International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2023; SP-8(4): 793-795

https://www.mathsjournal.com
Received: 03-05-2023
Accepted: 05-06-2023

Sonal Vishnoi
Associate Professor, Department of Chemistry, P.G. Govt. Collage, Hisar, Haryana, India

Manju Bala
Guest Lecturers, Department of Applied Chemistry, Govt. Polytechnic Sonipat, Haryana, India

Anu Godara
Research Scholar, Department of Chemistry, JCDV, Memorial College, Sirsa, Haryana, India

Corresponding Author:
Sonal Vishnoi
Associate Professor, Department of Chemistry, P.G. Govt. Collage, Hisar, Haryana, India

Post-harvest maize DTPA extractable Cd and Ni in soil as influenced by chelating agents

Sonal Vishnoi, Manju Bala and Anu Godara

Abstract
The pot experiment was conducted by taking three bulk surface soil samples varying in textures. First sample was taken from the sand dune area of Balsamand Village of Hisar District to study the tolerance of heavy metals by different genotypes of Indian mustard and maize crops. Second from the sewer water and sewage sludge polluted fields near the main disposal outlets behind main bus stand of Hisar to study uptake of Cadmium. The soil samples were air dried, grounded and passed through a 2 mm stainless steel sieve and was mixed thoroughly. The processed soil samples were used for laboratory and pot experiments. The pot experiment for heavy metal tolerance study was conducted, taking maize (three genotypes J-1006, HM-4 and HKH-1183) on Cd (@ 30, 60, 90, 120 and 150 mg kg^{-1}) and Ni (@ 100, 150, 200, 250, 300 mg kg^{-1}) spiked soil. From these investigations it is apparently clear that genotype J 1006 of maize can be grown successfully in soils having low to medium levels of pollution due to industrial wests, sewer water and sewage sludge. However, if the pollution persists and the heavy metals are accumulated in slightly toxic quantities below a threshold level, soil amendments with FYM and use of EDTA would be desirable to raise crops with reasonable success.

Keywords: Chelator, post-harvest, cadmium, nickel uptake, heavy metal, toxicity, maize

Introduction

In an ideal ecological system, there would be no pollution. However, with the establishment of permanent human settlements by great numbers of people, pollution became a problem and has remained one ever since. Cities of ancient times were often noxious places, fouled by human wastes and debris. In the Middle Ages, unsanitary urban conditions favoured the outbreak of population-decimating epidemics. During the 19^{th} century, water and air pollution and accumulation of solid wastes were largely problems of only a few large cities. But, over the course of recent decades, urbanization, industrial and agricultural activities have led to a continuous production of huge amount of heavy metals contaminated solid, liquid and as fine particles directly into atmosphere and ultimately deposited on the surface of land and water bodies which finally on reaching the agricultural fields get accumulated in soil at hazardous levels (Raskin *et al.*, 1997 and Al-Hawari and Mulligan, 2006) [10, 1]. In addition, mining, smelting, and the associated activities are one of important sources by which soils, plants, and surface waters are contaminated (Jung, 2008) [4].

In Haryana also large amount of sewage water and industrial effluent is produced every day which is used as a potential source of irrigation of fields. Long term application of effluent for irrigating crops may cause potentially toxic metal accumulation in soil to such an extent that they may cause toxic effect to plant growth. Soil contamination by heavy metals is of major concern because of their toxicity and threat to both human health and environment.

Hence, there is a need to develop suitable biological soil remediation technique to remove contaminants. In fact, traditional state-of-the-art technology for the remediation of metal polluted soils is the excavation and burial of the soil at a hazardous waste site. However, these approaches are expensive, disruptive, and are not economically viable. Recently, efforts have been made towards finding remediation strategies that are less expensive and less damaging to soil properties than current approaches. One such method is phytoextraction in which plants uptake heavy metal from the soil, followed by harvesting the above ground biomass. Harvested material is disposed in brick kilns (as bio-energy source) and byproduct in a landfill

(Kilns ash) or also treated to recover metals. Use of chelating agents to enhance heavy metal uptake is another new line in the technique of phytoremediation. To be successful on a specific site, the remediation technique must be selected according to heavy metals on the soil particles. Some scientists recommended the use of hyper accumulator species, other prefer plants with a lower accumulation rate but high biomass. Amongst the commercial crops grown in Haryana rabi season, Indian mustard has been reported to produce high biomass.

