NJESR/September-2023/Volume-5/Issue-9 E-ISSN-2582-5836
DOI-10.53571/NJESR.2023.5.9.38-44

Germination Study Of The Plants Trigonella Foenum-Graecum L. and Vigna radiata (L.) R. Wilczek On Contamination With Heavy Metals In The Soil

Dr.A.Pramila* M.Maithri**
HOD*
Associate Professor
Department of Botany
Andhra Mahila Sabha Arts And Science College For Women
O.U. Campus
Hyderabad
pramila21ams@gmail.com
M.Sc. Botany**
University College of Science
Osmania University
Hyderabad
. maithrimothe77@gmail.com

(Received:25August2023/Revised:13Septembr2023/Accepted:24September2023/Published:30 September 2023)

Abstract

With the advancements in human livelihood, the damage to nature is also rising rapidly, soil pollution being one amongst them. Soil pollution is caused by many direct or indirect anthropogenic activities. The soil pollution affects the food we eat, water we drink, the air we breathe and the health of our ecosystems. Heavy metal toxicity is one such consequence of soil pollution that leads to bioaccumulation of heavy metals and is of concern in agricultural production. Heavy metals naturally occur in various concentrations in the bed rock at different places. Due to anthropogenic activities, they pave their way into the biosphere. Heavy metal contamination of soils causes many hazardous consequences on plant growth and development. In this study, the soils were treated with Lead, Chromium, Cadmium and Mercury. The comparative seed germination and plant growth of Trigonella foenum-graecum and Vigna radiata in heavy metal treated soil with respect to the control was observed. The differences in growth pattern were noted. Germination was comparatively very low in soils contaminated with mercury. The seeds were restrained for viable germination in the soils contaminated with heavy metals. The seedlings showed necrosis, burnt patches, injuries and malformations. The overall growth and development was arrested. The length of the plantlets grown in heavy metal soils was reduced at respective stages as compared to thecontrolled. The reduction in biomass was also observed.

Key words : Trigonella, Vigna, Germination, Heavy metals, Bioaccumulation

Introduction

The term heavy metal is widely used in agriculture, nutrition and physiology for the metals having atomic number more than 23. Although some heavy metals such as Copper, Zinc, Manganese, Molybdenum etc., are considered as essential heavy metals, some like Lead, Cadmium, Chromium, Mercury etc., are considered to be non-essential having little or no beneficial role in the plants. The increase in their concentration is noted to be potentially toxic and adverse to plant life. Heavy metals naturally occur in various concentrations in the bed rock at different places. Due to anthropogenic activities, they pave their way into the biosphereand their deposits are considered as significant pollutants. The reasons for heavy metal toxicity in the soil may generally be due to sewage sludge, long term use of phosphate fertilizers, fossil fuel combustion, geological weathering and use of agrochemicals. The dust from smeltors, industrial waste, mining activities also contribute to the same. Badwatering practices are also observed to be the sources of heavy metal accumulation in the soil. These heavy metals present in the soil getcolloided with the clay particles and organic matter in the soil and get accumulated into the roots generally by active diffusion. These heavy metals when entered into the roots, get into the cytoplasm of the cell and also into the waterchannels, there by spreading all over the plant. This accumulation of heavy metals in the plant body results in the alteration of physiological and metabolic processes there by showing adverse effects. The effect observed depends on the type of heavy metal, its abundance, probability of its occurrence, the pH of soil, the transport proteins, the chelating ability of the metal, the form in which the metal in present in the soil, abiotic factors such as light, temperature etc. The toxic effects of heavy metals on the plants vary from metal to metal and from plant to plant. Though, the general effects include oxidative stress, disruption of membranes and their permeability, disturbance of metabolism of the other essential elements, disruption in the electron transport chain and may cause other effects**.** The primary response by the plants in response to heavy metal exposure is the increase in the level of Reactive Oxidation Species (ROS) by Haber-Weiss reactions. This causes oxidative stress. The heavy metals are also known to cause variationsin certain enzyme mechanics, cause chloroplast destruction and also affect the useful microorganisms in the soil. These biochemical aspects affect the physiological processes. Thus the defect is reflected in the morphological aspects.Generally if the morphology is examined; chlorosis, necrosis, reduction in the length of shoot and root, inhibition of germination, deformations, reduction in biomass etc., are observed. This is regarded to be the consequence of heavy metal contamination in the soil and their entry into the plant.

