Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 3, No. 10, p. 116-122, 2013
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

The using of mycorrhiza to lead extraction of contaminated soils by corn

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Article published on October 15, 2013

Key words: Mycorrhiza, *Glomus interaradiceae*, phytoremediation, lead, corn.

Abstract

In order to investigate the effect of mycorrhiza fungi on the phytoremediation of lead by corn, a pot experiment as factorial based on randomized complete blocks design with 3 replications was performed in Research Farm of Islamic Azad University, Saveh branch. The first factor was use and non use of mycorrhiza (*Glomus interaradices* strain) and the second factor was amounts of 0, 200, 300 and 400 mg/kg of lead nitrat in soil. The results showed that mycorrhiza in inoculated plants in compared with non inoculated plants increased significantly concentration and content of lead. Increasing in amount soil lead increased concentration and content of lead in corn. Morphological characteristics including shoot height, shoot dry weight and root dry weight of inoculated plants were significantly higher than non inoculated plants in all levels of used lead. Mycorrhiza increased lead extraction from soil by corn.

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Introduction

Stability of metal ions causes serious problems in the environment. Metals are not degraded by chemical or biological methods in nature. Metal compounds can be changed, but metal ions remain. One of the problems of heavy metals is theirs stability in the food chain that result large risks for living of plants and animals. Due to long life of some metals, living cells have a tendency to store them. Consumption of heavy metals such as lead, Cadmium, Mercury, Barium and Arsenic are very dangerous for human health (Negro, 1993). For example, lead ions were stored in bones, especially in children because of its similarity to calcium (Parsa Dost, 2008). The average amount of lead in soil has been reported 15 mg/Kg, while amount of lead in contaminated soils are more than 100 Kg/mg (Hutzinger, 1980). Therefore, food provider plants for humans should not be cultivated in contaminated areas with heavy metals particularly lead, or must reduce the amount of heavy metals in soils for using these soils in agriculture. Phytoremediation is one method for reducing heavy metals in soils. Phytoremediation is application of resistant plants for refining of organic and chemical compounds in contaminated soils (Mattina *et al*., 2003).

Mycorrhiza fungi are one of the effective factors in increasing uptake of heavy metals by plants during phytoremediation process. Mycorrhiza fungi are important microorganisms in soil (Smith and Read, 1997). Mycorrhizal hyphae develop in median the host plant roots and soil surrounding and increases absorption of nutrients such as phosphorus (Li *et al*., 1991) and Nitrogen (Ames *et al*., 1983) and micronutrient such as copper (Li *et al*., 1991) and zinc (Burkert and Robson, 1994) in the host plant. On the other hand fungus can refine contaminated soils from heavy metals with collection and storage of heavy metals in their tissues (Jamal *et al*., 2002). Myceliums of mycorrhiza fungi provide Possibility of elements absorption from greater volume of soil than to the root development zone (Khan, 2006). Therefore plants will access to higher amounts of the heavy metals in the rhizosphere that these metals are stored more in structures mycorrhiza fungi inside the roots and spores fungi. Besides, mycorrhiza fungi increase plant establishment and growth, despite high levels of toxic heavy metals in soil by improving mineral nutrition (Taylor and Harrier. 2001), access more to water (Auge, 2001) also improvement of physical condition and density of soil (Kabir and Koide, 2000).

In this research should be investigated the effects of mycorrhiza on the absorption of lead as a toxic metal pollutants in soil by corn.

Materials and methods

Location and experimental design

Experiments carried out in the Agricultural Research Farm of Islamic Azad University, Saveh branch. The research was conducted as a factorial experiment based on randomized complete blocks design with 3 replications.

Experimental treatments

The first factor was the use and none use of mycorrhiza (*Glomus interaradiceae*) and the second factor included use of lead nitrate at levels of 0, 200, 300 and 400 mg/Kg. In this study used 704 varieties of corn. Soil with sandy loam texture consisted of 87% sand, 3% silt and 10% clay used for pots.

