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EFFECT OF COW MANURE AND TIME ON ZINC EXTRACTABLE WITH DTPA

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ABSTRACT
Fertilization is a common method for supplying food elements required for the plant. For this purpose, the effect of cow manure and time on zinc extractable with DTPA was investigated. A factorial experiment including organic fertilizer in two levels (0 and 50 ton ha^{-1}), zinc in 4 levels (0,2,4,5 mg/Kg) and time factor (2-weeks and one month sampling after starting experiment) in three replications was conducted. Results of this research showed that the application of cow manure reduced zinc extractable with DTPA compared to the soil without applying cow manure. Moreover, extractable zinc with DTPA decreased by passing the time from beginning experiment, so that the highest rate of zinc extractable with DTPA was observed 2-week after treatments amended, showing a significant reduction in zinc extractable with DTPA from 2-week till one month after applying treatments, so that it indicated a significant decreasing by 38.8% in zinc extractable with DTPA in soil after applying 50 ton ha^{-1} cow manure and incubating for one month. Moreover, the zinc extractable with DTPA decreased by 48.6% in one month relative to two weeks incubated treatment. The results of this research indicate that adding cow manure reduced the absorption of zinc in soil by increasing absorbent phases of soil, showing the positive environmental point. Moreover, passing time may be an important influence on accessibility of zinc.

KEYWORDS: absorption, cow manure, DTPA, soil contamination, Zinc.

INTRODUCTION

Agronomic plants are one the essential resources of food elements for human growth and health (Welch and Graham, 1999). At the present time, production of food elements doesn't meet the health and nutritional requirements in many countries so that a half of world population suffers from malnutrition (Welch and Graham, 1999). In addition, more than 840 million persons have lack of protein or energy and more than 2 billion persons use low-diversity diets than the past 30 years (Moy 2014, Rukundo *et al.,* 2014). The highest rate of persons suffering from malnutrition is low-income persons especially women, children and juveniles (Welch and Graham, 1999). At the present time, more than 40% of world people have malnutrition of low- consumed elements (hidden hunger) (Welch and Graham, 1999).

It is being increased in the developing countries. Distribution of zinc in soils is regular and soon absorbed by organic and inorganic materials. It is aggregated in upper layers of soil. Since solubility degree of different zinc compounds is very high, chemistry of zinc in soil is complicated and change of its concentration in soil in quantity depends on the climate, and physicochemical specifications of soil (Yang *et al.,* 2014). When soil pH increases, absorbability of zinc for plants will reduce. Its sufficiency limit in plant tissues is based on the dry weight of 20-100 mg/kg. Harmfulness border for many agricultural plants is reported as 15 mg/kg, though 10 is sometimes sufficient. It is aggregated more in older leaves due to zinc inactivity in plants (Yang *et al.,* 2014; Salah and Barrington, 2006). Zinc in soil is much more in the form of divalent cation and may be absorbed in surface on organic materials and soil sands. Zinc activity in soil solution under balance conditions reduces by 100 times per border of pH increase (Chapman *et al.,* 2013; Sullivan *et al.,* 2013). The most important zinc application in industries is its use in coating metals and alloys, and mineral melting industries are the most important origins of environmental pollution with zinc. Total amount of zinc in soils 10-300 mg/kg and its solution in soil 10-100 mg/kg, and its harmlessness border in soil is 15 mg/kg and 50 mg/kg for reference plant. This element is necessary for both plants and animals (Pais and Jones 1997). Zinc is one of 15 mineral and essential elements human body needs. There is near to 14 g zinc in human body (2.2 g on average) as a half of body iron. Rate of this element is more in some body organs. The highest rate of zinc is reserved in eye, pancreas and skin (20% zinc in the whole of body). Zinc is an anti-oxidant playing critical role in oxidative responses of stress. Each cigarette, for example, imposes 15000 free radicals into body causing different diseases in body if not having any antioxidant. Complete absorption of zinc in human (1-2 g) will cause the headache, nausea, stomach pains and spams in gastrointestinal system. Generally, zinc participates in many chemical metabolisms, and is required for keeping health and long life without any disease (Hedari *et al.,* 2013; Pena- Fernandez *et al.,* 2014). Abtahi *et al.* (2012) reported in a research that the rate of zinc absorbable in clay loam soil shows a significant increase than sandy loam soil, increasing

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from 1.02 to 1.06 mg kg^{-1}. By developing agriculture and using chemical fertilizers, the function of many agronomic products has been considerably increased. Though a great amount of low-consumed elements, and therefore, the plant harvest from soil is being decreased, there has been paid less attention to their compensation in soil. On the other hand, the usable rate of zinc in many soils especially soils of dry and semi-dry districts is low due to high pH, high lime and lack of organic matters in soil (Aghili *et al.,* 2014 ; Mohammadi 2014).