Present Study Is Aimed At

The present study is aimed to observe the consequences of heavy metal contamination (Pb, Hg, Cr and Cd) on the germination of plants Trigonella foenum-graecum and Vigna radiata discerning from normal conditions. This is focused on the morphological observations there by eliciting the possible physiological changes that occurred on the exposure to heavy metals

Trigonella foenum-graecum and Vigna radiata are annual, branched dicotyledonous plants belonging to the family Fabaceae with neutraceutical importance. The leaves and dried seeds of Trigonella foenum-graecum are edible. The seeds contain in carbohydrates, proteins, alkaloids, flavonoids, vitamins and minerals. The leaves are rich in Iron. The plant is used as anti-diabetic, anti-inflammatory and for hypercholesterolemia.The seeds of Vigna radiata are edible which are of high protein content, starch and polyphenols. They are rich in folates, thiamine, other B-Complex vitamins, Copper and Iron.

Material And Methods

The healthy seeds were collected and sown in the soil containing heavy metal salts. The seedlings were raised to plants. The differences were distinguished making a sample pot as frame of reference with seeds sown in normal soil. The changes in the respective pots were noted for once in two days.The plants were observed for ten days until they grew well.

Preparation Of Media

The heavy metals taken for observation are Chromium, Cadmium, Lead and Mercury. These heavy metals were added in the form of their salts. Chromium was added in the form of K_2CrO_4(Potassium chromate), Cadmium in the form of $(CH_3COO)_2Cd$(Cadmium acetate), Lead in the form of $PbNO_3$(Lead nitrate) and $HgCl_2$(Mercuric chloride) was selected for Mercury. 1 gm. of each salt was taken in respective clean test tubes and dissolved by adding 10 ml of water. Five pots were filled with soil and designated with the name of metal present in the soil. The respective heavy metal salt solution was mixed thoroughly in four respective pots and one pot was left with normal soil. This pot was considered to be the control plant. The seeds were sown in five pots and given adequate amount of water

Observations

The changes in respect to particular heavy metal were observed once in two days. The morphological changes in treated pots and variations from the control plant were compared. The observations of the study are as follows

After two days of sowing in T. foenum-graecum the seeds have shown no much difference in morphology where as the seeds of V.radiata which were in the soiltreatedwithChromium were observed to change their colour to black. The seeds of plants treated with Cadmium also showed this effect, but to a very less extent.

After four days the sprouting in controlled T.foenum-graecum was observed luxuriantly and to a less amount in the soil treated with other heavy metals and no sprouting was observed in the soil treated with mercury. The same condition was reflected in the case of V.radiata.

After six days in T.foenum-graecum, abundant sprouting was observed in the control plant and considerably good sprouting was seen in the soil treated with Lead. The progression of sprouting was very low in the soil treated with cadmium followed by chromium. But no sprouting was observed in the soil treated with mercury. In the case of V.radiata, very healthy and plentiful growth of sprouting was noticed in the control plant and a considerablygood sprouting was seen in the soil treated with lead. The seeds in the soil treated with chromium were in early stages whereas, those treatedcadmium turned more dark. Initiation of fungal growth was observed in the soil treated with mercury.

