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EFFECT OF HEAVY METAL STRESS ON GROWTH CHARACTERS AND ENZYMES ACTIVITY IN *ZEA MAYS* L. PLANT

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Abstract

The experiment was conducted to study the effect of different concentrations of heavy metals (Cd, Zn and Pd) in the characteristics of vegetative growth, chlorophyll ratio, the effectiveness of antioxidative enzyme and the concentration of elements in the plant tissue of *Zea mays* L. Heavy elements were used in three concentrations (15, 30, 45) mg / kg and control treatment. The results showed that plant height, leaf area, dry weight of vegetative and root, and chlorophyll ratio decreased significantly when treated with heavy metals and increase the effect with increasing concentrations. As well as GR concentrations, A Sox decreased when adding Cd, Pd to the soil at a concentration of 45 mg / kg. While there was no significant effect of zinc. SOD concentration increased significantly with increased concentrations of heavy metals. The results showed that the highest values of Accumulation of metals (Cd, Zn and Pd) in shoot and root at a concentration of 45 mg / kg. The total root of the maize plant was more dense than the heavy metals of the vegetative.
Keywords: Cadmium, lead, leaf area, antioxidative enzyme, dry weight

Introduction

Heavy metals are a toxic contaminant of soil. Most heavy metals with low concentrations (5 ppm) are toxic to plants such as cadmium, nickel and lead while zinc and copper are needed by the plant at very low concentrations (Riesen and Feller, 2005). Heavy metals are transported from the soil to the plant and accumulate in the stem and root and inhibit the physiological and biochemical processes of the plant (Sharma *et al.*, 2008). Plants are a technology for removing heavy metals from soil (Jadia and Fulekar, 2008).

Several studies have shown the effect of heavy metals on plant growth. Riesen and Feller (2005) show growth of wheat plant adversely affected to presence of zinc, cadmium and nickel in the soil. Ather and Ahmed (2010) noted that wheat plant was treated with different concentrations of lead, cadmium and zinc, led to decrease of plant growth in the rate of 84% and cause effects on protein content and physiological processes within the plant. Lietal (2011) Note that addition of cadmium to the soil led to a decline in the characteristics of vegetative growth of wheat plant with a decrease in the total chlorophyll. Sinha *et al.* (2005) show the river's water contaminated with heavy metals had caused a decline in the growth of crop plants. John *et al.* (2009) observed the toxic effects of heavy metals in the plant and the biochemical properties and accumulation in plant tissues. Sao, Vibol and Paitip (2007) found the accumulation of cadmium in the plant tissue when agriculture in soil. Concentrations of antioxidant enzymes, amino acids and ascorbic acid are affected by increased levels of heavy metals in soil (Wu *et al.*, 2004). Tamas *et al.* (2008) studied the effect of heavy metals on the activity of enzymes in the roots of barley plant. Leon *et al.* (2002) recorded differences in the sensitivity of enzymes to the presence of heavy metals in the soil.

Zea mays L. is an important cereal crop, being widely cultivated in the world, so the third crop in the world is after wheat and rice in terms of area and production, used as human food and beverage manufacturing, used as fodder for animals and enters into several industrial fields such as starch The oil, as well as its use as food, is used in dyes and the rubber Industry.

Materials and Methods

The study was happened during the agricultural season (2017- 2018) to study the effect of heavy metals in the characteristics of growth and activity enzymes in the plant of *Zea mays* L. and the rate of accumulation of elements in the tissues of the plant.

The soil was placed in a plastic pot and then heavy metal cadmium; zinc and lead were added and mixed with soil before planting . Heavy metal was used at the concentrations of 15, 30 and 45 mg/k of soil and control treatment of each component. The 10 seeds were grown in pot and saw with water. After germination, seedlings reduced to only 5 plants. After 30 days of germination, the following measurements were taken: plant height, leaf area, dry weight of root and dry weight to shoot.

Measure the chlorophyll in the leaves used to SPAD-502. Glutathione enzymatic measured in leaves according to Griffith (1980) and according to Chen *et al.* (1989) measured Ascorbic acid oxidase enzyme in leave. Superoxide dismutase assayed according to Gong *et al.* (2005) The concentrations of heavy metals were analyzed in shoot and root plant parts using the spectrophotometer atomic after digesting samples depending on its method (APHA, 1998) Statistical data were analyzed using the SAS program in RCBD design using the Duncan test.

Results and Discussion

Table (1) showed that the addition of cadmium to the soil led to a significant decrease in the characteristics of plant height, leaf area, dry weight of shoot and root, and were the lowest values when treated with a concentration of (45mg/k) compared to control. Zinc and lead treatment at different concentrations caused a significant decrease in all vegetative characteristics.

Table (2) showed a significant decrease in chlorophyll concentrations in leaves (0.21, 0.46, 0.27) when treated with cadmium, zinc and lead in concentration 45mg/k respectively compared to control **.**Also, addition of cadmium and lead to soil significantly decreased the effectiveness of enzymatic antioxidants glutathione and ascorbic acid oxidase. Zinc did not have any significant effect on glutathione and ascorbic acid. While a large increase in the activity of the enzyme SOD in the plant was found to be treated with cadmium, zinc or lead and different concentrations.

