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# Cadmium Stress Alleviation by Thiourea in Barley

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**ABSTRACT:** Cadmium (Cd) is so perilous pollutant for living things when the certain threshold concentrations exceeded. Barley can accumulate higher concentrations of Cd but show genotypic differences in Cd uptake, moreover, the response to Cd have not been clearly determined yet. Exogenous use of thiourea ameliorates the stress conditions. The objective of this work was to determine the alleviation of various cadmium levels (Cd 0, 100, 500 and 1000 and 1500 µM/L) by 10mM thiourea on germination %age, days to 50% germination, plant height and biomass production of four barley genotypes. Barley plants were grown under controlled conditions and thiourea were applied along with and without increased doses of Cd. On the onset of germination, the seedlings then applied with the doses of thiourea and cadmium according to plan of work, on harvesting, data of seedling height, fresh and dry biomass were collected. The increased doses of Cd significantly affected ($P< 0.05$) all the parameters and thiourea alleviate the cadmium stress to some extent. The results revealed that high Cd toxicity is possibly associated with a decline in dry matter weight induced by the disturbance of nutrient uptake.

**KEYWORDS:** Thiourea, cadmium toxicity, cereal, growth.

## 1 INTRODUCTION

Heavy metals cannot be destroyed biologically but can only be transformed from one state to other (oxidation state/organic complex). That's why; heavy metal pollution poses a great prospective threat to the environment. Among the heavy metals, lead, cadmium, arsenic and mercury pose adverse intimidation to human health but Cd proves to be toxic to both plants and animals and has no beneficial biological function in the organisms (aquatic or terrestrial) (Jarup, 2003).

Growth parameters are best indicators to evaluate the plant's responses to any type of stress (Bhardwaj *et al*., 2009) and it is reviewed that the reduced concentrations of Cd enhances the seed germination and causes an increase in biomass of the plant (Shekar *et al*., 2011) but with the increase in Cd concentrations, gradual decrease in germination and plant growth was observed (Thamayanthi *et al*., 2011) e. g., in maize (Perveen, 2012), barley (Vessilev *et al*., 2004), wheat (Amirjani, 2012), pea (Januskaitiene, 2010), tobacco (Erdem *et al*., 2012) and soybean (Abdo *et al*., 2012) seedling's growth and germination were reduced by Cd exposure.

Crop varieties holding guarantee verses environmental stress is so pricey and long term speculation. Therefore, prominence has been given on exploiting quick and inexpensive means of obtaining satisfactory yield from stressed lands. One of hardheaded approaches is the exogenous use of seed or foliar application of stress alleviating compounds (Wahid *et al*., 2008). In this respect many nitrogenous compound, inorganic salts, natural and synthetic plant growth promorters (Kinetin, Gibberellic acid, Thiourea, Nitrate) and osmotica (Proline and Betain) are well known in plants (Khan and Ungar, 2001). Thiourea (also known as thiocarbamide and sulfourea) is a white crystalline solid (WHO, 2003) used to counteract the effect of cadmium toxicity as thiourea promote the germination %age and germination velocity, fresh and dry plant biomass (Siddiqui *et al*., 2006). According to previous researches, chemicals like kinetin, gibberellic acid and thiourea had pronounced effect on seed germination and growth (Khan *et al*., 2002; Khan and ungar, 2001) even in salt stress (Khan and Gul, 2006;

Khan and Ungar, 2001), drought stress (Abdelkader *et al*., 2012) water stress conditions (Burman, 2004) and even in metal stress conditions (Perveen, 2012).

The main objectives of this study were the assessment of comparitive cadmium tolerance in barley varieties and selection of Cd tolerant and sensitive varieties and elucidating the mechanism of thiourea action in reducing the cadmium toxicity in barley varieties.

## 2 MATERIAL AND METHOD

Whole study was conducted to evaluate the response of barley *Hordium vulgare* growth under Cd contamination with and without exogenous application of thiourea. Experiment was conducted in the Tissue culture Laboratory, Department of Botany, University of Agriculture, Faisalabad.

