International Journal of Basic and Applied Chemical Sciences ISSN: 2277-2073 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jcs.htm
2016 Vol. 6(2) April-June, pp.1-5/Ghani et al.
Research Article

EFFECT OF CADMIUM TOXICITY ON THE GROWTH OF SUNFLOWER (*HELIANTHUS ANNUUS* (L.)

Abdul Ghani[1], *Mujahid Hussain[1], Muhammad Ikram[1], Iftikhar Ahmad[1], Muhammad Imran[1], Abdul Majid[1], Mishal Iftikhar[1], Tahira Hameed[1], Muhammad Farooq[1], Noor Muhammad[2], Hira Fatima[3] and Muhammad Arshad[4]

[1]Department of Botany, University of Sargodha, Sargodha, Punjab, Pakistan
[2]Department of Botany, Ayub Agriculture Research Institute
[3]Department of Botany, University of Lahore, Sargodha, Punjab, Pakistan
[4]Department of Basic Sciences, University of Veterinary and Animal Sciences, Lahore
**Author for Correspondence*

ABSTRACT
The effects of cadmium on the germination of sunflower were investigated. The experiments were carried out in Pots under photoperiodic conditions. The results of the study showed the coefficient of germination velocity of the sunflower seeds decreased with increase in concentrations of the metal solutions in the media. As the pH value increases, the absorption of heavy metals by plants increases. Cadmium was added in different proportions at different stages and readings were taken. The concentrations of cadmium were 6pmm, 9ppm, 12ppm. Four treatments were plotted. One was control treatment and other three were taken after the application of cadmium. Based on observations of plant growth, both soil and plants were analyzed and the vegetation rate and absorption of cadmium were determined. Analytical results indicated that the soil without cadmium helped sunflower to develop. Cadmium in soil adversely influenced sunflower growth. Plants grown in soil that was contaminated with cadmium were shorter than those grown in soil without cadmium. Plant roots contained the most cadmium, followed by stems, leaves, flowers, and seeds. The heavy metal has no significant effect on plant dry matter but had significant effect on the accumulation of these elements in the plant parts, stem, leaves and roots.

Keywords: *Sunflower, Cadmium, Germination, Growth, Shoot-Root Ratio*

INTRODUCTION
The experiment was done in order to show how much toxic effect cadmium cause on the sunflower and how much it accumulates in the sunflower the result was plotted into a table. The tables are shown at the end of the paper. Cadmium can cause many toxic symptoms in plants, such as the inhibition, photosynthesis and nitrogen metabolism, activation or inhibition of enzymes, disturbances in plant–water relationships and the ion metabolism, resulting in low biomass accumulation and growth inhibition. At cellular level, Cd toxicity lead to the overproduction of reactive oxygen species (ROS) in plants which are highly reactive and toxic and cause damage to membrane integrity due to lipid per oxidation, which may result in generation of highly toxic compounds and reduction of plant development.
The aim of this study is to determine the impact of different cadmium levels in the irrigation water on germination and early seedling growth in sunflower. Furthermore, the concentrations of trace metals including cadmium, in roots and shoots of sunflower were determined and examined to obtain their relations with the cadmium dozes in irrigation waters. The growth and metabolism of plants are adversely affected by the increasing levels of these metals in the soil environment; we have two objectives in experiment.

MATERIALS AND METHODS
Soil Properties
The old-Pi soil was used in this experiment. This soil was taken from the nursery. Acidic soil is usually red and contains large amounts of Fe and Al oxides. In this study, soil samples were air-dried, ground and

sieved. They were stored in plastic containers. Then the soil was put in to the pots. The pots were about 20 cm and they were filled, small portion was left in order to water the plants.

Pot Experiment

Shoot-root ratio (by weight), dry matter partitioning, and growth analysis of Sunflower was investigated under excessive Cadmium applications in pot experiment at Dry land during winter. The experiment was performed in completely randomized design with three replicates. The four treatments were: T0= Control, T1= 6ppm, T2= 9ppm and T3= 12ppm.

Seeds were sowed in every pot. Water was given to every pot after duration. The pots were maintained at field capacity in the whole growing season. One week after emergence, plants were thinned to 3 plants per pot.