After eight days the control plantlets of T.foenum-graecum showed copious and healthy growth. Many of the seeds in the soils treated with lead could not viably germinate. Very few seedlings could make up till sprouting stage in the soil treated with cadmium. A sparse amount of seedlings were noticed in the soil treated with chromium. No seedling germination was observed in soil treated with mercury. The control plants of V.radiata showed ample growth and a fair growth was spotted in the plantlets grown in the soil treated with lead. Seedlings with short, curled, wrinkled leaves were observed in the soil treated with chromium. Negligible germination was observed in soil treated with cadmium but viability of seeds was meager. Deformed seedlings with crushed cotyledonary leaves were observed in the soil treated with mercury.Shrunken seed coat was marked.

After ten days of the seedlings of controlled T.foenum-graecum grew to proper sized healthy plantlets. The biomass was comparatively less in the plantlets grown in soil contaminated with lead than that of controlled. Few seedlings could reach plantlet stage in the soil treated with cadmium. Negligible amount of sprouting was seen in the soil treated with chromium. The seeds were unable to germinate.In Vigna radiata the controlled plantlets were luxuriantly grown. The plantlets in the soil treated with lead showed reduction in length of the plant height and leaf size.Necrosis and burnt spots were prominently observed in the cotyledonary leaves of chromium. The seed coat of seeds that were rendered unviable for germination got darker and many seeds failed to germinate. The leaves were curled, wrinkled and shrunken Deformations were also observed. The fungal growth in the soil treated with mercury started expansion. Deformed cotyledonary leaves and variation from normal growth pattern was noticed. No clear plant growth was noticed in soil treated with mercury.

Results And Discussion

The contamination of heavy metals in the soil and their accumulation in the soil influenced the normal plant growth in many ways.Mostof the seeds could not germinate in the soils contaminated with heavy metals. The comparative germination in different soils is as follows

T.foenum graecum – Control> Pb> Cd> Cr> Hg
V.radiata – Control> Pb> Cr> Hg> Cd

Some of the germinated seeds could not sprout properly. The comparative order of sprouting in different soils is as follows

T.foenum graecum – Control> Pb> Cd> Cr> Hg
V.radiata – Control> Pb> Cr> Hg> Cd

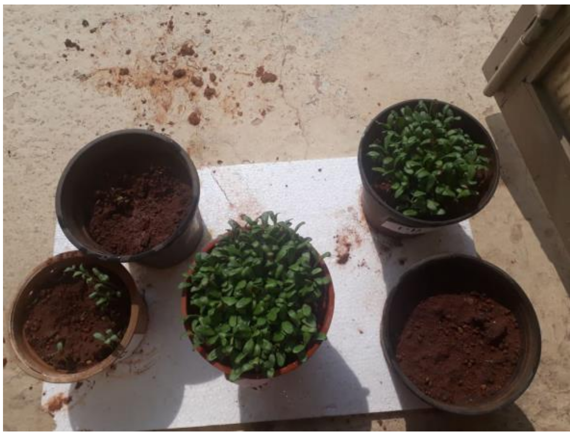
In the treated plants the rate of germination and sprouting was efficient in those treated with lead and least in those treated with mercury, in the case of T.foenum-graecum. For V.radiata, the germination of the plants and sprouting was most notable in those treated with lead and least in those treated with cadmium.

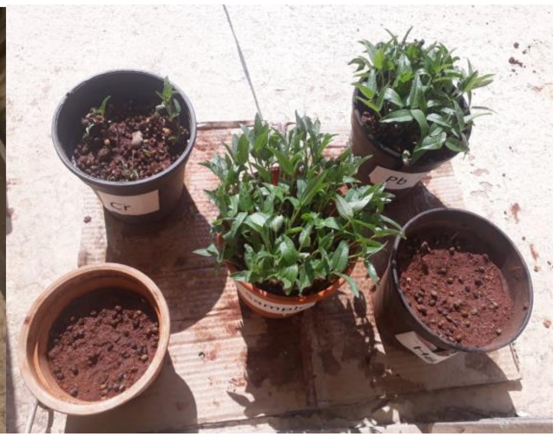
The overall growth and development was arrested. The length of the plantlets treated with heavy metals was reduced at respective stages as compared to the controlled plantlets.The reduction in biomass was also observed. The adequate germination and growth of plantlets treated with lead indicate good chelating ability in the plants as to overcome stress, although the effect was pronounced in the reduction of plant height, leaf number and leaf size. The burnt cotyledonary leaves, deformed leaves imply that foliar uptake of chromium is comparatively more than other heavy metals. Mercury was potentially toxic for seed germination in T.foenum graecum compared to the other heavy metals as the rate of germination was drastically low. Cadmium was potentially toxic for seed germination in V.radiata compared to the other heavy metals as the rate of germination was extremely low.