Materials and Methods

A pot experiment was conducted to investigate the Ni phytoextraction potential of three Maize plant genotypes, namely, J-1006, HM-4 and HKH-1183) on Cd and Ni (@ 30, 60, 90, 120 and 150 mg kg^{-1}), in a light soil from sand dune areas of Balsamand, Hisar. Five levels of NI concentration ranging from 0-120 mg kg^{-1} soil were taken for the study. The toxicity symptoms were recorded; biomass production, Ni concentration and finally the Ni uptake were measured to screen the best Ni tolerant Indian mustard genotype. The plants were harvested at maturity. The chlorophyll (a & b and total content) was extracted as per standard procedure of Hiscox and Israestam (1979) [15]. Eighty mg of washed and fine chopped leaf tissue was placed in a test tube containing 7 ml of DMSO (Di Methyl Sulphoxide). The chlorophyll was extracted without grinding by incubating at 65 ^{0}C for 1 hour. The extracted liquid was transferred to a graduated cylinder and volume made upto 10 ml with DMSO and optical density was recorded using spectrophotometer at 645 and 663 nm. Chlorophyll content was calculated following the standard equation proposed by Arnon (1949) [17] as follows: Chl 'a' (mg/g) = 11.63 x A_{663} –2.39 x A_{645}, Chl 'b' (mg/g) = 20.11x A_{645} –5.18 x A_{663}, Total Chlorophyll (mg/g) = 6.45 x A_{663} +17.72 x A_{645}

Estimation of nickel: In order to determine Ni in plant bio-mass, 0.5 g of grounded and well mixed plant materials were digested in a diacid mixture of nitric and perchloric acid (4:1). After digestion, the volume was made to 25 ml with double distilled water, filtered and stored in well washed plastic bottles and analyzed for Ni using the atomic absorption spectrophotometer (Lindsay and Norvell, 1978) [16].

Estimation of cadmium: To study the desorption of Cd from contaminated soil by different chelating agents. Two soil samples, *viz*., Cd spiked @ 30 mg Cd kg^{-1} soil and Cd spiked and FYM amended @ 3per cent of soil. Desorption was carried out using different EDTA and NTA chelating agents as extractants following the procedure as described by Cooper *et al*. (1999) [3].

Desorption Studies: To study the desorption of Ni from contaminated soil by different chelating agents. Two soil samples for Ni, *viz*. 1) Ni spiked @ 150 mg Ni kg^{-1} soil. 2) Ni spiked and FYM amended @ 3 per cent of soil. Procedure:

Statistical analysis of data: Factorial CRD for two factors were employed to study the effect of different treatments in various experiments. The analysis was carried out with the help of computer. The effects of treatments were compared with the help of the interaction CD.

Results and Discussion

DTPA-extractable Cd and Ni

Post-harvest (Maize) DTPA-extractable Cd (mg kg^{-1} soil) in soil as influenced by chelating agents

The data in Table 1 revealed that the availability of mean values of DTPA-extractable Cd increased significantly with increasing level of Cd in post harvested soil samples. With the addition of chelating agents and FYM, the DTPA-extractable Cd decreased significantly as compared to where no chelates and FYM applied. Highest mean DTPA-extractable Cd was found in control (25.25 mg Kg^{-1}) followed by FYM, NTA and EDTA. Further, the DTPA-extractable Cd decreased when chelates were applied in combination with FYM.

Table 1: Post harvest (Maize) DTPA extractable Cd (mg kg^{-1}soil) in soil as influenced by application of chelating agents

Treatments	Cd levels (mgKg^{-1} soil)					
	0	30	60	90	120	Mean
Control	0.22	12.26	21.24	36.32	56.24	25.25
EDTA	0.17	07.43	13.26	26.35	46.40	18.72
NTA	0.20	09.29	14.12	27.75	49.05	20.08
FYM	0.21	10.53	15.42	30.58	53.24	21.99
FYM+EDTA	0.14	05.97	12.60	24.25	43.12	17.21
FYM+NTA	0.16	06.33	13.87	24.92	44.90	18.03
Mean	0.18	8.63	15.08	28.36	48.82	20.22

CD (P=0.05) Chelating Agent-0.53; Cd Levels-0.48; CA x Cd-1.18

The decrease was 25.86, 20.47, 12.91, 31.84 and 28.59 per cent with the addition of EDTA, NTA, FYM, FYM+EDTA and FYM+NTA, respectively over control. The maximum mean DTPA-extractable Cd decrease was found in FYM+EDTA amended soil samples. The application of chelating agent decreased the mean DTPA-extractable Cd over control because most of the Cd bound with chelating agents and very less act as free ions.

Table 2: Post harvest (Maize) DTPA extractable Ni (mg kg^{-1}soil) in soil as influenced by application of chelating agents

Treatments	Ni levels (mgKg^{-1} soil)					
	0	100	150	200	250	Mean
Control	1.44	25.45	37.57	64.45	98.47	45.47
EDTA	1.13	20.73	29.64	51.27	93.75	39.30
NTA	1.17	22.29	30.31	58.72	95.32	41.56
FYM	1.24	23.53	31.45	62.84	96.84	43.18
FYM+EDTA	1.05	17.68	27.81	48.44	87.57	36.51
FYM+NTA	1.12	18.33	28.85	50.51	89.32	37.62
Mean	1.19	21.33	30.94	56.03	93.54	40.61