Separate pots (treatments) were maintained for the three growth stages i.e. 7, 14 and 21, days after emergence (DAE). All the 3 plants were uprooted from each pot at 7, 14 and 21 DAE and the data was recorded as the average of three plants.

The roots were washed with tap water and the plants were then divided into three parts i.e. roots, leaves, and stems, and length of root, shoot and fresh and dry weight was also taken. Also number of branches, number of leaves note down and width of shoot and root also taken and the average length of root, leaf and stem per plant was determined.

Parameters Include

Shoot length, root length, no. of leaves, leaf area, dry and wet weight of root and shoot, chlorophyll extraction.

Plants had a diameter of 19cm. The contents of the pots were fertilized regularly, and plant growth was recorded from Sep 14 to 2013 until Jan 21, 2014, when the plants were harvested**.** The plants were sampled 25 days after sowing and the various growth parameters were employed. Then the samples were dried. Dry weight of root and shoot was determined.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) according to the methods described in Steel and Torre (1980) and treatment means were compared using the least significant difference (LSD) using MSTAT-C software.

RESULTS AND DISCUSSION

The growth of Sunflower decrease with the excessive amount of Cadmium with the passage of time. Here, we analyze different parameters under different concentration of heavy metal Cd on sunflower. We draw plots for each case and observe the different values of parameters for each ppm of the Cd on sunflower.

From the tables, we come to know that no. of leaves and branches and all other parameters increases normally, but for metal application we observe a decrease in them. Most of the sunflower seedlings turned yellow at three days, before they died. The yellow coloration is attributable to chlorosis (Bernstein, 1961). The characteristic feature of toxicities in plants due to heavy metal is chlorosis and reduction in net photosynthetic rate which leads to decrease in plant growth and productivity.

In the present investigation Cd was found to be significantly reduced the plant height of sunflower plant at higher concentration. Cadmium is a nonessential element and exerts hazardous effects on plant height of plants.

The higher concentration of heavy metals has been reported to retard the cell division and differentiation, reduce their elongation and effect plant growth and development.

The various levels of cadmium used in the germination and growth study did substantially prevent seed germination. In the present study, suppression of the germination of the sunflower seeds manifested in delay in germination with increase in concentrations of cadmium, and solutions.

The ability of low concentrations of metals to reduce plant growth was also reported by some workers in the past.

Table 1: Effect of Cadmium Toxicity after first Week

Treatment	Root Length (cm)	Shoot Length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Leaf Area	No of Leaves	No of Branches	Root Fresh Weight	Root Dry Weight	Chlorophyll
T_0	4.67	3.70	1.5	0.1	1.71	5	4.85	1.3	2.38	0.75±0.009
$T_{1(6ppm)}$	4.03	3.38	1.088	1	1.64	4.8	4.81	1.3	2.22	0.65±0.01
$T_{2(9ppm)}$	3.98	2.35	1.05	1.2	1.08	4.6	3.11	1.5	1.98	0.55±0.015
$T_{3(12ppm)}$	3.22	1.19	1.00	1.40	1.05	3	2.77	1.5	1.76	0.49±0.013

Table 2: Effect of Cadmium Toxicity on Growth of Sunflower after 2 Weeks

Treatment	Root Length (cm)	Shoot Length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Leaf Area	No of Leaves	No of Branches	Root Fresh Weight	Root Dry Weight	Chlorophyll
T_0	5.03	5.73	1.7	0.5	2.32	8	5.93	1.8	3.44	0.78±0.010
$T_{16ppm)}$	4.92	3.38	1.2	0.5	2.65	5.1	4.55	1.9	3.44	0.60±0.015
$T_{2(9ppm)}$	3.98	2.35	0.8	0.9	2.08	4.5	3.11	2.0	3.55	0.50±0.013
$T_{3(12ppm)}$	3.23	1.19	0.5	1.0	1.05	3.55	2.34	1.2	3.66	0.40±0.001

Table 3: Effect of Cadmium Toxicity on Growth of Sunflower after 3 Weeks

Treatment	Root Length (cm)	Shoot Length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Leaf Area	No of Leaves	No of Branches	Root Fresh Weight	Root Dry Weight	Chlorophyll
$8T_0$	6.00	7.35	2.0	0.7	2.99	10	6.34	2.3	5.92	0.80±0.012
$T_{1(6ppm)}$	5.96	3.38	1.088	0.5	2.64	7.5	5.44	2.0	5.99	0.55±0.012
$T_{2(9ppm)}$	4.45	2.35	1.05	0.8	2.08	6.5	4.33	1.46	6.22	0.45±0.01
$T_{3(12ppm)}$	3.25	1.19	1.09	1.4	1.05	3.55	3.77	1.1	6.40	0.35±0.010

