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HEAVY METAL INDUCED STRESS IN MUSTARD

Abstract

Heavy metals are the most important sorts of contaminant in the environment. Brassica juncea (L) commonly known as mustard is an important minor spice crop plant. The mustard is cultivated throughout India. It is cultivated as oil seed plant almost throughout the tropical and subtropical regions of the world. Phasic effect of moderate and severe heavy metal stress on growth of mustard seedling were observed. The uniform graded seeds of Mustard were germinated in D.W and 200 ppm and 600 ppm of $Cucl_2$, $CdCl_2$ and $HgCl_2$ for 96 h. The duration of phasic treatment was 48 h. Experimental period was 96h.The effects of phasic treatment of heavy metal were studied with the help of controlled and treated seedlings. The heavy metal toxicity was evaluated with the help of RRG, percent phytotoxicity and Root – Shoot Ratio. Longer duration caused more adverse effect. Root was affected more than shoot by phasic treatment of heavy metal.

Keywords: *heavy metals, phasic treatment, toxicity, Brassica juncea*

Introduction

Almost all human activities have potential contribution to produce heavy metals as side effects. The most common heavy metal contaminants are Cd, Cr, Cu, Hg, Pb, and Zn. Heavy metal enhance environmental Pollution is a global issue (Bhat et al 2014). Copper toxicity in plants is discussed by Levitt (1980). Cadmium is recognized as an important trace contaminant in both aquatic and terrestrial environment. Chronic effects of cadmium compounds were first recognized by Nord berg (1974) and Friberg et. al.,(1974). Its phytotoxicity has been reported by number of workers (Page et. Al., 1972; Friberg et.al. 1974; Kloke and Schenke 1979). The contamination with heavy metal like cadmium is due to the manufacture of diverse products such as batteries, chipsets, pigments, television receivers, and semiconductors (Dubey et. al., 2014). Toxic effects of mercury in plants include growth reduction, general distressed vigour; abscission of older leaves (Heck and Brandt 1971), inhibition of root and leaf development (Siegal et. Al, 1973) and leaf necrosis (Waldron and Terry, 1975). Mercury affects living membranes and their function in several ways. Mustard is considered to be one of the most important oil yielding crop of North India and it is majorly used as edible oil (Meena et al, 2011, Gautam et al (2012, Bhat et al (2014)). In Gujarat Varuna T-15 is cultivated in large scale thus mustard variety Varuna T- 15 was selected for study on heavy metal toxicity. The present study demonstrates the phasic effect of different HM i.e. 200 ppm and 600 ppm of $Cucl_2$, $CdCl_2$ and $HgCl_2$, along with the control.

MATERIAL AND METHOD

The uniform graded seeds of Mustard (Brassica Juncea) var. Varuna T - 15 were germinated in D.W and 200 ppm of Cucl2 , CdCl2 and HgCl2 for 96 h. The duration of phasic treatment was 48 h. Thus seeds were germinated in D.W. for 48 h. and then transferred in 200 ppm of each metal for next 48 h. The seed were also germinated in 200 ppm of CuCl2, CdCl2 and HgCl2 for 48 h. then transferred in D.W. for 48 h. The following were the treatment.

1. D.W. 96 h.
2. 200 ppm $CuCl_2$ 96 h.
3. 200 ppm $CdCl_2$ 96 h.

4. 200 ppm $HgCl_2$ 96 h.
5. D.W. 48 h. + 200 ppm $CuCl_2$
6. D.W. 48 h. + 200 ppm $CdCl_2$
7. D.W. 48 h. + 200 ppm $HgCl_2$
8. 200 ppm $CuCl_2$ + D.W. 48 h.
9. 200 ppm $CdCl_2$ + D.W. 48 h
10. 200 ppm $HgCl_2$ + D.W. 48 h

The similar experiment was done using sever heavy metal stress i.e. 600 ppm of each metal. The effects of phasic treatment of heavy metal were studied with the help of controlled and treated seedlings. The heavy metal toxicity was evaluated with the help of RRG, percent phytotoxicity and Root – Shoot Ratio.

1) Relative Root Growth was calculated according to the formula given by Ouzounidou et al (1992). The formula is given below :-

$$RRG = \frac{\text{Mean length of longest root in toxic solution}}{\text{Mean length of the longest root of control}} \times 100$$

2) Percent Phytotoxicity was calculated following bioassay technique suggested by Chou and Muller (1972).

$$\text{Percent Phytotoxicity} = \frac{\text{Radicle length of control} - \text{Radicle length of test}}{\text{Radicle length of control}} \text{ X } 100$$

3) Root Shoot ratio was calculated using the following formula:

$$\text{Root-Shoot Ratio} = \frac{\text{Root length of particular treatment}}{\text{Shoot length of same treatment}}$$

RESULTS:

Results clearly indicate that the phasic treatment of heavy metals shows adverse effect in higher concentration of metals in comparison of the control.