For each pot weighed 10 kg of soil and then poured into plastic bags. Then amount of 3.4, 4.8 and 6.4 grams of lead nitrate, respectively, for treatments 200, 300 and 400 mg/Kg dissolved in 2 liters of water and added to the soil and for two weeks remained in sealed plastic bags. Finally, contaminated soil transferred to pots. For plants inoculation, 100 gram of mycorrhizal inoculums added to a pot and then completely mixed with top soil in pots. Corn seeds with hydrogen peroxide 10% (H_2O_2) sterilized for 5 minutes and then washed with distilled water. Number of 5 seed planted in each pot and after germination plants number reduced to one plant in each pot.

Traits and methods of studying Parameters

Plants harvested at the end of eighth week and after the measurement of plant height, for determine root and shoot dry weight, plants were dry in oven 70 ° C for 48 hours. In order to measurement lead concentration in shoot tissue used from acid digestion method to help nitric acid and then lead concentrations determined with atomic absorption spectrophotometer.

Statistical analyses

Data analyzed with use of SAS software and means compare performed with Duncan's multiple range test (P<0.05).

Table 1. Variance analyses table the effects of fungi and lead levels on studied characteristics of corn.

Source of Variation	df	MS				
		Pant lead content	Plant lead concentration	High	Shoot dry mater	Root dry mater
Block	2	ns 10505.9	ns 0.667	13.72 ns	ns 2.06	0.0838 ns
Fungi	1	**27834283.8	** 15505.5	**25162.7	** 2026.7	113.75**
Lead	2	** 168828.2	** 666.6	ns 14.13	* 5.39	0.0379 ns
Fungi*Lead	2	** 154358.8	** 114,2	ns 15.39	ns 1.06	ns 0.56
Error	10	10418.8	0.882	12.26	1.12	2.426
CV%		6.99	1.3	4.3	6.64	7.3

*significant in P<0.05 ** significant in P<0.01 n.s: not significant

Table 2. Comparison of average effect of mycohrriza inoculation on studied characteri

Mycohrriza inoculation levels	Studied characteristic				
	Root dry weigh (gr)	Shoot dry weigh (gr)	Height (cm)	Lead concentration (mg/kg)	Plant lead content mg/plant
Use fungi(F1)	9.31a	25.56a	118a	101.83a	2694.34a
Non use fungi(F2)	4.28b	5.32b	43.22b	43.13b	227.51b

Results and discussion

Morphological characteristics

The effects of mycorrhiza on morphological characteristics such as shoot height, shoot dry weight and root dry weight was significant has shown in Table 1. (P<0.01). Morphological characteristics in inoculated plants were significantly higher than non inoculated plants (Table 2.). Mycorrhiza fungi increased vegetative growth of plants due to improvement of plant mineral nutrition, increase of moisture availability for plants, increase of plant resistance to environmental stresses of living (Disease) and non-living (salinity, heat and cold) and many other reasons. Bagayoko *et al.*, (1998) reported vegetative growth inoculated plants was better than non inoculated plants. Faramarzi *et al* (2012) reported mycorrhiza application increased biomass, yield and yield component of corn.

Table 1. shows the effects of lead were not significant on root dry weight and plant height but its effects were significant on shoot dry weight (P<0.05). Root dry weight and plant height were not affected with increase of lead concentration of soil but shoot dry weight in the third and fourth levels used lead decreased in compared control plants and first level of used lead (Table 3.).

Interactions fungi and soil lead amount were not significant on morphological characteristic (Table 1.).

Inoculated plants had greater shoot dry weight than non inoculated plants in any level of used lead (Fig.2.). Shoot dry weight of inoculated plants reduced with increase of soil lead but it were ineffective on non inoculated plants (Fig.2.). The height and root dry weight of inoculated and not inoculated plants did not affect with increase of soil lead (Fig. 1. and Fig. 3.).

