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**Research Article**

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# Effect of arsenic, manganese and chromium on *in vitro* seed germination of black gram (*Vigna mungo* L.) and green gram (*Vigna radiata* L.)

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**ABSTRACT**

*Heavy metals are the metals having a density at least five times more than that of water. The effects of different concentration (1, 2, 3, 4 and 5 mg/l) of arsenic, manganese and chromium on germination, root growth and protein content of green gram (Vigna radiata. L) and black gram (Vigna mungo L.) were studied. The inhibition of germination, root growth and protein content was noticed at higher concentrations of Arsenic, manganese and chromium. The results also indicated that the germination percentage, root length and protein content were gradually decreased with the increasing concentration of both heavy metals.*

**Key words:** Heavy Metal, Black gram, Green gram, Germination, Root growth, Protein

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## INTRODUCTION

Environment is the combination of external physical conditions that affect and influence the growth, development, and survival of an organism, including air, water and soil. The pollution of terrestrial environment has become a serious problem with increasing industrial and agricultural operations. The environmental pollutants are likely to affect biological systems in different ways according to their chemical properties [1]. Metals have toxic effects and act as persistent pollutants in the atmosphere and add either by natural or anthropogenic activities. Although some metals are regarded essential nutrients, excess concentrations of all metals lead to various toxic effects such as oxidative stress and inhibition of enzyme activities [2][3]. Heavy metals are of great interest for research purpose with respect to toxicological importance to human health, plants and animals [4][5][6]. Heavy metals make a significant contribution to environmental pollution as a result of human activities such as mining, smelting, electroplating, energy and fuel production, power transmission, intensive agriculture, sludge dumping and military operations [7]. The contamination of soil by heavy metal enhances uptake causing their accumulation in different plants organs [8][9][10]. Heavy metal presence in the atmosphere, soil and water can cause serious problems all organisms [11]. Excessive level of heavy metals in the soil environment adversely affect the germination of seeds, plant growth, alter the level of biomolecules in the cells and interfere with the activities of many key enzymes related to normal metabolic and developmental processes [12-16].

## EXPERIMENTAL SECTION

Sodium arsenate (Na2HASO4-7H2O) salt is used as arsenic source; Manganous sulphate (MnSO4H2O) salt is used as manganese source and potassium chromate (K2CrO7). Salt is used as chromium source for the present study. The different concentrations (1, 2, 3, 4 and 5 mg/l) of arsenic, manganese and chromium were prepared and used for the

germination studies. The seeds of black gram and green gram were surface sterilized with 0.1% mercuric chloride solution for 2 minutes and washed thoroughly with tap water and then by distilled water for 30 minutes. The seeds were placed equally in sterilized petriplates. Each petriplate was moistened uniformly by various concentrations of different heavy metal solutions. The seeds were irrigated with distilled water was treated as control. All the petriplates were kept at room temperature (28 ± 2°C). The number of seeds germinated in each treatment was counted and calculated on 10th day after sowing. The emergence of radicle was taken as a criterion for germination. Ten seedlings from each replicate were selected for recording the root length and the protein content was determined by the Lowry method [17].

## RESULTS

In the present study, seed germination percentage, root growth and protein content decreased gradually with increase in heavy metals (Arsenic, manganese and chromium) concentrations. The control seed of black gram and green gram exhibit maximum percentage of germination, root growth and protein content when compared with all other concentrations are presented in table 1 and 2. Results showed that significant variation was observed among seeds at all other concentrations. At control, arsenic exhibit maximum percentage of germination in green gram, chromium exhibit maximum percentage of root growth in green gram and manganese exhibit maximum percentage of protein content in black gram when compared with all other concentrations. There are no significant difference in 2 mg/l and 3 mg/l in seed germination and root growth, both black and green gram. . There are also no significant difference in 3 mg/l and 4 mg/l protein content in both black and green gram.

**Table 1. Effect of arsenic, manganese and chromium on germination, root length and protein content of black gram (*Vigna Mungo* L.)**

| Treatment | Arsenic | Manganese | Chromium |
|---|---|---|---|
| **Germination** | | | |
| Control | 93.66 ±1.20 | 94.66 ± 0.88 | 95.33 ± 1.76 |
| 1 mg/L | 84.66 ± 0.66 | 85.00 ± 0.57 | 86.33 ± 0.88 |
| 2 mg/L | 78.66 ± 0.66 | 80.33 ± 0.88 | 78.66 ± 1.45 |
| 3 mg/L | 77.33 ± 0.33 | 78.66 ± 0.88 | 77.00 ± 0.57 |
| 4mg/L | 72.33 ± 0.33 | 73.66 ± 0.66 | 71.66 ± 0.88 |
| 5mg/L | 64.33 ± 0.88 | 65.00 ± 0.57 | 66.66 ± 1.85 |
| **Root growth** | | | |
| Control | 8.76 ± 0. 21 | 9.43 ± 0.12 | 8.56 ± 0.08 |
| 1 mg/L | 7.50 ± 0.15 | 8.06 ± 0.06 | 7.26 ± 0.12 |
| 2 mg/L | 6.46 ± 0.20 | 7.60 ± 0.05 | 6.40 ± 0.15 |
| 3 mg/L | 6.03 ± 0.08 | 6.01 ± 0.20 | 6.03 ± 0.08 |
| 4mg/L | 4.03 ± 0.13 | 3.80 ± 0.15 | 3.03 ± 0.12 |
| 5mg/L | 2.16 ± 0.18 | 2.13 ± 0.08 | 2.23 ± 0.17 |
| **Protein content** | | | |
| Control | 15.66 ± 0.17 | 15.85 ± 0.14 | 15.36 ± 0.14 |
| 1 mg/L | 14.44 ± 0.10 | 14.99 ± 0.44 | 14.98 ± 0.32 |
| 2 mg/L | 13.69 ± 0.29 | 13.94 ± 0.53 | 13.45 ± 0.10 |
| 3 mg/L | 12.74 ± 0.30 | 12.99 ± 0.52 | 12.68 ± 0.29 |
| 4mg/L | 12.18 ± 0.17 | 12.56 ± 0.22 | 12.05 ± 0.40 |
| 5mg/L | 9.39 ± 0.37 | 9.443 ± 0.33 | 10.80 ± 0.42 |

