



## HEAVY METAL STRESS ON GROWTH AND CARBOHYDRATE METABOLISM ON MUSTARD AND FENUGREEK SEEDLINGS

### Abstract

*In Gujarat Mustard and Fenugreek are important minor spice crops, seeds are economically useful. Both crops are cultivated from seeds. Seed germination and seedling growth are influenced by number of factors; heavy metal is the one of the factor. It was interest of heavy metal stress on growth and metabolism of Mustard and Fenugreek seedlings. Seeds of Mustard var. Varuna T-59 and Fenugreek var Gujarat-1 were germinated in 200ppm and 600ppm of  $\text{CuCl}_2$ ,  $\text{CdCl}_2$  and  $\text{HgCl}_2$  in petridishes under laboratory condition up to 96h. The root shoot elongation of 96h old control and treated seedlings were studied. The Invertase, non-reducing sugar and reducing sugar were also estimated from treated and control seedlings. Root shoot elongation was lowered by heavy metal. Effect of inhibition was in the order of  $\text{Hg} > \text{Cd} > \text{Cu}$ . Severe concentration i.e. 600ppm was more effective than 200 ppm. The Invertase, non-reducing sugar, reducing sugar were lowered by heavy metals and effects were dose dependent. Heavy metal effect on growth and metabolism was more significant on mustard than in Fenugreek. Thus mustard is consider sensitive than Fenugreek to heavy metals.*

**Keywords:** Heavy metals, carbohydrate metabolism, Mustard, Fenugreek.

### Introduction

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentration. Heavy metals are defined as chemical elements with a specific gravity that is at least 5 times the specific gravity of water (Lide, 1992). The accumulation of these heavy metals in plants causes physiological and biochemical changes (Davies A.G, 1976, Rosko J.J. and Rachlin J.W.1977). High concentrations of heavy metals in soils represent a potential threat to human health because it is incorporated in the food chain mainly by plant uptake (Morzeck J.R.E. and Funicelli N.A 1982). Seed is a stage in the plant life cycle that is well protected against various stresses. However, soon after imbibition and subsequent vegetative developmental processes, they become stress-sensitive in general. Therefore, seeds are thought to carefully monitor such external parameters as light, temperature and nutrient in order to maintain the protective state until external conditions become favorable for following developmental processes (Karssen 1982; Pritchard et al. 1993; Bungard et al. 1997). Excess concentrations of some heavy metals in soils such as Zn, Ni, Cu, Cr and Cd have caused the disruption of plant, natural aquatic and soil microflora [Meagher RB 2000, Israr et.al., 2006]. Some heavy metals at low doses are essential micronutrients for plants, but in higher dose they many cause metabolic alterations and inhibits the growth in many plant species (M. Wójcik, A. Tukiendorf 2004, Scoccianti et.al.,2006, Rahman et.al., 2005) .High accumulation of metals affects both growth and metabolism of plants (Baccouch et al.,1998)

### Materials and Methods

The uniform graded seed of Mustard (*Brassica juncea*) var. Varuna T - 15 and Fenugreek (*Trigonella foenumgraceum*) var. Guj - 1 were germinated in sterilized petri dishes ( 20 seeds / dish) Lined with wattman filter paper no. 1. The media for germination were as follows.

1. D.W.
2. 200 PPM CuCl<sub>2</sub>
3. 200 PPM CdCl<sub>2</sub>
4. 200 PPM HgCl<sub>2</sub>
5. 600 PPM CuCl<sub>2</sub>
6. 600 PPM CdCl<sub>2</sub>
7. 600 PPM HgCl<sub>2</sub>

Three Petri dishes were kept for each treatment. The experiment was carried out at  $28 \pm 2^{\circ}$  c under laboratory condition. The experiment was continued up to 96 hrs. The Effect of moderate i.e. 200 ppm and sever i.e. 600 ppm of CuCl<sub>2</sub> , CdCl<sub>2</sub> and HgCl<sub>2</sub> on growth and metabolism on completion of 96 hrs. Following is the detail.

#### (A) Study on Seedling growth: -

Twenty seedlings from each treatment were studied for elongation. The elongation of root shoot and seedling length was measured; mean was calculated and expressed as cm/seedling.