Seeds of barley (*Hordium vulgare*) genotypes were obtained from Ayub agricultural and Research Institute, (Faisalabad, Pakistan). Seeds of each genotype were spreaded in pots filled with sand. Each treatment was replicated thrice. Each replicate was consisted of five pots and each pot has twenty seeds. On the onset of germination, seedlings were treated with the following concentrations of cadmium and thiourea in the following pattern. Control, 100 µM, 500 µM, 1000 µM, 1500 µM, 10 mM thiourea, 10mM thiourea + 100 µM Cd, 10mM thiourea + 500 µM Cd, 10mM thiourea + 1000 µM Cd, 10mM thiourea + 1500 µM Cd. The data of germination %age and days to 50 % germination were taken from the 2$^{nd}$ day of sowing(data not given). On availing 50 % germination, seedlings were harvested and shoot and root were separated, washed, blotted with filter paper and weighed. Length of roots and shoots were measured. For dry weight determination, plants were dried in oven at 70 ± 2°C for 3 days.

### 2.1 LENGTH, WEIGHTS AND BIOMASS

Roots and shoots of germinated seedlings were separated, washed in distilled water, blotted with filter paper and then weighed on analytical balance; length was taken in centimeters and means values were calculated. Then dried in oven at 70 °C and again weighed.

### 2.2 STATISTICAL ANALYSIS

The experiments were designed in completely randomized with three replications of each treatment. Results were statistically evaluated using the software program COSTAT v 6.3 (CoHort software, Berkeley, California) at p ≤ 0.05. Mean and standard errors were performed on Microsoft Excel Version-2007 and differences between individual means were tested using least significant differences (LSD) using Statistix 8.1.

## 3 RESULTS

Four selected genotypes with differential responses to cadmium and thiourea were used to assess differential mechanism of Cd-tolerance and possible role of thiourea in the mitigation of adverse effect of cadmium. Data were recorded for some aspects of growth i. e., fresh and dry weight, root and shoot length.

### 3.1 ROOT LENGTH AND SHOOT LENGTH

Figure (1 and 2) revealed that combine treatments (thiourea and cadmium) and genotypes induced significant differences in root length and shoot length and there was a significant interaction of both these factors. All the selected genotypes showed decline in their root and shoot length under the cadmium toxicity. As the concentration of Cd increases, more was the reduction in length of root and shoot but the maximum reduction was noted at 1500 µM concentration. 10 m*M* thiourea ameliorates the toxicity of cadmium effectively. All the four genotypes showed sensitivity to the Cd toxicity but the Jau-83 showed less decline and the Quina showed highest decline. Again the data revealed that thiourea was well effective in alleviating the cadmium stress.

### 3.2 FRESH AND DRY WEIGHT

Figure (3 and 4) reported significant difference in treatments and genotypes along with significant interaction of these factors for fresh and dry weight of barley genotypes. Best response to thiourea was observed in Jau-83 and poor response was by 4th genotype i.e., Quina. Cd toxicity reduces the fresh and dry weight of barley genotypes and thiourea was proved to be effective in alleviating the toxicity.

## 4 DISCUSSION

It is observed from the present study and also from the previous studies (Hassan *et al*., 2007) that damage was more prominent when Cd was applied in earlier stages of plant growth (in present study in pot experiment) as compared to the experiment in which Cd was applied after 10 days of the germination. Similar study reported by Singh and Tewari, (2003) that *Brassica juncea* showed significant decreased at 500 mg/kg Cd.

Higher conc. of Cd reduced the shoot and root length, fresh and dry biomass of barley plant as shown in the figures (1, 2, 3 and 4). Previous studies confirmed significantly depressed seedlings growth by Cd of *Brassica napus* (Wan *et al.,* 2011). The decline in plant biomass at high concentration was due to high Cd accumulation in plant parts. Negative correlation existed between decline in dry weight and Cd accumulation in respective tissues (Zorrig *et al.,* 2010).

