Effect of Mycorrhizal Fungi on the Absorption of Phosphorus and Zinc by two Alfalfa Varieties in Cadmium Contaminated Soils

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ABSTRACT

Some agricultural and industrial practices such as mining activities, waste materials of industrial factories, other pollutants and the application of wastewater on farmlands contaminate the agricultural soils. Cadmium is one of the most common heavy metals which accumulates in agricultural soils as a result of the application of phosphorus fertilizers and can easily be absorbed by plants even at very low concentrations with detrimental effects on the living systems. Alfalfa requires high rates of phosphorus fertilizer and therefore the soils under alfalfa are more prone to contamination of cadmium. Arbuscular Mycorrhizal fungi exist as obligate symbiotic organisms on roots of more than 80% of plant families and enhance the growth of the host plant by providing water and nutrients when the plant growth limited by environmental stresses. In order to evaluate the effect of Mycorrhiza symbiosis on nutrient absorption by alfalfa under the cadmium pollution, a factorial experiment base on completely randomized design conducted by using two alfalfa varieties (2122 and Hamadani cultivars); Glomus intraradices fungi; and four levels of cadmium (0, 5, 10 and 20 mg kg^{-1} soil) with four replications in green house on 2005. The plants cut at 50% bloom to determine root and shoot dry matter as well as mineral nutrient absorption by using standard laboratory procedures. The soil material rhyzosphere collected to determine colonization percent. Results showed that phosphorus and iron absorption of 2122 was superior under normal growing conditions. However, under cadmium stress Hamadani performed superior where it also proved none suitable as a host plant for symbiosis with Mycorrhiza. Fungi significantly $(\alpha = \%1)$ increased the absorption of nitrogen, phosphorus and zinc by shoots and phosphorus even in the presence of cadmium adverse effects. Time of harvest also significantly improved the uptake of all the nutrients by the shoots as well as the dry matter production by shoots.

Key words: Alfalfa, Arbuscular mycorrhiza, Cadmium, Symbiosis, Yield

INTRODUCTION

Some human efforts such as industrial, agricultural, mining and use of wastewater in irrigation caused soil contamination. The main source of soil contamination to Cadmium is phosphorous fertilizers (Sheila 1996). Short term effects of Cadmium on human health is mainly respiration disorders (Merian 1991). It accumulates in kidney and liver (Davies 1980), so long term effects have been on kidney and bon hallow (Friberg et al 1986). Some plant species such as alfalfa (Peralta et al 2001) have the ability to accumulate heavy metals and soil detoxification (Bert et al 2003). The main effect of cadmium is on alkaline and acidic phosphatase enzymes in soil (Alloway 1990). Over 40 % of world cultivated lands have lower phosphorous (Igul and

Rodriguez 2002). Phosphorous fertilizers applied to overcome the P deficiency but it cause Cadmium contamination in arable lands. Mycorrhiza can aid plants to absorb P even though p is insufficient in soil, and can replace for parts of chemical fertilizers (Mukerji and Chen et al 2003).

MATERIALS and METHODS

The selected soil for this study had P lower than 10 mg kg^{-1}. Soil sterilized three times before use (Dodd 2000). Seeds treated with ethanol 96% for 30 seconds and Hg Cl_2 for two minutes. Soil autoclaved 24 hr for three times. Fungi of VAM (Glomus intraradices) provided as Adholeya et al (1997) method. Four Kg sterilized soil used in ach pot. A split plot design used with four replications based on CRD. Cadmium used as $CdCl_2$, H_2O at 0, 5, 10 and 20 mg Cd per kg soil. Two alfalfa cultivars of 2122 and Hamedani and soil inoculation or non-inoculation with VAM fungi were used. Plants (4 seedlings in each pot) grown in growth chamber at 16:8 H day-night and 26-28$^{\circ C}$ at 10000 lx PPFD. In 50% bloom shoot were cut and oven dried at 65-70$^{\circ C}$ for 48 hr. Dry mater grounded and P, Zn, Cu, Fe and Mn were determined (Cottenie 1980). Root removed from soil and dried at 65-70$^{\circ C}$ for 72 hr and used colonization assays (Philips and Hayman 1970). Data's were analyzed with SAS, MSTATC, Minitab and SPSS and figures by Excel soft ware.

RESULTS and DISCUSSION

There were significantly effects between alfalfa cultivars and 2122 had superiority in P and Fe absorption (Fig: 1). Higher root dry mass and roots development of 2122 may caused this superiority. Inoculation of soil with VAM caused that N, P and Zn absorption increased 61.4, 28.09 and 4.7 per cent respectively (Fig. 2). Kaya et al. (2003) also obtained such results on water melon.