Table 4: Effect of Cadmium Toxicity on Growth of Sunflower after 4 Weeks

Treatment	Root Length (cm)	Shoot Length (cm)	Shoot Fresh Weight (g)	Shoot Dry Weight (g)	Leaf Area	No of Leaves	No of Branches	Root Fresh Weight	Root Dry Weight	Chlorophyll
T_0	6.60	8.99	3.12	0.9	3.25	12	6.97	2.9	6.22	0.90±0.013
$T_{1(6ppm)}$	6.22	3.38	2.088	0.9	1.64	5.1	5.35	2.04	6.66	0.55±0.010
$T_{2(9ppm)}$	5.99	2.35	1.05	1.35	1.08	4,33	3.11	1.46	6.55	0.40±0.01
$T_{3(12ppm)}$	5.22	1.19	1.09	1.40	1.05	3.55	2.33	1.2	6.40	0.30±0.09

The shoot growth response decreased with increase in metal salt contents in the growing media. This linear dimension growth study indicates that increased levels of metal contaminants produced sunflower growth inhibition to the extent of seedling mortality. Adhikari *et al.,* (2005) also reported that above 80mg Cd per kilogram soil, there is very slow growth of sunflower after germination. Most of the sunflower seedlings turned yellow at three days, before they died. The yellow coloration is attributable to chlorosis (Bernstein, 1961).

Conclusion

Thus, the present investigation showed that Cd at higher concentrations exerted toxic effects on sunflower growth and on the accumulation of these elements in the plant parts, stem, leaves and roots. But, the heavy metals have no significant effect on plant dry matter.

REFERENCE

Abranches JL, Batista GS, Ramos SB and Prado RM (2009). Resposta da aveiapreta à aplicação de zinco em Latossolo Vermelho Distrófico. *Revista Brasileria de Ciencias Agrárias* **4**(3) 278-282.

Adhikari T, Biswas AK and Saha JK (2005). Cadmium phytotoxicity in spinach with or without spent wash in a vertisol. *Communications in Soil Science and Plant Analysis* **36**(11-12) 1499-1511.

Bernstein L (1961). Osmotic Adjustment of Plants to Saline Media. *American Journal of Botany* **48** 909-918.

Bouazizi H, Jouili H, Geitmann A and Ferjani EEI (2010). Copper toxicity in expanding leaves of Phaseolus vulgaris L.: antioxidant enzyme response and nutrient element uptake. *Ecotoxicology and Environmental Safety* **73** 1304–1308.

Gopal R and Khurana N (2011). Effect of heavy metal pollutants on sunflower. *African Journal of Plant Science* **5**(9) 531-536.

Hansch R and Mendel RR (2009). Physiological functions of mineral micronutrients (Cu, Zn, Mn, Fe,Ni, Mo, B, Cl). *Current Opinion in Plant Biology* **12** 259–266.

Jadia CD and Fulekar MH (2008). Phytoremediation: the application of vermicompost to remove zinc, cadmium, copper, nickel and lead by sunflower plant. *Environmental Engineering and Management Journal* **7**(5) 547-558.

John R, Ahmad P, Gadgil K and Sharma S (2009). Heavy metal toxicity: Effect on plant growth, biochemical parameters and metal accumulation by Brassica juncea L. *International Journal of Plant Production* **3** 65-76.

Jothinayagi N, Anbazhagan C and Brabakaran A (2009). Heavy metal and biochemical content of Sargassumwightii occurring in Tuticorin Coast, Tamil Nadu, India. *Journal of Phytology* **1**(2) 112– 116.

Kabata-Pendias A and Pendias H (1992). *Trace Elements in Soils and Plants.* 2 edition, (CRC Press, Boca Raton, Florida) 413.

Kumari MM, Sinhal VK, Srivastava A and Singh VP (2011). Zinc Alleviates Cadmium Induced Toxicity in Vignaradiata (L.) Wilczek. *Journal of Phytology* **27** 174.