In the present study, cadmium toxicity was more significant for root than that of shoot elongation that was least affected which is in line with findings of many workers (Yasar and Ahmet, 2006; Anamika *et al*., 2009; Chen *et al*., 2010). Further reduction in the root length was due to its direct contact with Cd polluted soil (Bhardwaj *et al*., 2009).

Thiourea alleviate the Cd toxicity, although not completely but to some extent. The present study confirmed that thiourea enhanced root length in stressed and non stressed conditions. de-Agazio and Zocchini, (2001) reported that DMTU (thiourea) enhanced the root length of spermidine treated maize plants and FTMP (TU) ameliorate the inhibition caused by paraquat (herbicide) in barley plant where paraquat reuced the root and shoot growth especially the root growth (Yonova *et al*., 2009) and same in *Glycine max* (Srivastava *et al*., 2011).

Same inhibition caused by Cd in shoot length but TU ameliorated the Cd toxicity at all concentrations that are in agreement with the previous results that TU resuscitated the seedling length particularly the shoot length in case of NaCl treated wheat plants (Anjum, 2008) and Cd stressed maize plants showed alleviation by TU (Parveen, 2012).

A critical analysis of results had shown that 10 mM thiourea promoted growth in selected barley genotypes moreover, its role appears to be like that of a growth regulator, which is much effective when applied to the seed or as foliar spray (Garg *et al*., 2006; Anjum *et al*., 2008, 2011).

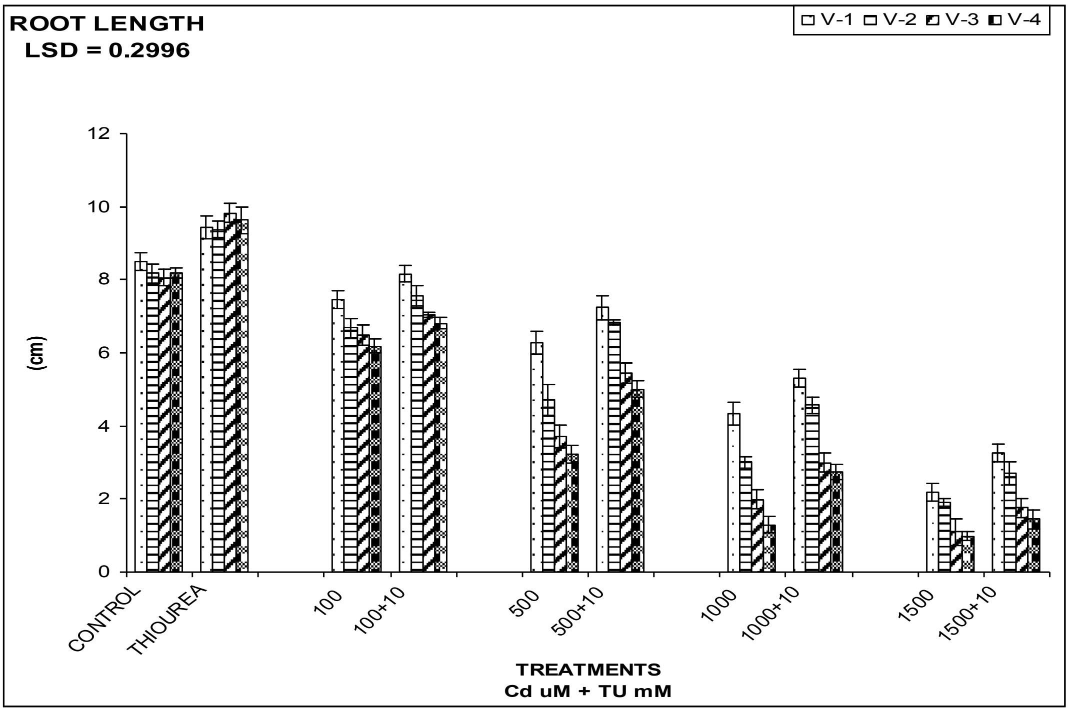


***Fig. 1. Changes in root length of plant with exogenous use of thiourea of barley V1-Jau-83, V2-Jau87, V3- Haider93, V4-Quina under cadmium stress***

