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ORIGINAL ARTICLE

Using Plant Hormone to improve Phytoremediation of Cadmium Contaminated Soil from a *Brassica napus* (Canola) plant

Niloofar Rahimi[a], Leila Pishkar[b]*, Davood Eradatmand Asli[c]
[a]Department of Biology, Islamshahr Branch, Islamic Azad University, Tehran, Iran
[b]Department of Biology, Islamshahr Branch, Islamic Azad University, Tehran, Iran
[c]Department of Agriculture, Payame Noor University , Tehran, Iran
Corresponding author address: leilapishkar@gmail.com

ABSTRACT
Cadmium-contaminated soils from a Brassica napus (canola) plant were examined to probe the phytoextraction efficiency of plants treated with cytokinine (CK) hormone. Fresh root and leaf weight, following treatment with different concentration of cadmium and CK hormone were compared. Results show the effectiveness of CK in enhancing fresh root and leaf weight while Brassica napus (canola) plant incubated with cadmium treatment. The addition of CK increased the durability of Brassica napus (canola) plant against heavy metal. Obtained results support the application of plant growth hormones in the assisted phytoextraction process for cadmium-contaminated soils.
Keywords: Cd, Brassica napus, CK

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INTRODUCTION

Technologies of the last centuries have resulted in environmental pollution such as water, air and soil [1]. Therefore, environmental pollution is the main risk of human health and natural life. Phytoremediation is defined as removing of the external harmful materials by means of plants. This method is focused on a set of techniques utilizing natural or transgenic plants for removing of organic and inorganic pollution of environment which acted as an effective, inexpensive and environmentally friendly technology. In this method plants in cooperation with soil microbial agents cause the reduction contamination of soil and groundwater [2]. This technology can be applied to reduce a variety of soil contaminants which can be categorized in organic and inorganic pollutants. Some well- known plants such as mustard, sunflower, tobacco, wheat and corn have been reported to decrease the amount of heavy metals pollution (2). Phytoremediation in relative to other techniques of soil enrichment has introduced many advantages of lower cost and groundwater safety, durable method and in conformity with the environment procedures [3]. Presence of heavy metals in general, it must be defined as those elements that have gather in various parts of living organisms and are not biocompatible and leads to long-term risk of different disease such as different kinds of cancer, mutation and genetic inheritance disorders. On the other hand, the heavy elements can be considered as elements which show a density of greater than 5 grams per cubic centimeter [4]. All heavy metals provide no biological importance for biological systems. Among heavy metals, iron, molybdenum, manganese play a pivotal role in micronutrient. Zinc, nickel, copper, vanadium, cobalt and chromium considered to be among the toxic metals. Arsenate, mercury, silver, cadmium, lead and uranium showed no significance role in the food and demonstrate a conflicting reported risk of toxicity to plants [5]. Presence of heavy metals such as cadmium, nickel and chromium in the soil can induce dramatic change on agricultural land and plants. Concentration of heavy metals can play a remarkable effect on the plant's safety [6]. Heavy metals may be considered harmful agents because of inducing the organism-accumulation. Organism accumulation result in enhancing the concentration of toxic materials overt time and their absorption by plant roots and transporting to shoots. This results in impaired metabolism and promoting plant growth failure [6]. Furthermore, the accumulation of high

concentrations of heavy metals in the soil, decreasing the soil fertility and corresponding biological action and thus result in a reduction of yield product and their quality. Also enhancing of heavy metal concentration in plants products is considered as dangerous agents to human health [7]. Presence of high amount of heavy metals induces toxic effects for plants because they switch on oxidative mechanism and cascades in plants signaling pathways and the accumulation of harmful free radicals. Plant hormones are considered as a group of biological molecules that control necessary mechanism in a plant's life cycle. They regulate essential plant pathways such as root growth, growth and yielded products. Cytokinins (CKs) are known as a group of plant hormones that induce a considerable effect in cell division and cell differentiation. They are responsible for the regulation of many functional mechanism of growth such as cell division and apical dominance, essential nutrient absorption, chloroplast maturing, owering and retard of leaf senescence [8, 9]. Furthermore, CKs can induce an increase of plant resistance to salinity, temperature fluctuation and drought [10- 13]. Extensive using of CKs demonstrated that their exogenous usage remarkably enhance yield and quality of products in a variety of plant species; however, outcomes depend on the way of usage, the stage of growth cycle when used and on environmental situations. Phytohormones and especially CKs can also show an effective part in the mechanism linked to stress- induced metal . Many studies have been focused on the impacts of phytohormone usage for phytoextraction reasons. In this report it was suggested that the exogenous application of CKs induces a decrease of heavy metal toxicity in plants applied for phytoremediation, considerably in terms of biomass production. Brassica napus (canola) plants have been considered as a great potential to the western countries, through production of oil with higher quality. Canola is grown essentially for its qualified seeds which yield between 35 % to over 45 % oil. In this report, soil samples contaminated by cadmium were applied to examine the idea of addition of CK application to the soil could enhance cadmium uptake and translocation in Brassica napus (canola) plants.