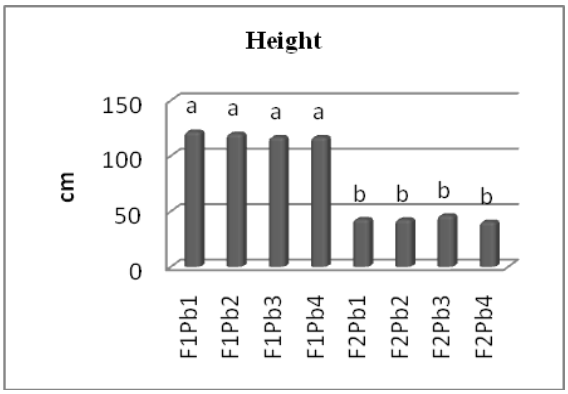

Fig. 1. Mean comparison effect of mycohrriza and lead levels on height of corn.

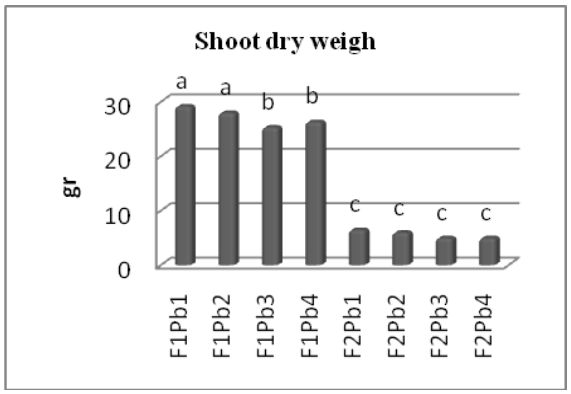

Fig. 2. Mean comparison effect of mycohrriza and lead levels on shoots dry weigh of corn.

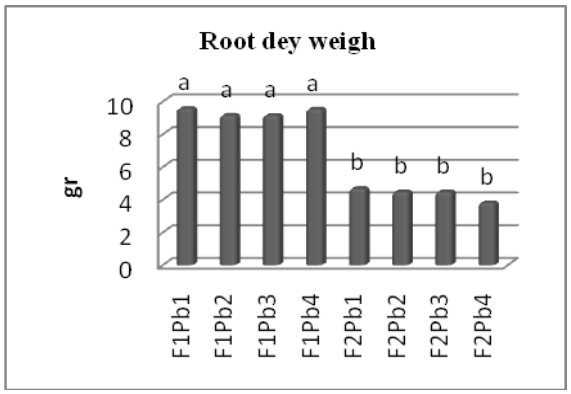

Fig. 3. Mean comparison effect of mycohrriza and lead levels on root dry weigh of corn.

Table 3. Comparison of average effect of lead consumption on studied characteristic.

Consumption lead levels (ppm)	Studied characteristic				
	Dry wieth root (gr)	Dry wieth shoot (gr)	Height (cm)	Lead concentration (mg/kg)	Plant lead content mg/plant
(Pb1)0	a 6.91	a 18.2	a 82	d 0	0d
(Pb2)100	a 6.84	a 17	a 81.33	c 60.7	c 1305.39
(Pb3)200	a 6.83	b 15.17	a 81.68	b 75.7	b 1438.97
(Pb4)300	a 6.7	b 15.67	a 78.83	a 81.03	1638.42a

Lead concentrations

The research findings in Table 1. show the effects of mycorrhiza were significant on plant Lead concentrations ($P<0.01$). Inoculated plants had the most Lead concentrations than non inoculated plants (Table 2.). Lead concentrations in inoculated plants increased than in non inoculated plants almost 2.4 times. Therefore, fungus symbiosis with roots of corn was effective on the uptake of lead by plants. External Hyphae of mycorrhiza fungi in soil moves with speed of approximately 800 times speed of plants root and causes increase of elements uptake

with penetration into regions where root not exist. These results were consistent with findings Del Val *et al.*, (1999) and Joner and Leyval, (2001).