References

1. Ambika asati, Mohnish pichhode, Kumar Nikhil. Effect of Heavy Metals on Plants: An Overview.
2. N.W.Lepp.Metals in the Environment-.Effect of Heavy Metal Pollution on Plants, Vol. 2.
3. M.N.V.Prasad. Heavy Metal Stress in Plants, From Biomolecules to Ecosystems, Second Edition.
4. Iwona Morkunas, Agnieszka Woźniak, Van Chung Mai, Renata Rucińska-Sobkowiak and Philippe Jeandet. The Role of Heavy Metals in Plant Response to Biotic Stress.

5. Antonella furini. Plants and Heavy Metals.
6. SK. Yadav .Heavy metal toxicity in plants, South African Journal of Botany, Vol. 76, Issue 2.





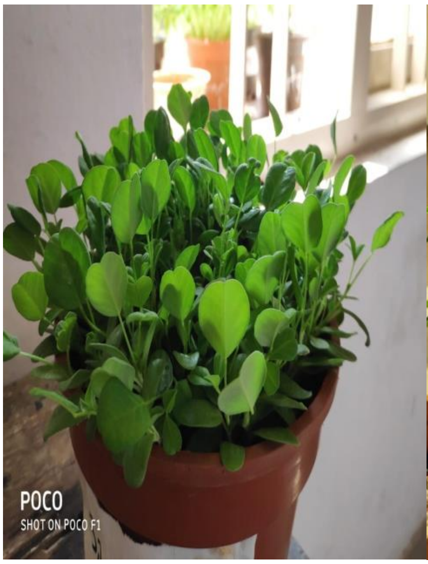
T.foenum-graecum ***V.radiata***

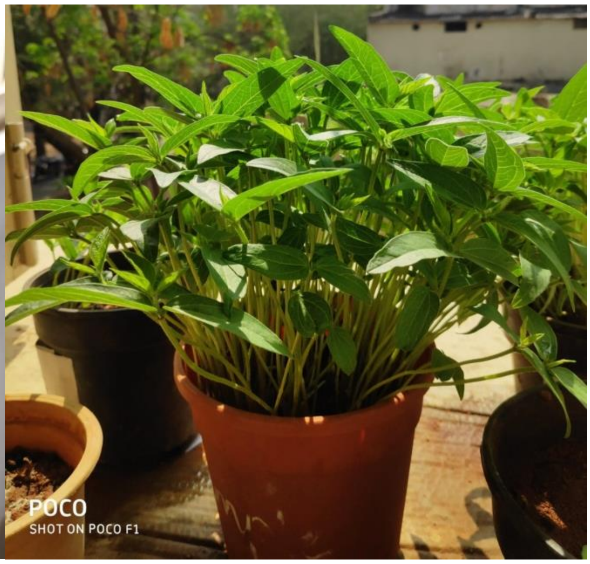
Sproutings of T.foenum-graecum and V.radiata respectively in different heavy metal contaminated soils and control after four days.

T.foenum-graecum ***V.radiata***

Germination status of T. foenum-graecum and V.radiata respectively in different soils and control after ten days.

The deformed sproutings of V.radiata The effects of Chromium on the in thesoil treated with mercury germination of V.radiata





T.foenum-graecum ***V.radiata***

Controlled plants of T. foenum-graecum andV. radiata respectively.