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Brief Article

# Effects of Cadmium on Chemical Markers in Wheat (*Triticum aestivum* L.) Yield Production

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## ABSTRACT

A greenhouse experiment was conducted in 2013 in Research Lab of Karaj Islamic Azad University to determine the yield and activity of chemical markers as the response to different concentrations of Cadmium (Cd) (0, 5, 10 and 20 mg of Cd/kg of soil) in wheat cultivars (Karaj 1 and Karaj 2). Treatments were tested in a factorial experiment with four replications in 7.5 kg plastic pots. The response of seed yield and other parameters to Cd was negative, but the rate of Di-Tyrosine (Di-Ty) was increased. In comparison of cultivars, Karaj 1 had higher production and lower rates of Di-Ty at high concentrations of Cd than Karaj 2. There was a significant increase of Di-Ty in the leaf tissue due to Cd increase. The effects of Cd were high on measured characters in control treatments. This reaction was due to increase of Di-Ty by heavy metals in cultivars. Finally cultivars need to have high tolerance to Cd for optimum production of seed yield in this study at high concentrations of cadmium, but high yield in Karaj 1 was related to low rates of Di-Ty.

**Keywords*:*** *Cadmium, Chemical Marker, Wheat.*

## INTRODUCTION

One of the important crops in Karaj region in Iran is wheat. In earlier research, the negative response of the wheat yield to Cd has been shown (Marcason, 2008). There is a great attitude in wheat in response to heavy metals, because this reaction can enhance the destructive effects of environmental stresses due to high rates of Di-ty (Lenz *et al*., 2008). Cd can enhance activity of chemical markers in cereals in saline soils (Li *et al*., 2008) and reduce requirements of wheat plants to water and nutrients. Activity of Di-Ty in leaf (Masciandaro *et al*., 2004), in response to Cd, is important to determine low yield in saline soils. It is because of ion separate of DNA and RNA branches in the cells of tissue (Icoz and_Stotzky, 2008). Di-Ty in crops that have sensitive reproductive stage can play an to important role for

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enhance of $H_2O_2$ rates, which results in maintaining of grain weight under water deficit condition (Wright *et al*., 2008, Lemly, 2007). However, Oremland *et al*. (2007) found negative effect of Cd on relative water content (RWC). These parameters (DNA and RNA branches) are the most sensitive in response to water deficit which occur in a soil and will help to determine best ways of production in sustainable agriculture (Tejada and Gonzalez, 2009). The objectives of this study was to determine the responses of two wheat cultivars to Cd for seed yield,1000 seed weight and Di-Tyrosine rate.

## MATERIALS AND METHODS

### *Lab and Treatment Information's*

The experiment was conducted during 2013 in Karaj Research Greenhouse, on a silt loam soil with 1.3 $g.cm^{-3}$ bulk density in 7.5 kg plastic pots. Eight germinated seeds were planted in each pot and the pots were irrigated with water twice a week to keep the soil water content higher than the field capacity (10%, soil dry weight basis). P was applied to all pots at the rate of 45 $mg.kg^{-1}$ of soil. After 25 days, 5-leaved seedlings were thinned to 4 per pot. Seven days later, Cd treatments (0.5, 10 and 20 mg of Cd per kg of soil were added to the pots. Eighty days after Cd treatment, the various analyses were performed. Treatments were arranged in a factorial experiment based on a completely randomized design (CRD) with four replications.

### *Marker Assay*

#### *Di-Tyrosine*

Leaf segments were homogenized with phosphate tris buffer (pH 7.5) containing 0.2 $mol.L^{-1}$ and then ascorbate (0.2 $mmol.L^{-1}$, pH 7.2), and EDTA (0.2 mol) were added to this extract. For the assays of marker activity, the leaf segments were homogenized with 0.2 mol potassium phosphate buffer (pH 7.2). The activity of (Di-Ty) was tested according to Steven and Sidney method, (2006). All data collection areas were selected to be representative of a surrounding area that was 10 $cm^2$ and reasonably uniform with respect to Di-Ty, yield and seed weight. This calculated area (10 $cm^2$) was converted to hectare unit in all traits.

### *Statistical analysis*

Data analyses were performed with the SAS-STAT package (SAS Institute, 2005). Means were compared by Duncan's test at P= 0.05 level.