#### (B) Study on Metabolism:

96h old control and treatedseedlings in replicate were analysed for carbohydrate metabolism metabolism, The biochemical parameters estimated were as follows :

#### (I) Carbohydrate Metabolism

1. Invertase Activity

Invertase activity was determined by the method of Hatch and Glasziou (1963).

2. Reducing sugar and Nonreducing sugar content.

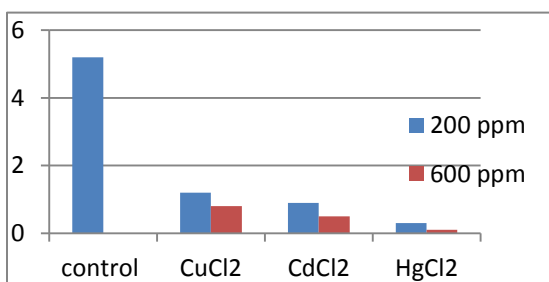
Sugar estimation by the method of Nelson-Somogyi (Wharton and McCarty 1972).

#### Results:

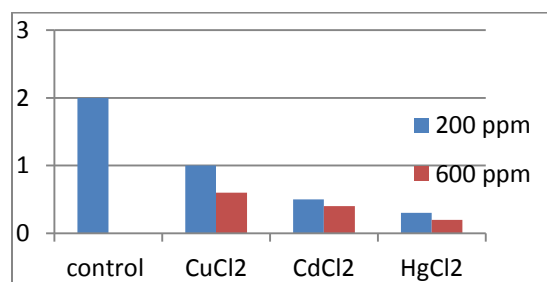
**Fig.1: Effect of moderate and severe heavy metal stress on elongation of 96 h old mustard and fenugreek seedlings**

#### MUSTARD SEEDLINGS

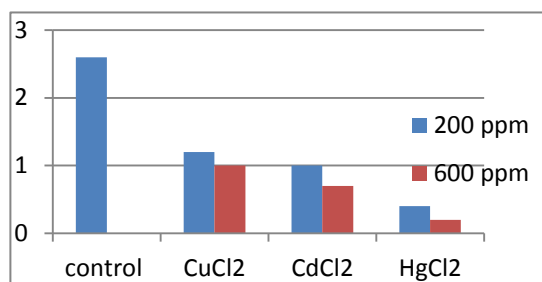
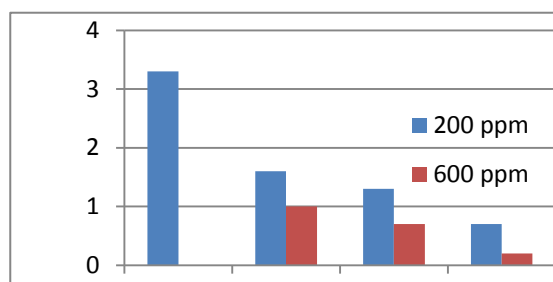
##### Root length



#### FENUGREEK SEEDLINGS



### Shoot length



### Seedling length

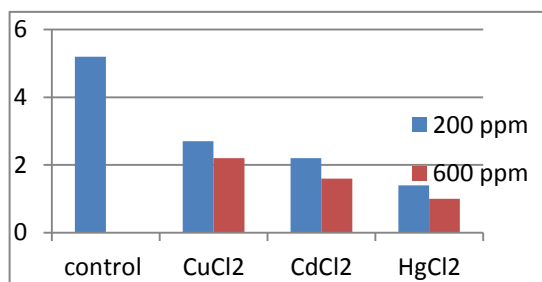
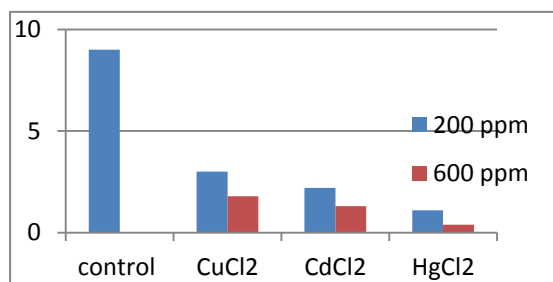


