oleifera L. Journal of Bioresource Management. 2024d; 11(1):102 (Zeeshan et al 2024d)

Zeeshan A, Nazar A, Akram H, Hafeez I, Tariq A, Ali G, et al. Parthenium Hysterophorus L: A Review of Its Phytochemical, Biological and Therapeutical Applications. Lahore Garrison University Journal of Life Sciences. 2023g; 7(3):281-302.

Zeeshan A, Waqas M, Ramzan M, Ghafoor F, Usama I, Ibrahim M, et al. Narrative Review From Fields to Families: Understanding the Health Impacts of Excessive Soil Fertilization. Journal of Health and Rehabilitation Research. 2024e; 4(2):990-995.

Zeeshan, A., & Zaib, M., Ahmad, S., Akram, H. & Qasim, S. (2023). Diversity of Weeds in Rose Field in District Kasur Punjab Pakistan. *Int. J. Adv. Res. Sci. Technol. 12(09),* 1122-1132.

Zubair, H., Afzal, A., Shahid, M., Ali, U., Iftikhar, H., Abuzar, A., Zaib, M. & Marium, A. (2023a). Historical Overview of the Chinese Agricultural Sciences and Technological Development. *Curr. Rese. Agri. Far. 4(4),* 35-45. DOI: http://dx.doi.org/10.18782/2582-7146.206

Zubair, M., Raza, I., Batool, Y., Arif, Z., Muneeb, M., Uzair, M., Haidar, A., Zaib, M., Ashfaq, M., Akbar, H., Abbas, Q. & Ali, A. (2023b). A Review of Remediation Strategies against Arsenic (As) Removal from Groundwater by Using Different Filtration Techniques. *Curr. Rese. Agri. Far.* 4(3), 1-14. doi: http://dx.doi.org/10.18782/2582-7146.192