In table 1. is observed effects of soil lead were significant on lead concentration of corn (P<0.01). Increase of soil lead amount from 0 to 400 mg/kg, increased plants lead concentration so that from second level to third and fourth levels of lead in soil increased plant lead concentrations 25 and 39 percent, respectively (Table 3.).

In table 1. is seen interactions fungi and lead were significant on lead concentrations of corn (P<0.01). Fig.4. shows effect of fungal and lead on lead concentration of plants. Inoculated plants in 400 mg Pb per kg of soil (F1Pb4) had the highest lead absorption and the lowest lead uptake was seen in non inoculated and inoculated plants in control lead level (F1Pb1, F2Pb1). The results showed that mycorrhiza lead concentration in inoculated plants significantly increased than non inoculated plants at all levels of consumption lead and lead concentration in inoculated and non inoculated plants increased with increasing Pb soil. Therefore, we can be concluded that corn symbiosis with *Glomus interaradiceae* showed a positive reaction and even in high levels of soil lead has been maintained plant symbiotic and fungi. Mycorrhizal was tolerant to lead high level. These results were consistent with studies Diaz *et al.*, (1996) and also Markova *et al.*, (2003).

Lead content

In table 1. is seen the effect of mycorrhiza was significant on corn Pb content (P<0.01). In a plant, the content of an element is obtained by multiplying element concentration in dry weight. Mycorrhiza increased lead concentration and dry weight of inoculated plants significantly compared to non inoculated plants. Therefore, use of mycorrhiza increased significantly lead content in inoculated plants in compared to non inoculated plants (Table 2.). Lambert *et al* (1979) reported increase of elements content in inoculated plants with mycorrhiza.

In table 1. is observed effect of soil lead was significant on plants lead content (P<0.01) and increase of soil Lead amount significantly increased lead plants content (Table .). Also Interactions of lead and fungi were significant on plants lead content (P<0.01). Increasing soil lead caused an increase of significant in lead content of inoculated plants whereas no response was seen in non inoculated plants (Fig. 5.).

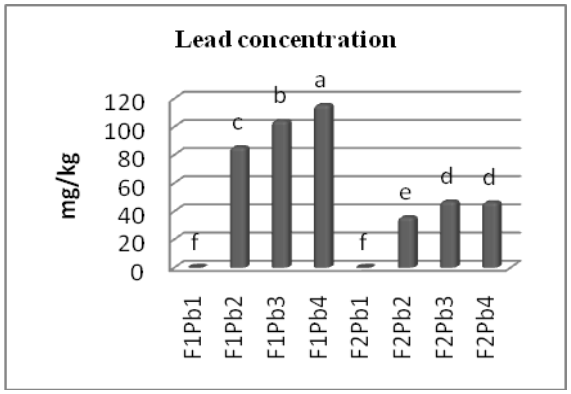

Fig. 4. Mean comparison effect of mycohrriza and lead levels on lead concentration.

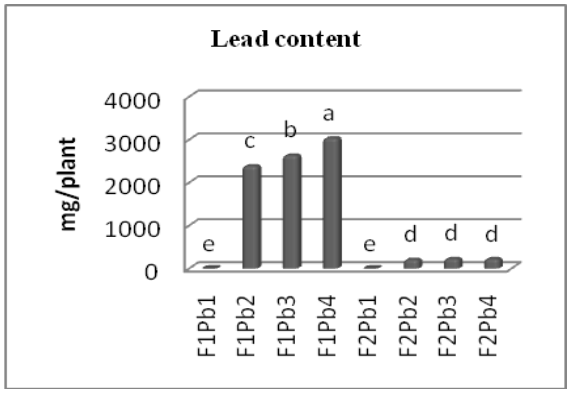

Fig. 5. Mean comparison effect of mycohrriza and lead levels on lead content.

Therefore presence mycorrhiza increased significantly phytoremediation corn and inoculation with mycorrhiza was a positive factor in increase of corn tolerance to Pb contamination.

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