Although agriculture is the most essential resource of supplying low-consumed elements for human, improvement of low-consumed food elements in agricultural products has been given less attention. It shall be considered that agriculture plays critical role in controlling world crisis of human nutrition. This is the time that we may find the sustainable approaches based on production of agronomic plants for solving the problem of malnutrition of low-consumed elements by integration of agriculture, nutrition and health. The only way and permanent solution for controlling malfunction of low-consumed elements and improving health of people is to improve food quality of agronomic plants particularly wheat (Graham and Welch, 1999). Soil consumption method, leaf nutrition or seeds treatment with zinc may be used in order to remove the lack of zinc. Zinc fertilizer resources include organic and inorganic compounds of zinc. Zinc sulfate ($ZnSO_4$) is the commonest. It has high solubility in water, forms as crystal and grain, and more economical than artificial chelates including ZnEDTA (Mordvedt and Gilkes, 1993; Mckenna *et al.,* 1993).

The application of organic fertilizers (sludge of wastes, compost, and cow manure) in heavy soils may improve aggregation, porosity, permeability and ventilation, and help the preservation of water and foodstuff in sand soils (Abusharer, 1996). Moreover, using the organic wastes will increase the organic matters and also the rates of nitrogen, phosphor and low-consumed elements including iron and zinc in soil, causing the improvement of soil productivity (Bai *et al.,* 2014; Mendez *et al.,* 2012). Various studies have represented that the organic wastes including wastes sludge, waste compost and cow manure includes a considerable amount of low-consumed elements, transformed to the organic chelates due to many organic matters, and increasing the solubility and absorbability of these elements in soil (Huang *et al.,* 2012 ; Razavi Toosi, 2000). Using chemical fertilizers is an important method in increasing soil productivity due to useful effects on the physicochemical specifications of soil, although overuse of some organic fertilizers will aggregate heavy metals in soil and its inclusion in food chain cycle. Because the zinc accessibility amount in central districts of Iran is a little low, and passing time and soil characteristics including texture, rate of organic carbon, etc may have effective role on the zinc accessibility. This research aims at study of influence of cow manure on zinc extractable with DTPA.

MATERIALS AND METHODS

This research was performed in Faculty of Agriculture, Islamic Azad University, Arak Branch, with the purpose of studying effect of cow manure on zinc extractable with DTPA under in vitro conditions. The experiment includes factors of organic fertilizer in two levels (0 and 5 ton ha^{-1}) and zinc in 4 levels (0, 2, 4, 5 mg kg^{-1}) and time factor includes 2 weeks and one month sampling after the beginning of the experiment in three replication. A factorial experiment as a completely block randomized design was conducted. For performing treatments, manure dried for one week in 25 ^{o}c and then each was mixed with soil by 0 and 5 ton ha^{-1}, and incubated for two weeks. During this period, soil and fertilizer samples got wet and dried regularly and its humidity was kept in 70% of agronomic capacity of farm. After 2 weeks and one month from beginning the experiment, soil and fertilizer mixture was sampled. 25 g of every soil sample was inserted in the plastic containers. The sample was added by 50 ml of DTPA- TEA extractor. An important item in preparing this compound is the fixation of its pH in 7.3 by help of condense hydrochloric acid. Samples were mixed by mixer for 2 hours then the solid matters therein were settled as sediment by centrifuge. They were filtered by Watman 42 filter paper, and all essences were reached to 50 ml by distilled water. Zinc concentration in the extracted essences was determined by help of Perkin Elmer 3030 atomic absorption machine (Lindsay and Norvell 1978).

RESULTS AND DISCUSSION

Manure includes organic materials which may have good influences on physicochemical specifications of soil. According to total nitrogen percentage in manure by using this fertilizer, considerable nitrogen is added to the soil, as a main share in supplying plant needs to this element. Comparison of concentration of heavy metal in manure on test with standards of US Environment Preservation Agency showed that the concentration of this element is in allowable

scope and these fertilizers enjoy low contamination potential in terms of the metals. In order to compare effect of organic and inorganic part of zinc on change of zinc absorption in soil, a soil with clay loam texture with low lime and organic carbon was selected. [Physical and chemical properties of soil and cow manure used in this experiment are shown in table 1 and 2 respectively.

