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The Effects of *Arbuscular Mycorrhizal* Fungi on Nitrogen Concentration of Berseem Clover in Contaminated Soil with Cadmium

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Abstract: The effects of *Arbuscular Mycorrhizal* fungi on nitrogen concentration of berseem clover were examined in contaminated soil with cadmium. Examined factors included: levels of *arbuscular mycorrhizal* fungi inoculation (*Glomus mosseae*) (With and without inoculation), and different levels of soil contamination by cadmium (0, 5, 10, 20, 40 and 80 mg.kg-1). The results showed that the effects of cadmium levels and *mycorrhiza* fungi were significant on nitrogen concentration ($P \leq 0.01$). *Arbuscular mycorrhizal* fungi increased nitrogen concentration in the root and aerial plant 30% and 40.3% respectively. Also cadmium in concentration of 80 $mg.kg^{-1}$ reduced nitrogen concentration in root and aerial plant 28.3% and 35% respectively.

Keywords: *Arbuscular mycorrhizal*, cadmium, contaminated soil

INTRODUCTION

Soil contamination with heavy metals represents a potential risk to the biosphere and leads to increase concentration in the ground or surface water, therefore metals mobility in soil have been extensively studied in the last decade [1]. Toxic heavy metal contaminations in soils and crop plants have major importance due to their health effects on humans and other animals [2]. Cadmium is a heavy metal with a strong effect on crop quality. Moreover, it is a very mobile element in the environment. Plants can easily uptake cadmium and transfer it to other organs [3]. Experiments on the effect of cadmium on contents of macro elements in plants are scarce and therefore the mechanism of its effect has not yet been fully explained [4]. Contaminated soil can be remediated by chemical, physical or biological techniques [5]. *Arbuscular mycorrhizae* have been observed to play a vital role in metal tolerance [6] and accumulation [7]. Many workers have reported enhancement of phosphate uptake and growth of leguminous plants by vesicular *arbuscular mycorhizal* fungi (AMF). It is well documented that AM symbiosis can increase plant growth and nutrient uptake, improve fruit quality and enhance several abiotic stresses such as low temperature stress, drought, salt stress [8]. The effects of AM fungi on plant uptake of metals are varied [9]. For example, some studies suggest that high concentrations of heavy metals in soil may significantly decrease root colonization by AM fungi [10]. Heggo and his colleagues (1990) and Hetrick his colleagues (1994) demonstrated that at high soil heavy metal concentrations, *arbuscular mycorrhizal* infection reduced the concentrations of Zn, Cd and Mn in plant leaves [11, 12].

MATERIALS AND METHODS

The study in June of 2011 was performed the

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factorial experiment on based completely randomize design (CRD) with three replications in the greenhouse of Agriculture Faculty of University of Zanjan. Examined factors include levels of *arbuscular mycorrhizal* fungi inoculation *Glomus mosseae*) (With and without inoculation),and different levels of soil contamination by cadmium (0, 5, 10, 20, 40 and 80 mg.kg-1). The soil prepared of arable land of depth of 0-20 cm at University of Zanjan, after the complete analysis of soil and obtains chemical and physical properties in the laboratory, 6 kg of soil were weight for each pot and then the soil was contaminated. Cadmium sulfate salt used in this experiment, for contaminate soil samples different amounts of salts dissolved in were distilled water and sprayed on the soil, weighed 150 grams to the *mycorrhizal* fungi and mixed with the soil. After mixing the soil with *mycorrhizal* fungi, the soil was put in pots and then cultivated clover. After the complete growth plant (70 days), Plant aerial and roots were harvested. Data were analyzed by SAS and MSTATC software, and obtained variance analysis tables. Average comparison of different treatments was conducted by Duncan test. Charts were obtained by Excel 2010.