*Values are arithmetic mean ±S.E*

**Table 2. Effect of arsenic, manganese and chromium on germination, root length and protein content of greengram (*Vigna radiata* L.)**

| Treatment | Arsenic | Manganese | Chromium |
|---|---|---|---|
| **Germination** | | | |
| Control | 95.66 ± 0.88 | 95.33 ± 0.88 | 95.00 ± 0.57 |
| 1 mg/L | 86.00 ± 1.15 | 85.33 ± 0.66 | 85.66 ± 0.88 |
| 2 mg/L | 79.66 ± 0.66 | 81.00 ± 1.15 | 81.33 ± 0.88 |
| 3 mg/L | 78.33 ± 0.88 | 79.33 ± 0.33 | 79.00 ± 0.57 |
| 4mg/L | 71.66 ± 0.88 | 73.66 ± 0.88 | 75.66 ± 1.20 |
| 5mg/L | 68.33 ± 0.33 | 67.33 ± 1.20 | 66.00 ± 1.15 |
| **Root growth** | | | |
| Control | 8.70 ± 0.17 | 8.30 ± 0.15 | 9.83 ± 0.16 |
| 1 mg/L | 8.06 ± 0.29 | 7.50 ± 0.25 | 8.23 ± 0.39 |
| 2 mg/L | 6.90 ± 0.32 | 5.83 ± 0.05 | 7.73 ± 0.20 |
| 3 mg/L | 5.26 ± 0.26 | 4.66 ± 0.08 | 6.90 ± 0.15 |
| 4mg/L | 3.36 ± 0.21 | 2.83 ± 0.03 | 3.96 ± 0.03 |
| 5mg/L | 2.26 ± 0.14 | 2.16 ± 0.08 | 2.20 ± 0.05 |

| Protein content | | | |
|---|---|---|---|
| Control | 15.72 ± 0.22 | 15.30 ± 0.25 | 14.71 ± 0.37 |
| 1 mg/L | 15.15 ± 0.22 | 14.07 ± 0.25 | 14.08 ± 0.26 |
| 2 mg/L | 13.89 ± 0.33 | 13.13 ± 0.29 | 12.91 ± 0.33 |
| 3 mg/L | 12.94 ± 0.20 | 13.02 ± 0.48 | 12.88 ± 0.57 |
| 4mg/L | 12.53 ± 0.79 | 11.57 ± 0.55 | 10.94 ± 0.04 |
| 5mg/L | 11.05 ± 0.32 | 10.49 ± 0.54 | 10.26 ± 0.31 |

*Values are arithmetic mean ±S.E*

## DISCUSSION

Heavy metals are one of the most important groups of pollutants of aquatic environment, which originate from domestic sewage, industrial effluents and agricultural run off etc. Addition of heavy metals (As, Al, Cr, Mn, Mo, Ni, Cu, Pb, etc.) into the environment causes toxic and carcinogenic effects on flora and fauna and create great ecological crisis at the global level. Heavy metal accumulation in soil and its importance on the morphological, biochemical and cytological aspects of plants have received more attention in recent times by many workers [18][19][20]. The plants under stress conditions are most likely to be adversely affected by high concentration of heavy metals. Heavy metals have become important due to their constant increase in the environment. In the present investigation, Ar, Mn and Cr treatment decreased seed germination, and seedling growth of blach gram and green gram. The decrease in seed germination can be attributed to the accelerated breakdown of stored food materials in seed by the application of heavy metal. Reduction in seed germination can also be attributed to alterations of selection permeability properties of cell membrane. The decrease in seed germination of blach gram and green gram due to heavy metal treatment is in conformity with the findings of other workers [21][22][23][24][25][26]. The inhibition of germination and root growth was noticed at higher concentrations of Arsenic and manganese. Similar result was also reported in wheat [27], Cowpea [28], Pea [29] and cotton [30]. The content of protein was also reduction with the increasing concentration at 1, 2, 3, 4 and 5 mg/L of heavy metal when compare to control. Alterations in the functioning and speed of enzymatic activity, like amino acid synthesis [31] and decrease in protein levels as metabolically response to water restrictions

## CONCLUSION

The present study reveals that the presence of heavy metal causes many variations in germination, root growth and biochemical of green gram and black gram with the concentration of heavy metal. However this work is an important to find the photosynthesis progress in plant by the absorption of heavy metals. Hence it may be suggested that the plants are being affected by the heavy metals surrounding sources. It can be concluded that the heavy metal are toxic to seed. So, this polluted water should be properly treated to remove the heavy metals and treated water with suitable dilution may be used for irrigation purpose.

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