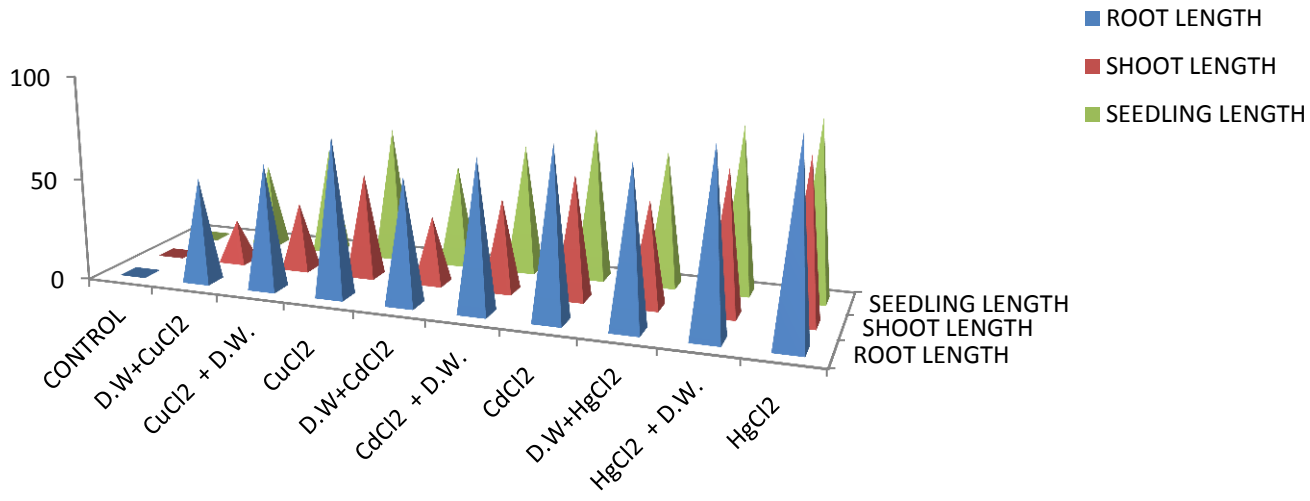
Table 1

RRG		
	200ppm	600ppm
CONTROL	0	0
D.W+CuCl2	48	48
CuCl2 + D.W.	38	15
CuCl2	23	15
D.W+CdCl2	38	38
CdCl2 + D.W.	26	11
CdCl2	17	9

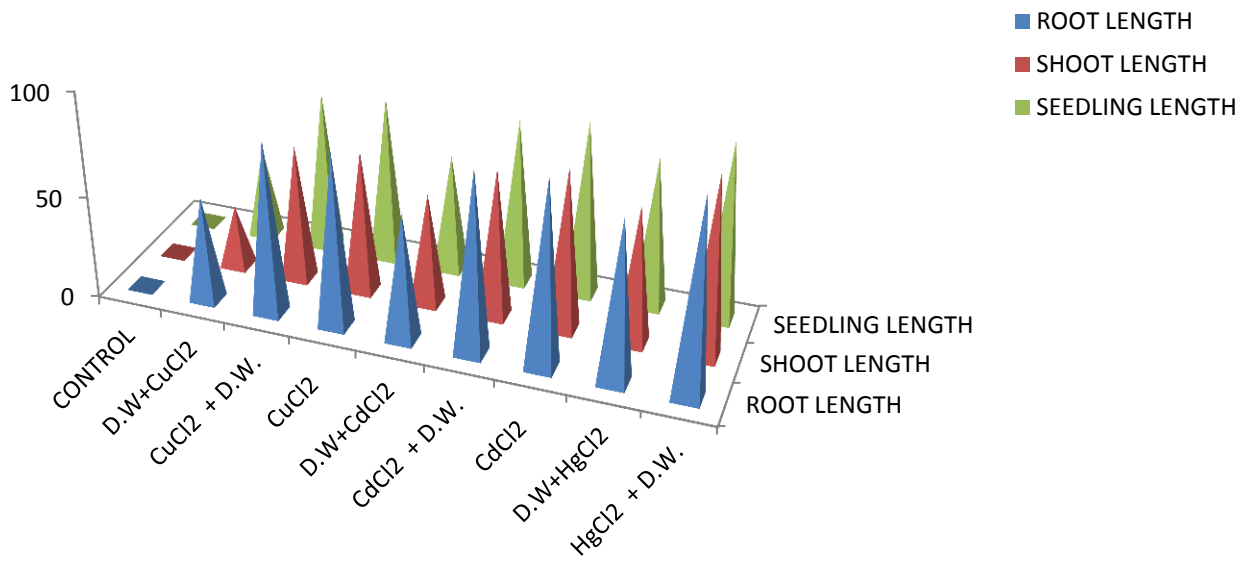
D.W+HgCl2	23	21
HgCl2 + D.W.	11	6
HgCl2	5	2

Table 1 represents the value of RRG in control and treated seedlings. This value is less where seedlings continuously grown in heavy metal, least value were found in Hg treated seedlings. RRG values were lower in the seedlings which were first germinated either in heavy metals than that in the first germinated in DW indicating that initial germination in HM was more harmful for seedling growth. With higher concentration, less the RRG value was found. Thus determination fo RRG indicates heavy metal toxicity with reference to nature of metal, crop response, seedling age, sensitivity etc. Ouzounidou et al (1992) reported toxic effect of copper on RRG of Thiaspi seedlings. RRG is considered as one of the most simplest parameter for evaluating heavy metal toxicity and tolerance of crop plants (Brown and Martin 1981, Nagoor and Vyas 1997, 1998, 1999, Vediya and Vyas 2000a, 2000b).