Table 1 : Effect of heavy metals on vegetative characters of *Zea mays* L. plant.

Heavy metals	Con. Mg/kg	Shoot height (cm)	Leaf area (cm^2)	Dry weight of shoot(g)	Dry weight of root (g)
Cd	0	87.31 a	378.33 a	30.21 a	11.28 a
	15	81.56 b	255.61 b	27.69 b	11.01 a
	30	67.20 c	169.20 c	27.00 b	8.75 b
	45	54.33 d	118.87 cd	21.68 c	8.33 bc
Zn	0	87.22 a	375.31 a	31.61 a	11.20 a
	15	85.16 a	370.69 a	28.87 a	10.37 b
	30	77.61 b	225.36 b	25.00 b	10.02 b
	45	65.33 c	198.02 c	23.66 cb	8.81 c
Pd	0	87.51 a	372.61 a	30.57 a	11.32 a
	15	66.78 b	285.17 b	22.81 b	9.17 b
	30	60.39 c	227.58 b	20.91 c	9.05 b
	45	49.02 d	170.33 c	13.35 d	7.78 c

Table **(3)** showed the accumulation of the heavy elements in the vegetative tissue of the *Zea mays* increased by increasing concentrations. The highest value of the elements at the concentration of 45mg/k was compared with the control. In the root was accumulated of heavy elements more than shoot, and its concentration increases with increasing concentration of the element in the soil**.**

Table 2: Effect of heavy metals on total chlorophyll and antioxidative enzymes of *Zea mays* L. plant.

Heavy metals	Con. Mg/kg	Total chlorophyll	Glutathione (GR)	Ascorbic acid oxidase (ASox)	Superoxide dismutase (SoD)
Cd	0	1.08 a	0.95 a	1.62 a	0.57 a
	15	0.63 b	0.64 b	1.47 a	0.78 a
	30	0.37 c	0.55 c	1.05 b	1.19 b
	45	0.21 c	0.41 cd	0.87 c	1.53 c
Zn	0	1.04 a	0.94 ns	1.63 ns	0.58 a
	15	0.74 a	0.91	1.61	0.59 a
	30	0.63 b	0.89	1.57	0.97 b
	45	0.46 c	0.82	1.20	1.08 c
Pd	0	1.03 a	0.93 a	1.65 a	0.54 a
	15	0.78 a	0.72 b	1.52 b	1.03 b
	30	0.49 b	0.56 c	0.93 c	1.41 c
	45	0.27 c	0.53 c	0.51 d	1.73 d

Table 3 : Effect of heavy metals on concentration (cd, Zn and Pd) in tissue of *Zea mays* L. plant.

Heavy Metals	Con. Mg/kg	Con. of metal in shoot (mg/g)	Con. of metal in root (mg/g)
Cd	0	2.38 a	30.98 a
	15	5.47 b	40.61 b
	30	6.39 c	44.90 c
	45	8.75 d	46.81 c
Zn	0	2.51 a	29.37 a
	15	6.03 b	42.67 b
	30	7.89 c	75.15 c
	45	10.21 d	89.37 d
Pd	0	2.91 a	32.82 a
	15	3.36 ab	41.81 b
	30	3.79 b	42.00 b
	45	5.68 c	56.92 c

It is clear from the results that the height plant and area leaf decreased when heavy metals were added to the soil due to effect of heavy elements on the processes of photosynthesis, proteins and carbohydrates (Kumar *et al.*, 2011).

Also, there was a significant decrease in the dry weight of shoot and root when increasing the concentration of metals because of the toxic effect of elements in the division and differentiation of cells and damage to apical root as a result of the accumulation of high concentrations of heavy elements lead to change in the regularity of transport tissues. This is consistent with Srinivas *et el.* (2013).

The low concentration of chlorophyll is due to the inhibition of chlorophyll building before the stage protochlorophyllide because of interaction with protochlorophyllide reductase enzyme due to the presence of heavy metals(Kupper *et al*., 2002). It may be due to the replacement of Mg atom at the center of the chlorophyll molecule with the heavy metal atoms, thus causing the destruction of chlorophyll (Gopal and Khurana, 2011) this is consistent with results of Bouazizi *et al*. (2010).

The results also showed that the biological accumulation of the heavy elements in the root is higher than the vegetation in the plant, and this is the conclusion of many studies (Garofola *et al*., 2011). According to Das and Maiti (2007) that show the most of plants have the ability to collect elements of heavy when the soil contaminated with heavy elements, and this accumulation increases with increasing concentrations and time of exposure to the element.

Conclusions

Soil contamination by heavy metals causes toxic effects on plant growth, chlorophyll and antioxidant enzymes. The accumulation of heavy metals in plant tissues has also increased due to soil contamination.

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