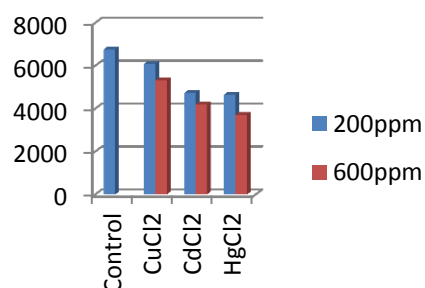
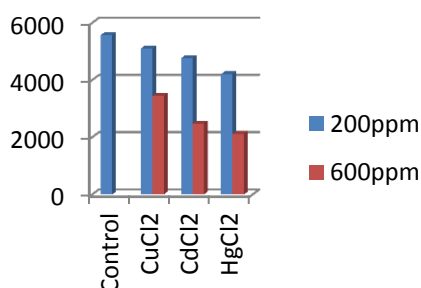
Figure 1 suggest that seed germination and seedling growth were highly sensitive to moderate and severe heavy metal stress simulated by 200 and 600ppm of heavy metals. The seedling length of both the crops was decreased by Cu, Cd and Hg. severe heavy metal caused significant damage to the seedling length. Seedling growth of mustard in comparison to fenugreek was more suffered by all heavy metals.

**Fig: 2 Effect of moderate and severe heavy metal stress on carbohydrate metabolism of 96 h old mustard and fenugreek seedlings**

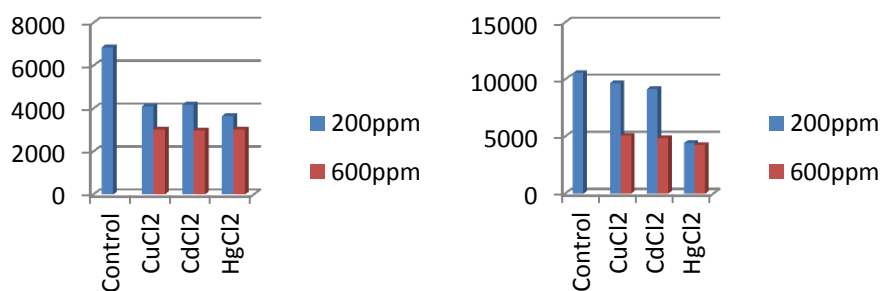
#### MUSTARD SEEDLINGS

#### FENUGREEK SEEDLINGS

#### Invertase (mg glucose liberated/h/ $\mu$ g protein)



### Non reducing sugar (mg /g dry weight)



### Reducing sugar (mg /g dry weight)

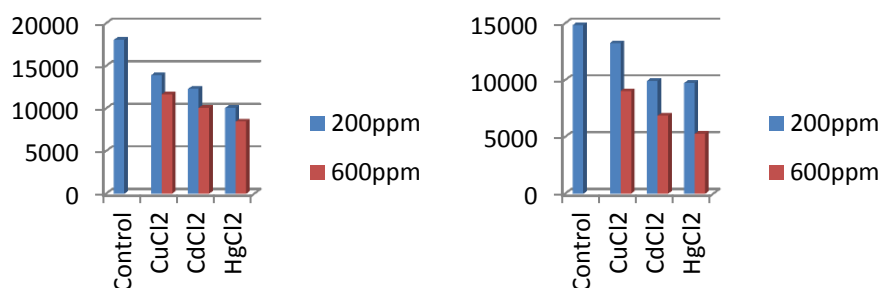


Fig: 2 represent that carbohydrate metabolism was suppressed by all the heavy metal. Disturbance of carbohydrate metabolism is the major biochemical lesions of the toxic compound. Reduction of seedling growth was due to lowering in carbohydrate metabolism. The heavy metal tolerance of fenugreek seedlings may be correlated with comparatively less disturbance in carbohydrate metabolism. The heavy metal toxicity and tolerance of mustard and fenugreek seedlings may be determined by estimating invertase activity and non-reducing and reducing sugar from the seedlings.

### Conclusion:

Root was affected more than shoot by all the metals. Inhibitory effect was highly significant in the seedlings germinated under severe heavy metal stress. Mustard seedlings were more suffered than Fenugreek seedlings by all the metals. Heavy metal toxicity was in the order of Hg>Cd>Cu. Moderate and severe heavy metal stress decreased invertase activity and non-reducing and reducing sugar level in both spice. The changes were more sharp in mustard than fenugreek seedlings.

However, extended research is necessary in metal contaminated soil and water, to determine and overcome the detrimental effect of different metals in the environment on plants. There is a great necessity to find out how heavy metals affect spices in low amount and it is also essential to improve understanding of the exact mechanisms involved in. Contamination of soil by heavy metals in changing environment poses a serious concern.

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