Table 1- Some physical and chemical characteristics of soil tested

Feature	Unit	Value
PH	-	7/8
EC	dS/m	1/35
OC	Percent	0/1
Soil texture	-	Silty clam
$CaCO_3$	Percent	10
Total zinc	mg/kg	0/02
CEC	$Cmol/^{+}kg$	18

Table 2- Some physical and chemical characteristics of cow manure used in this study

Feature	Unit	Value
PH	-	8/8
EC	dS/m	18
OC	Percent	32
Total nitrogen	-	1/1
Phosphorous	Percent	1/7
Total zinc	Mg/kg	0/7

A statistical analysis was performed by SAS software; comparison of averages was calculated by LSD test at the 5% level; and graphs were drawn using Excel software.

The simple effect of cow manure on the extractable value of zinc with DTPA

Adding 50 ton ha^{-1} cow manure to the soil, the extractable zinc value with DTPA was reduced significantly compared to a treatment lacking cow manure. As shown in Fig (1), the most extractable value of zinc with DTPA was observed in treatment lacking the cow manure that this treatment compared to one with the application of 50 ton ha^{-1} cow manure indicated a significant increase of about 42% in the extractable value of zinc with DTPA. This can probably be known due of the role of absorption properties of organic and mineral part of the cow manure in the accessible value of zinc with DTPA (Basta, *et al.* 2005, Lee *et al.* 2001).

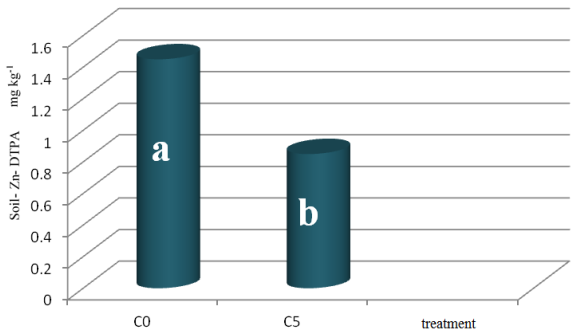

Fig (1): The effect of the cow manure on the extractable zinc with DTPA, C_0 and C_{50} are applying cow manure at the rates of 0 and 50 ton ha^{-1}, respectively.

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The simple effect of time on the extractable value of zinc with DTPA

The most extractable value of zinc with DTPA was observed two weeks after treatment that this treatment compared to one with one month after treatment indicated a significant increase of about 48% in the extractable value of zinc with DTPA. This can probably be resulted from moving the available zinc of plant from an exchangeable to organic or carbonic phase that can influence the accessibility of metal.

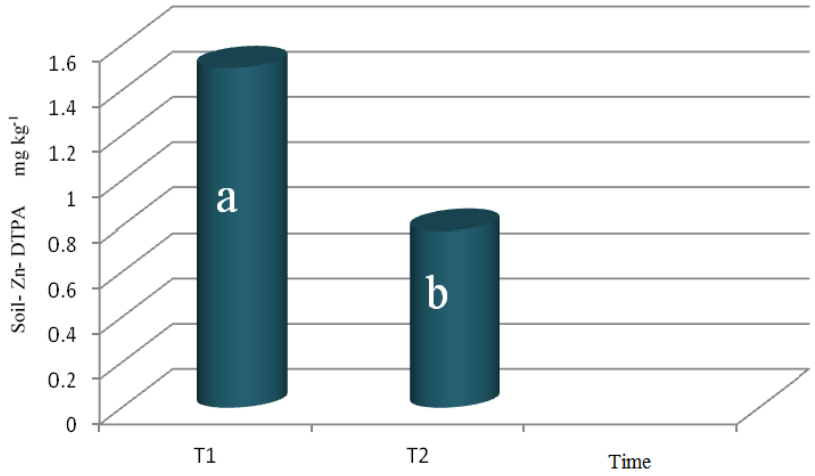

Fig (2): Effect of time on the extractable zinc with DTPA, T_1 and T_2 are two-week and one-month times of soil sampling after the experiment started, respectively.

The interaction effect of time and cow manure on the extractable value of zinc with DTPA

In this study, it was observed in the interactive effect of time and cow manure on the extractable value of zinc that with the passage of time and adding the cow manure, the exchangeable value of zinc was reduced. This reduction was significant compared to control (Fig 3). The most extractable value of zinc with DTPA was observed at the time of two weeks after the test and in the soil lacking cow manure, and the least value was also observed in the soil containing 50 ton ha^{-1} cow manure one month after the test started so that after treatment application of manure in the soil, it showed a significant reduction of about 38/8% in the value of zinc over one month. In addition, the extractable value of zinc with DTPA at the time of two weeks after treatment application in the soil containing 50 ton ha^{-1} cow manure indicated a significant increase of about 48/6% in the extractable value of zinc with DTPA compared to a treatment with one month after treatment application in the same soil.