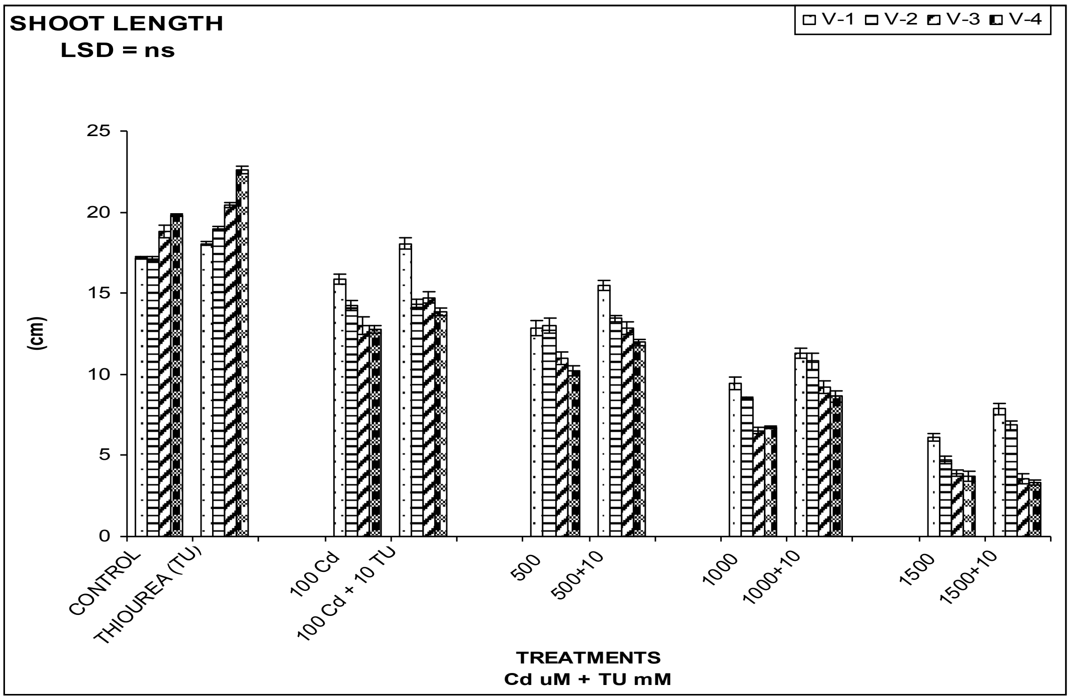


*Fig. 2. Changes in shoot length of plant with exogenous use of thiourea of barley V1-Jau-83, V2-Jau87, V3- Haider93, V4-Quina under cadmium stress*