Table 1: Chemical and physical analysis of soil

Soil depth cm	EC dsm^{-1}	PH	Soil texture	N %	P (ppm)	K (ppm)	Cd (ppm)	Fe (ppm)	Mn (ppm)
0-20	2.3	7.27	Sandy loam	o.19	21	224	1.2	0.4	1.4

RESULT AND DISCUSSION

Effect of cadmium levels on nitrogenconcentration

According to analysis of variance table 2, the effect of cadmium levels and *mycorrhiza* fungi on nitrogen concentration was significant ($P \leq 0.01$). With increasing cadmium concentrations in soil, nitrogen concentration reduced in root and aerial plant (Figure1). 80 $mg.kg^{-1}$ Cadmium concentrations reduced nitrogen concentration in root and aerial plant 28.3 and 35% respectively.

Table 2: Analysis of variance the traits measured

Variation Resource	Degree of Freedom	Nitrogen $_{Root}$	Nitrogen $_{Aerial}$
Cadmium	5	1.567**	0.908**
Mycorrhiza	1	11.156**	6.079**
Cadmium× Mycorrhiza	5	0.176*	0.083*
Error	24	0.047	.027
Coefficient of Variation (%)	-	6.56	5.37

******: significant p<0.01 *****: significant p<0.05

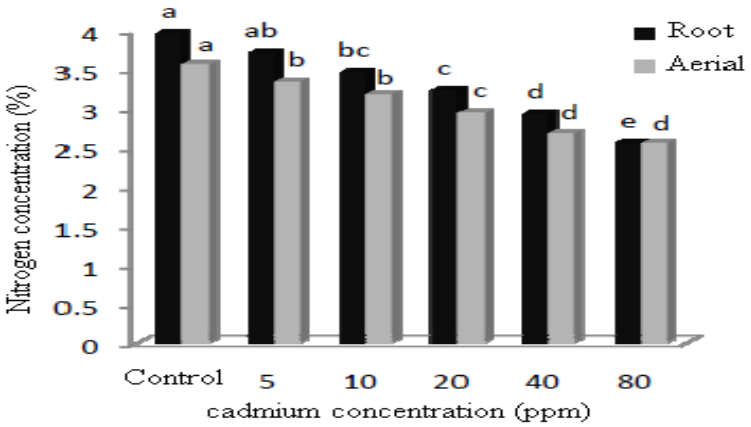

Figure 1: Effect of levels cadmium on nitrogen concentration

External mycelium of AM fungi provides a wider exploration zone [13]. thus providing access to greater volume of heavy metals present in the rhizosphere. Also AM symbiosis can establish extra radical mycelia, which disperses outside the roots to have access to a greater quantity of water and soil minerals for the host plants [14].

Effect of mycorrhiza fungi on nitrogen concentration

According to analysis of variance table 2, the effects of *mycorrhiza* fungi on nitrogen concentration were significant ($P \leq 0.01$). 80 $mg.kg^{-1}$ cadmium, reduced nitrogen concentration in root and aerial plant by 30% and 40.3%, respectively in compared to control

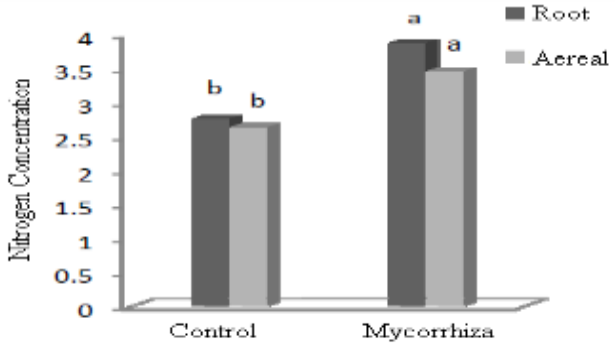

Figure 2: Effect of mycorrhiza fungi on nitrogen concentration

Zandavalli and his colleagues (2004) studied *Araucaria angustifolia* inoculated with *Glomus clarum*, found that the biomass and nitrogen content of *A. angustifolia* forming AM increased significantly [15]. AM fungi, as endomycorrhiza, functions mainly to regulate nutrients (trace metals included) assimilation and sequester noxious metal translocation from mycorrhizal root to the shoot, so that the associated plant can grow better [16]. Ghazala (2005) reported that nutrient uptake of mycorrhizal plants was higher when compared with non-mycorrhizal one [17].

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