## RESULTS AND DISCUSSION

Significant differences for cultivars, rates of Cd and their interaction for each parameter are presented in Table (1). Average of seed yield (in two cultivars) had negative response to different rates of Cd (0-20 $mg.kg^{-1}$ soil) (Table 2). The effect of cultivars × Cd was significant for seed yield, seed weight and Di-Ty ($P \leq 0.01$) (Table 1). The response of seed yield and yield weight to Cd was different among cultivars. The results showed that the Karaj 1 was more responsive to decrease of Di-Ty than Karaj 2 at high content of Cd (10-20 mg of $Cd.kg^{-1}$ of soil). Karaj 1 and Karaj 2 could reduce Di-Ty content on an average, 18.7 to 7.6% and 23.6 to 11.3%, than the control treatments, respectively. In comparison, the mean yield of Karaj 2 and Karaj 1 was 35.9 to 11.6% and 31.8 to 9.6% lower than control treatments at 5-20 mg of Cd per one kg soil, respectively (Table 2). Seed weight was affected by cultivars × Cd interaction. Seed weight was reduced about 32.4 to 10.5 % in Karaj 2 and 27.2 to 7.4 % in Karaj 1 at 5-20 mg of Cd per kg soil when compared with control treatments (Table 2).

Thus, Karaj 1 could be more efficient in response to Cd than Karaj 2 in yield production. These results indicated that the potential of seed yield was affected by Di-Ty that could create optimum environment (Schulz and Dickschat, 2007). Seed yield in normal conditions (without Cd) was high for cultivars, with the lowest rate of Di-Ty. Hence, 20 mg of Cd per kg soil had lowest yield and 1000-seed weight (Table 2). These results suggested that the amount of Cd had significant effect on grain yield and activity of markers. Poor yield levels at the high rate of Cd caused high activity of markers. It is important to note that low yields could be affected by several factors. Lenz *et al*. (2008) reported that when Cd content was high, yield tended to decline after application of 5 mg Cd $.kg^{-1}$ soil. In the absence of Cd, Di-Ty in the leaf samples was lowest (Table 2). The activity of Di-Ty was increased by more Cd application. Rate of Di-Ty due to Cd was lowest for Karaj 1. This was due to high efficiency of roots in saline soils in this cultivar. The maximum rate of Di-Ty was 4.23 $nm.mg^{-1}$ at 20 mg $Cd.kg^{-1}$ soil in Karaj 2 (Table 2). This suggested that Karaj 1 had positive reaction in soils. Other studies showed that Cd in wheat caused low activity of markers in saline soils (Mullen *et al*., 2008). But this may be important for wheat cultivars that activity of Di-Ty was affected by Cd in the present study (Table 2). The results of our study did show a clear effect of Cd for each cultivar and almost all production parameters in saline soil. High yield indicated that the rates of Di-Ty were different in wheat cultivars in response to rates of Cd (Nelson *et al*., 2008) (Table 2).

**Table 1.** Analysis of variances for tested traits

| S.O.V | df | Yield ($kg.ha^{-1}$) | 1000 Seed Weight(g) | Di-Ty $Nm.mg^{-1}$ |
|---|---|---|---|---|
| **Replication** | 3 | $0.812^{ns}$ | $0.925^{ns}$ | $0.876^{ns}$ |
| **Cultivars** | 1 | $514.27^{**}$ | $63032^{**}$ | $587.11^{**}$ |
| **Cd** | 3 | $343.12^{**}$ | $402.91^{**}$ | $320.29^{**}$ |
| **Cultivars × Cd** | 3 | $198.76^{**}$ | $275.64^{**}$ | $181.40^{**}$ |
| **CV (%)** | | 6.13 | 5.28 | 5.75 |

$^{**}$Significant differences at P=0.01 levels: Not Significant.

**Table 2.** Mean comparison of tested traits

| Plant responses Cd ($mg.kg^{-1}$ soil) | Yield ($kg.ha^{-1}$) | 1000 Seed Weight(g) | Di-Ty ($nm.mg^{-1}$) |
|---|---|---|---|
| **Karaj1** | $4112.23^{a}$ | $48.76^{a}$ | $2.44^{b}$ |
| **Karaj2** | $3561.42^{b}$ | $42.13^{b}$ | $3.57^{a}$ |
| **Karaj1** | $3717.46^{a}$ | $43.65^{a}$ | $2.71^{b}$ |
| **Karaj2** | $3283.30^{b}$ | $36.45^{b}$ | $3.84^{a}$ |
| **Karaj1** | $3240.44^{a}$ | $40.91^{a}$ | $2.89^{b}$ |
| **Karaj2** | $2678.19^{b}$ | $34.26^{b}$ | $4.01^{a}$ |
| **Karaj1** | $2804.55^{a}$ | $37.36^{a}$ | $3.01^{b}$ |
| **Karaj2** | $2282.88^{b}$ | $30.68^{b}$ | $4.23^{a}$ |

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