Mineral absorption decreased by increasing Cd concentration in soil (Fig. 3). Some disorders effects of cadmium such as toxicity, ion imbalance in plant, reduction in photosynthesis and turgor potential cause growth and yield reduction (Gupta et al. 1990).

Root colonization reduced by increasing in cadmium concentration (Fig.4). Cadmium decreased shoot dry weight (Fig. 5). Nutrient absorption disorders, reduction in chlorophyll content, leaf chlorosis are some cadmium effects on plants (Alloway 1990). Our results showed that we can decrease P fertilizer application and so decrease soil contamination by using biofertilizers (such as VAM).

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Figures:

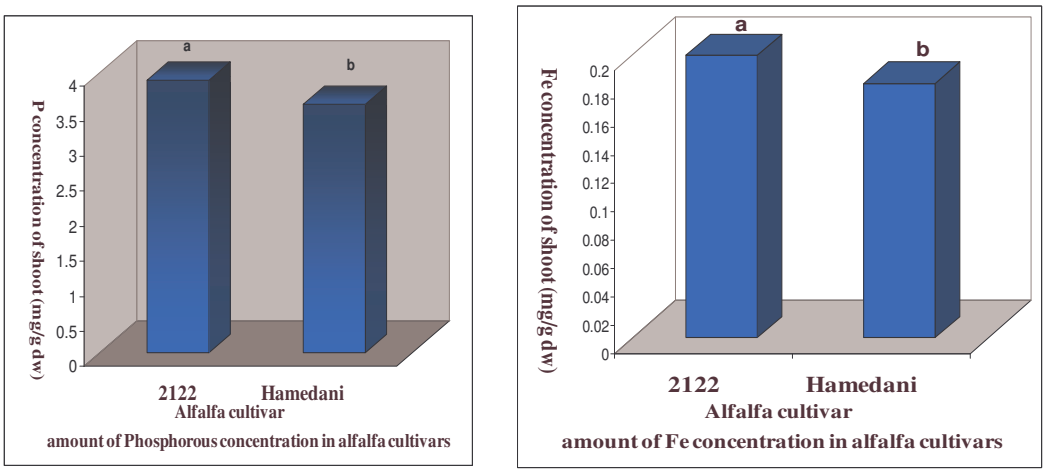

Figure: 1 - P and Fe absorption in two alfalfa cultivars

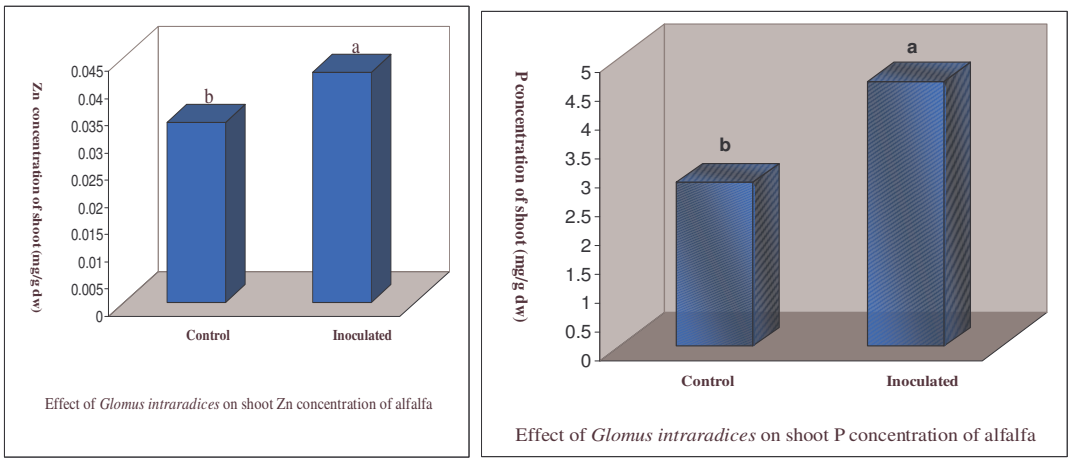

Fig. 2 : Effect of VAM inoculation on P and Zn absorption of alfalfa

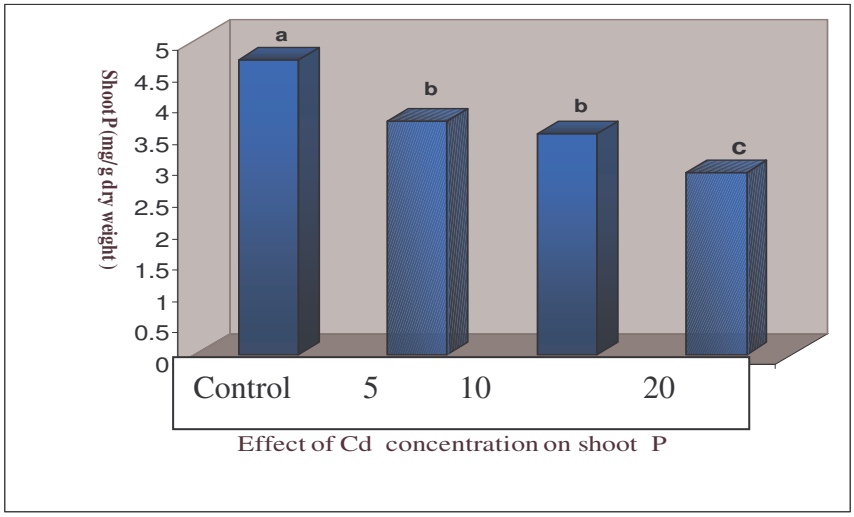

Fig. 3 : Effect of cadmium contamination of soil on phosphorous content of alfalfa shoot

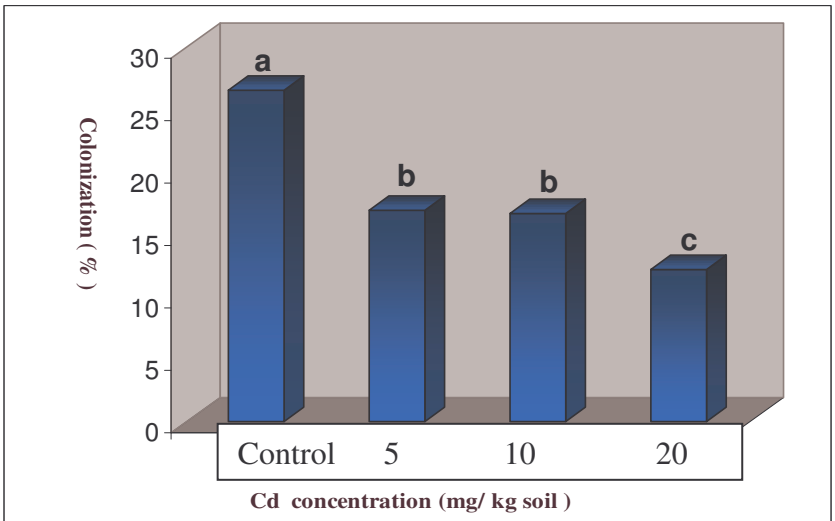

Fig.4: Effect of Cd conc. on alfalfa root colonization

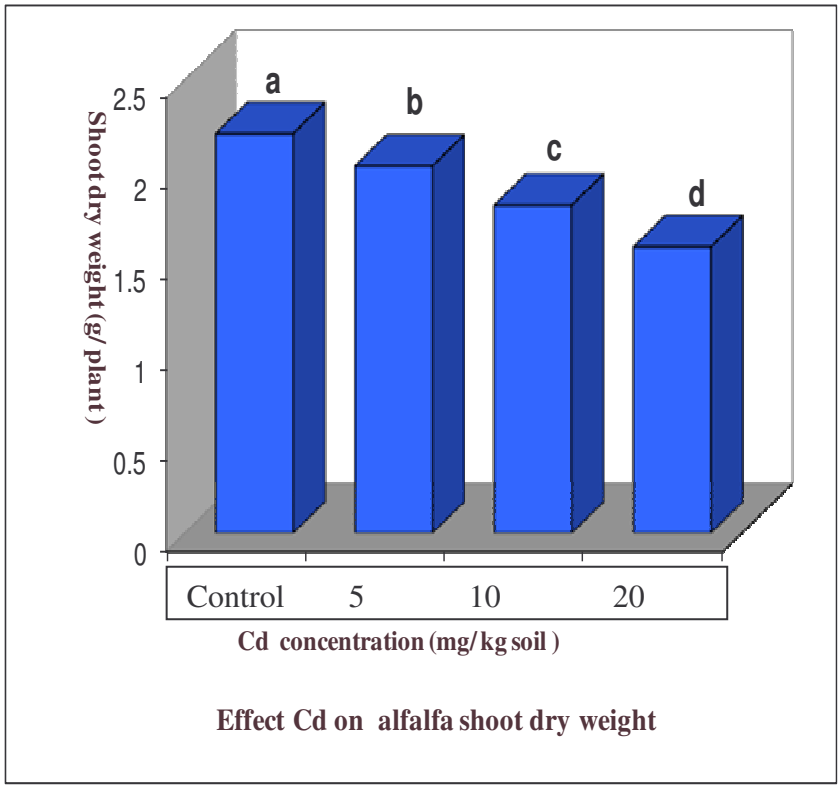

Fig. 5: Effect of cadmium contamination of soil on alfalfa shoot dry mass