MATERIAL AND METHODS

Preparation and seed planting

Before planting, canola seeds are rinsed several times with distilled water. In order to run ou seed treatment and incubation with hormone cytokinin, seeds for 8 hours in concentration different concentration of cytokinins were treated in the beaker. In order to determine the amount of cadmium uptake by canola concentrations of cadmium in four levels (0 mM, 100 mM, 500 mM and 1000 mM) was examined. Then, 30 seeds exposed 16 hours to the light with a temperature of 25°C and 8 hours of darkness and finally were transferred. For 14 executive days, irrigation solution with different concentrations of cadmium for each of the treatments, were performed on a daily basis. For each treatment, three medium was chosen as repetition.

RESULTS AND DISCUSSION

Effect of treatments on plant growth

Generally, the biomass produced in this experimental condition (presence of cadmium) by canola in both tissues (shoots and roots) was higher in the presence of CK hormones than that produced in the absence of hormones. All treatments result in increasing the root and shoot biomass produced.

Fresh leaf weight

The results demonstrated that with increasing concentrations of the CK hormone in combination with (0, 100, 500, 1000 mM) cadmium, fresh leaf weight has been remarkably reduced than the control sample and cytokinins caused the increasing of the amount of fresh weight when the plants were treated with different concentrations of cadmium. Cadmium treatment concentrations (0, 100, 500 and 1000 mM) cause the reduction of fresh weight decreased in the absence of cytokinins and adding cadmium concentration (0,100, 500 and 1000 mM) in the presence of cytokinin in a concentration manner increases the weight leaves in a significant manner (Table 1 and Figure 1).

Fresh Root weight

Treatment of canola with cadmium (0, 100, 500 and 1000 mM) in the absence of cytokinin hormone significantly reduces the root biomass in the treatment of cadmium. However based on the results obtained by increasing the concentration of cytokinin in combination with different concentrations (0,100,500 and 1000 mM) of cadmium, root biomass was increased than that of the control sample (Table 2 and Figure2).

Table 1. The results of the different concentrations of cytokinins and cadmium on the fresh weight of leaf

concentration of cytokinin	Concentration of cadmium	Fresh leaf weight
s0	cd 0	3.01
s0	cd 100	3.12
s0	cd 500	2.53
s0	cd 1000	1.93
s1	cd 0	3
s1	cd 100	3.1
s1	cd 500	3.15
s1	cd 1000	3.2
s10	cd 0	3.72
s10	cd 100	3.63
s10	cd 500	3.02
s10	cd 1000	1.95
s100	cd 0	3.7
s100	cd 100	3.65
s100	cd 500	2.98
s100	cd 1000	1.75

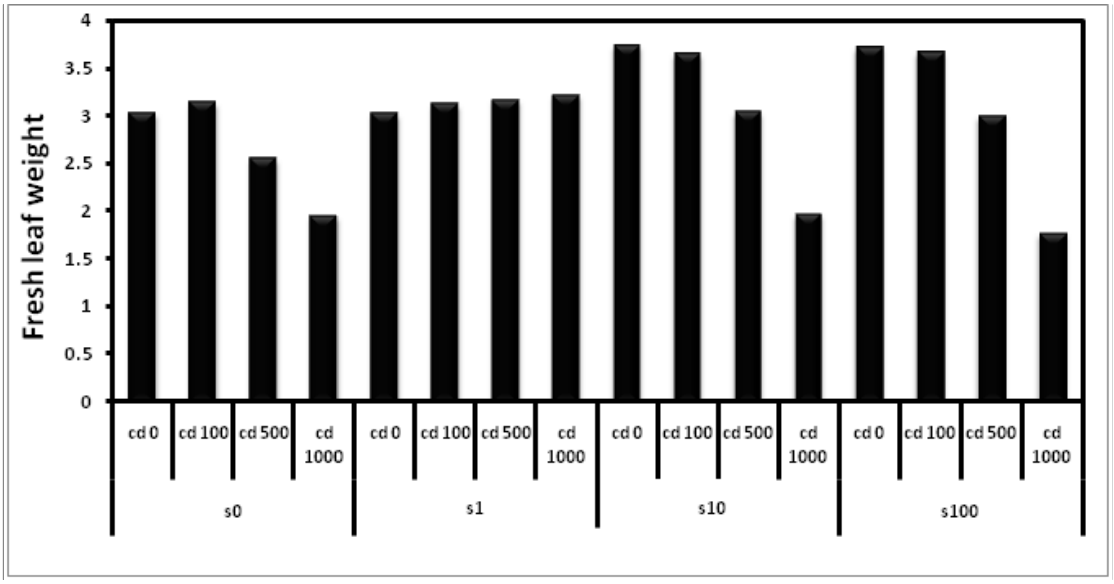

Figure 1. The results of the different concentrations of cytokinins and cadmium on the fresh weight of leaf