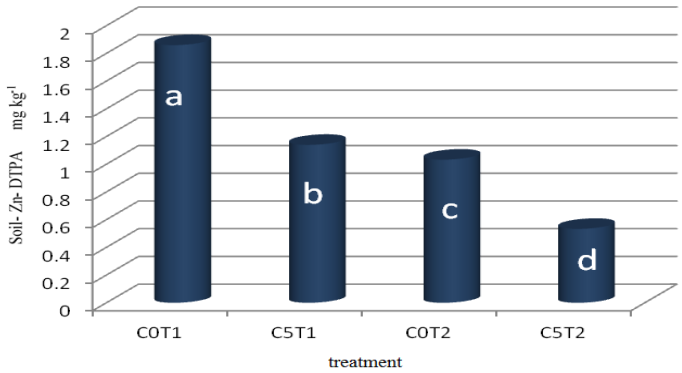

Fig (3): Effect of cow manure on the extractable zinc with DTPA, C_0 and C_{50} are applying cow manure at the rates of 0 and 50 ton ha^{-1}, T1 and T_2 are two-week and one-month times of soil sampling after the experiment started, respectively.

The extractable value of zinc with DTPA at the time of two weeks after treatment application in the soil lacking cow manure compared to a treatment with the same time in the soil containing 50 ton ha^{-1} cow manure indicated a significant increase of about 38/7% in the extractable value of zinc with zinc.

The overall results of this study suggest that the cow manure application reduces the capability of the extractable value of zinc with DTPA compared to the value from its mineral salt source. Also, over time, and with the start of the experiment, the extractable value of zinc with DTPA was reduced. Although the initial value added to the soil can have an effective role in determining the extractable value of zinc with DTPA, the results of this experiment suggest that the passage of time can be an effective factor in determining the extractable value of zinc with DTPA. However, the role of the mineral and organic part in the cow manure cannot be ignored in the extractable value of zinc.

Nowadays, in soils of arid and semi-arid regions, the application of organic fertilizers can have an effective role in increasing the value of soil organic matter and increasing the availability of soil nutrients (Egiarte *et al*., 2008; Obbard and Joans, 2001). A lack of zinc element as a trace element in soil nutrients in the soils of central areas of the country with relatively high percentage of lime is found abundantly. Enrichment of elements in organic fertilizers used can have an important role in increasing the availability of metals; however, the role of time and type of the used fertilizer is considered as an effective factor in changing the accessibility of zinc element.

The results of several studies suggest that the effect of application of organic compounds increases the absorption phase of solid phase that this will result in reducing the available value of cadmium with DTPA (Baghaie *et al*., 2011; Sharifi *et al.*, 2010). Schumann *et al.*, (2002) expressed in the research that a treated soil with values of 0, 100, and 300 ton ha^{-1} composte and cadmium salt in values of 5, 10, 20 and 50 mg/kg reduced the cadmium availability in soils treated with organic fertilizer. Ghafari *et al.*, (2012) also stated that in a study that the absorption value of heavy metals increased with the passage of time but after a while, its changes would be lowered. The present research results are matched with that of Rahmani *et al.*, (2011). (Seyedashrafy *et al*., 2011). In a study entitled "The Effect of Chemical Fertilizer of Enriched Zinc and Cow manure on the Absorption of Zinc, Yield, Yield Components and some Agronomic Characteristics of Makuyi Variety Barley, the application of the Cow manure effect enriched with zinc on the value absorbed with DTPA was measured in the barely plant and reached this result that the extractable value of zinc with DTPA in treating the organic fertilizer indicated a significant reduction compared to chemical treatment of zinc from the source of zinc sulfate; the reason of this reduction was the role of the organic and mineral part in Cow manure fertilizer in stabilizing the zinc element (Seyedashrafy *et al*., 2011).

CONCLUSION

The overall results of this study suggest that although the application of cow manure increases the availability of trace elements, including soil zinc, the results of this research showed that the availability value of soil zinc treated with cow manure was lower than the soil lacking the application of cow manure. This can be known from the role of organic and mineral part of cow manure in reducing soil zinc availability. Moreover, with the passage of time, the extractable value of zinc with DTPA was reduced. The important point is that the total value of trace or macro element cannot be as a determinant of the soil element availability, and the role of physical and chemical properties of soil should not be ignored in the availability of these metals.

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