CD (P=0.05) - Chelating Agent-0.42; Ni Levels-0.38; CA x Ni-0.93;

Post-harvest (Maize) DTPA-extractable Ni (mg kg^{-1} soil) in soil as influenced by chelating agents

The data in Table 2 showed that maximum decrease in mean values of DTPA-extractable Ni was found FYM+EDTA amended soil (19.70%) over the control. Whereas, the availability of DTPA-extractable Ni increased significantly with increasing level of Ni in post harvested soil samples. Data further showed that mean values of DTPA-extractable Ni decreased with the addition of EDTA, NTA, FYM, FYM+EDTA and FYM+NTA and the decrease was 13.56, 8.59, 5.03, 19.70 and17.26 per cent, respectively. The data clearly showd that the availability of both Ni and Cd in post harvested sample were minimum in FYM+EDTA amended soils.

Conclusions

The post-harvest soil samples of both crops were concluded for the mean DTPA-extractable Cd and Ni as influenced by application of chelating agents. The results showed that availability of mean values of DTPA-extractable Cd and Ni increased significantly with increasing level of Cd and Ni. With the addition of chelating agents and FYM, the DTPA-extractable Cd decreased significantly as compared to where no chelates and FYM were applied and trend observed was control>FYM>NTA>EDTA>FYM+NTA>FYM+EDTA both in maize and Indian mustard post harvested soils.

References

1. Al-Hawari A, Mulligan CN. Heavy metals uptake mechanisms in a fixed column by calcium-treated anaerobic biomass. Process Biochemistry. 2006;41(1):187-198.
2. Chaney RL, Angle JS, Broadhurust CL, Peters CA, Tappero RV, Sparks DL. Improved understanding of hyperaccumulater yield commercial Phytoextraction and phytimining technologies. J Environ. Qual. 2007;36:1429-1443.
3. Cooper EM, Sims JT, Cunningham SD, Huang JW, Berti WR. Chelate assisted phytoextraction of lead from contaminated soils. J Environ. Qual. 1999;28:1709-1719.
4. Jung MC. Heavy Metal Concentrations in Soils and Factors Affecting Metal Uptake by Plants in the Vicinity of a Korean Cu-W Mine. Sensors. 2008;8:2413-2423.
5. Kulli B, Balmer M, Krebs R, Lothenbach B, Geiger G, Schulin R. The influence of nitrilotriacetate on heavy metal uptake of lettuce and ryegrass. J Environ. Qual. 1999;28:1699-1705.
6. Lombi E, Zhao FJ, Dunham SJ, McGrath SP. Phytoremediation of heavy metal contaminated soils: natural hyperaccumulation versus chemically enhanced phytoextraction. J. Environ. Quality. 2001;30(6):1919-1926.
7. Maxted AP, Black CR, West HM, Crout NMJ, McGrath SP, Young SD. Phytoextraction of cadmium and zinc by Salix from soil historically amended with sewage sludge. Pl. Soil. 2007;290:157-172.
8. Neugschwandtner RW, Tlustos P, Komarek M, Szakova J. Phytoextraction of Pb and Cd from a contaminated agricultural soil using different EDTA application regimes: Laboratory versus field scale measures of efficiency. Geoderma. 2008;144(3-4):446-454.
9. Nowack B, Schulin R, Robinson BH. Critical assessment of chelant-enhanced metal phytoextraction. Environ. Sci. Technol. 2006;40(17):5225-5232.
10. Raskin I, Smith RD, Salt DE. Phytoremediation of metals: Using plants to remove pollutants from the environment. Current Opinion Biotechnol. B. 1997;13(2):221-226.
11. Robinson BH, Mills TM, Petit D, Fung LE, Green SR, Clothier BE. Natural and induced cadmium - accumulation in poplar and willow: Implications for phytoremediation. Pl. Soil. 2000;227:301-306.
12. Robinson BH, Schulin R, Nowack B, Roulier S, Menon M, Clothier B, *et al*. Phytoremediation for the management of metal flux in contaminated sites. Forest Snow Landscape Research. 2006;80(2):221-234.
13. Romkens P, Bonwman L, Japenga J, Draaisma C. Potential drawback of chelate-enhanced phytoremediation of soils. Environ. Pollut. 2002;116:106-121.
14. Strickland RC, Chaney WR, Lamoreaux RJ. Organic mater influences phytotoxicity of cadmium to soybeans. Pl. Soil. 1979; 52:393-402.
15. Hiscox JD, Israelstam GF. A method for the extraction of chlorophyll from leaf tissue without maceration. Canadian journal of botany. 1979 Jun 15;57(12):1332-4.
16. Lindsay WL, Norvell W. Development of a DTPA soil test for zinc, iron, manganese, and copper. Soil science society of America journal. 1978 May;42(3):421-8.
17. Arnon DI. Copper enzymes in isolated chloroplasts. Polyphenoloxidase in Beta vulgaris. Plant physiology. 1949 Jan;24(1):1.