Table 2. The results of the different concentrations of cytokinins and cadmium on the fresh weight of root

concentration of cytokinin	Concentration of cadmium	Fresh Root weight
s0	cd 0	2.01
s0	cd 100	1.73
s0	cd 500	0.98
s0	cd 1000	0.36
s1	cd 0	2.09
s1	cd 100	1.65
s1	cd 500	0.9
s1	cd 1000	0.45
s10	cd 0	2.03
s10	cd 100	1.54
s10	cd 500	1.12
s10	cd 1000	1.03
s100	cd 0	1.98
s100	cd 100	1.9
s100	cd 500	1.22
s100	cd 1000	0.68

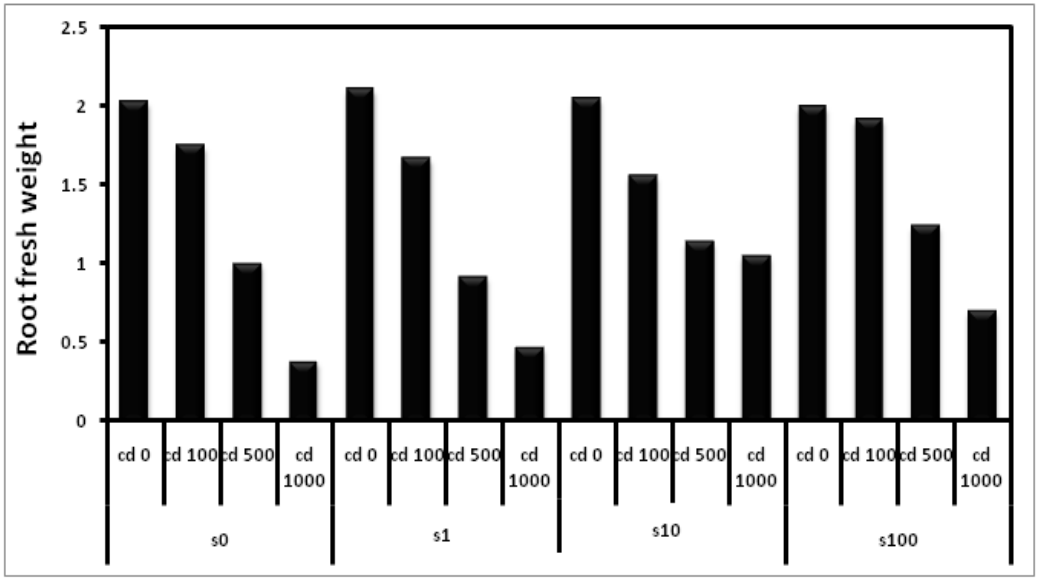

Figure 2. The results of the different concentrations of cytokinins and cadmium on the fresh weight of leaf

Since necessary metals play a pivotal effect on the formation of essential enzymes; thus, the enzyme is disrupted and presence of heavy metal and negligible concentration of necessary metals in the soil are the main responsible factors for preventing plant growth and destroys biodiversity. The toxicity of heavy metals can be defined in three different molecular steps: 1) switching on reactive oxygen species (ROS) signaling pathways. B) inhibiting of essential functional native molecules and C) replacement of essential metal ions in native molecules, where as cadmium and other heavy metals stopping the activities of antioxidant enzymes (5). Indeed, due to the low mobility of cadmium in soil, treatment with CK hormones remains remarkable, and these results demonstrate that CK hormones play of significant concern, since it was seen an evidence of cadmium loss by CK hormones. The results thus encourage the use of CK hormones maybe coupled with other complements to increase cadmium phytoextraction

CONCLUSION

Phytoremediation is considered as a low-cost technique which plays a significant role for soil decontamination of environment. Using this technique also limit the destruction of natural materials and increases and enrich the enzymatic activity of soil to control healthy ecosystems and corresponding to this properties, this method can represent as an alternative to traditional techniques of removing contaminants, especially heavy metals from soil and should consider as an pivotal role in doing our purposes.

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