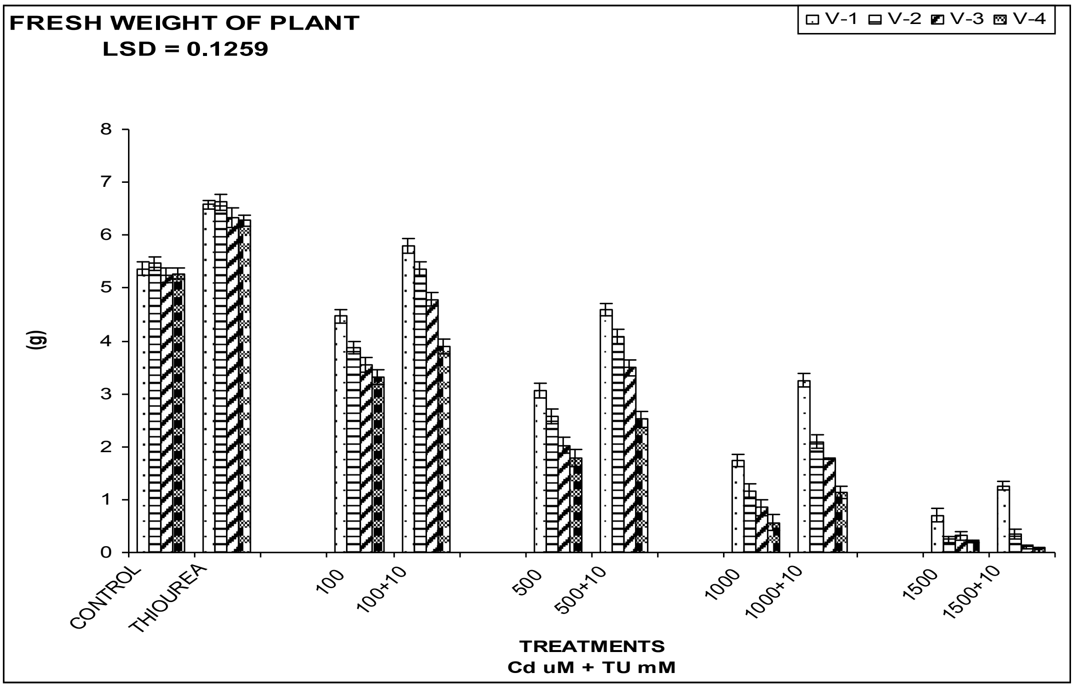


*Fig. 3. Changes in fresh weight of shoot with exogenous use of thiourea of barley V1-Jau-83, V2-Jau87, V3- Haider93, V4-Quina under cadmium stress*

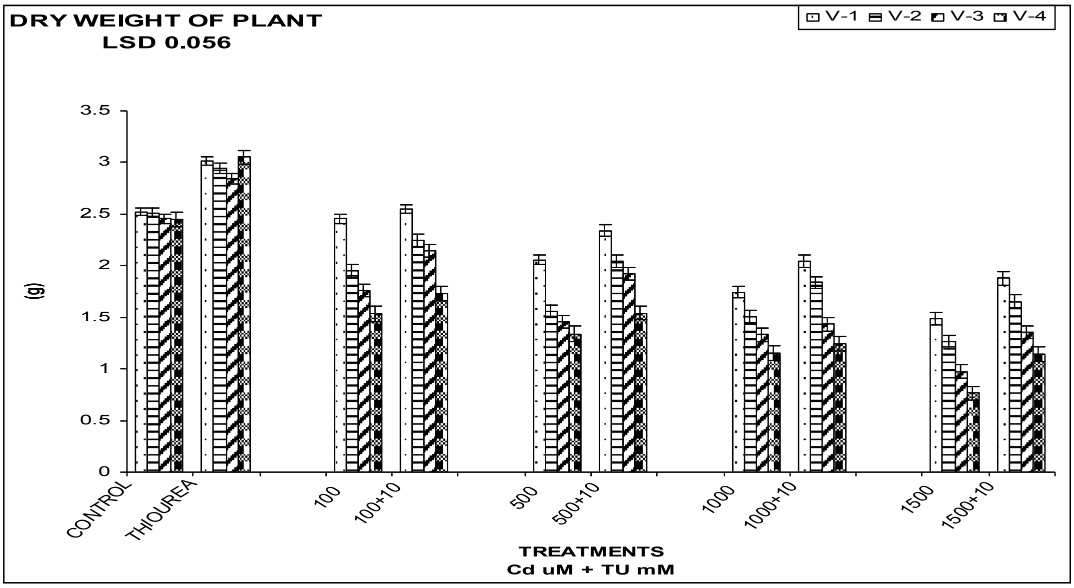


***Fig. 4. Changes in dry weight of plant with exogenous use of thiourea of barley V1-Jau-83, V2-Jau87, V3- Haider93, V4-Quina under cadmium stress***

## 5 CONCLUSION

The present study revealed that the cadmium toxicity severly affect the growth of the barley genotypes but the tolerant genotype show lesser affect but sensitive genotypes show grater. Exogenous application of thiourea ameliorate the cadmium stress to some extent and not completely.

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