Graph A and B represents the values of percent phytotoxicity in control and treated seedlings with 200 and 600ppm of heavy metal. The value of percent phytotoxicty was increasing with increasing duration of the heavy metal treatment. Values were higher in seedlings, which were first grown in heavy metal and then transferred in DW, in comparison to values in the seedlings which were first grown in DW and then in heavy metal. Generally percent phytotoxicity values were higher in $HgCl_2$ treated seedlings than in $CdCl_2$ and $CuCl_2$ treated seedlings. Thus Hg seems most inhibitory heavy metal for early seedling growth of mustard. With the help of percent phytotoxicity heavy metal effect was assessed in food grasses (Arora and Katewa 1999). Percent phytotoxicity was also used for evaluating the Cd toxicity and Hg toxicity in Cumin (Vedia and Vyas 2000a, 2000b). The values were almost similar for seedlings continuously grown in 600ppm heavy metal and in the seedlings which were first grown in 600ppm heavy metal for 48h.

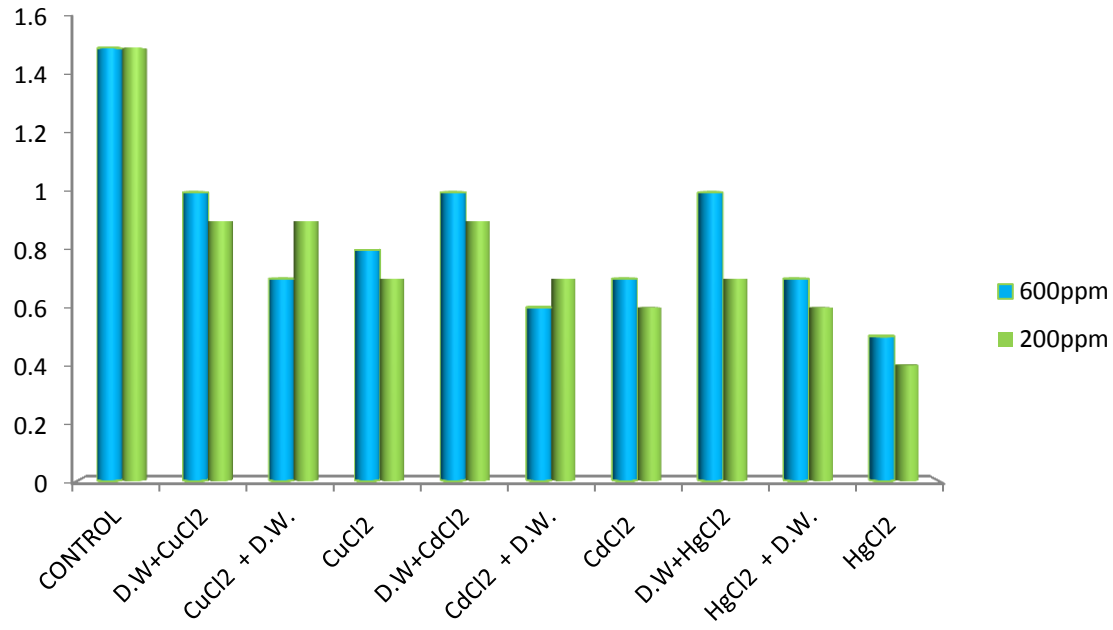


GRAPH A: Percent phytotoxicty 200ppm



GRAPH B: Percent phytotoxicty 600ppm

GRAPH C: ROOT SHOOT RATIO



GRAPH C represents the data on root shoot ratio of mustard seedlings. Maximum root shoot ratio was found in control and generally ratio was lowered in heavy metal treated seedlings. The above data indicates that early seedling growth sensitivity to heavy metal may be known by studying the root shoot ratio. Phasic treatment with copper, cadmium and mercury decreased root shoot ratio. Hg resulted as the most toxic metal followed by Cu and Cd.

CONCLUSION:

When mustard seeds were germinated in moderate and severe concentration of copper, cadmium and mercury for different durations i.e. for 96h and 48h, longer duration caused more adverse effect but root and shoot ratio was affected in the seedling germinated in 600 ppm either for 48h or 96h. Root was affected more than shoot by phasic treatment of heavy metal. Heavy metal caused less effect in the seedlings, which are grown in DW then in heavy metal. The inhibitory effects were related with concentration of heavy metal and duration of treatment.

We must think on, prevention of soil contamination is far less expensive than any kind of remediation and much better for the environment.

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