University College of Takestan

Volume6 ,Issue4

Available online at **http://UCTjournals.com**

UCT Journal of Research in Science, Engineering and Technology
UCT. J. Resea. Scien. Engineer. Techno. (UJRSET)
11-18 (2018)

ISSN 2382-977X

The Effects of Compost and Super Absorbent on the Heavy Metals Concentration and pH of the Soil

***Atefe Noorali*[*1] *Safar Marofi*[2], *Hassan Babolhavaeji*[3]**

1, 2 M.Sc. Student and Professor, Department of Water Resource Eng, Faculty of Agriculture, Bu-Ali Sina University, Hamedan

3.Instructor, Department of Crop Production and Plant Breeding, Faculty of Agriculture, Bu-Ali Sina University, Hamedan

**Corresponding Author: atefenoorali@ymail.com*

Original Article:
Received 3Nov. 2018 Accepted 10 Dec. 2018 Published 30 Dec. 2018

ABSTRACT

In order to investigate the effects of compost and super absorbent on quality of soil, an experiment was carried out in Bu-Ali Sina University at 2013-2014. A randomized complete block design with six treatments and three replicates was employed. The treatments used included: three level of super absorbent (1, 2 and 4 ton per ha) and three level compost (0, 20 and 40 ton per ha). In this study, effects of compost and super absorbent were investigated on heavy metals concentration and pH in soil. The Results showed that the effect of treatments on heavy metals concentration (except Fe in block) and pH of the soil was statistically non- significant ($p<0.01$). Also, the interaction of treatments and block wasn't significant ($p<0.01$) on pH and heavy metals concentration. The maximum of Fe, Zn, Cu and Mn concentrations were observed in treatments of 1 ton/ha super absorbent, 2 ton/ha super absorbent, 40 ton/ha compost and 20 ton/ha compost, 0 ton/ha compost, respectively. The maximum of pH values were also occurred in 40 ton/ha compost. The results show that the maximum concentrations between heavy metals belonged to Fe.

Keyword:

Compost, Heavy metals, pH, Soil, Super absorbent

*** Corresponding author: Atefe Noorali**
Email: Email: atefenoorali@ymail.com

I. INTRODUCTION

In order to fertilize the soils of arid and semi-arid regions, which account for more than 80% of agricultural land and lack organic materials, the addition of organic materials to them is necessary. Recently, the process of compost production using some kind of earthworms has been considered as an easy and nature-friendly technology for the production of organic compost from waste materials and the stabilization of such materials (Ahmadabadi et al., 2011).

Super absorbent polymers effectively influence soil components such as penetration rate, density, structure, compression and texture. Also, stability of aggregates, soil crusting, and rate of evaporation are other factors that can be affected by super-adsorbents. These materials can absorb 200 to 500 milliliters of water per gram of dry weight and preserve it in the root environment. superabsorbents are odorless, colorless, and their consumption in water, soil and vegetation does not cause contamination. Finally these polymers undergo decomposition in soil by microorganisms depending on their type and break down to their components including ammonia, carbon dioxide and water without toxic wastes (Abedi and Asadkazemy 2006).

In the context of compost and superabsorbent application in soil, some researches have been carried out inside and outside the country. Iglesias (1996) reported that urban waste compost significantly increased the concentration of manganese and zinc in the soil compared to chemical fertilizers, which is symmetrical to the application of compost amount. Zohorianmehr and Kabiri (2008) also showed that application of moisture absorption materials is an approach to enhance efficiency of irrigation enhancement in different agricultural projects, particularly in arid and semi-arid regions. These moisture absorbing materials are hydrophilic networks that both absorb and maintain water large amounts of water or any aqueous solvents. Fink (1992) reported that super-adsorbents can reduce water usage in some light soils to one-third due to their ability to maintain moisture in the soil for a long time, and these substances have no environmental adverse effects on soil.

Transportation of heavy metals in soil is not high, and usually remains in the entrance area (Eschorado et al., 1991). But in some studies, the transfer of these metals has been clearly observed. Dodiwolk (1991) observed symptoms of the rare metal movements in an area lower than root zone. Aluvio (1990) stated that the movement of heavy metals in soils with large pores could be as a consequence of the colloidal sediments and clay particles movements along with the movement of the soil solution, which also transfers heavy metals binding to them. Chen et al. (2010) reported that less than 4% copper and more than 58.3% zinc were leached in the compost, using compost application in red soils of China. The researchers reported that the leaching of metals from the compost was due to binding of metals to soluble organic matter.

According to the previous studies, most of these studies have investigated the effect of superabsorbent and compost on plant and less attention has been paid to application effect of these materials on the quality of soil. Considering the fact that any research has not been studied the effect of these materials on soil quality (saturated extract) without plant cultivation conditions, Therefore, in this research we focused on the use of different treatments of super-absorbents and composts in controlled farm conditions. In addition, the effect of temperature and climate conditions has also been the subject of this research.

Materials and methods

Area of study

This research was conducted in 2012-2014 at the farm of the Faculty of Agriculture, University of Bu-Ali-Sina, Hamedan province, Hamedan, which is located between 33 degrees 48 minutes north latitude and 47 degrees 34 minutes 49 degrees and 36 minutes east longitude from prime meridian. The average annual atmospheric precipitation in Hamedan region estimated 317 mm, which is 26% higher than the average of the country (Parsafar, 2011).

This research was carried out as a randomized complete block design with six treatments and three replications. In this regard, six treatments utilized including: compost fertilization at three levels (consumption without compost, 20 and 40 tons per hectare) and different levels of chlorophyll superabsorbent at three levels (1, 2 and 4 tons per hectare).

Medium preparation

In the implementation of this study, 18 cretes with space of 2 square meters were prepared. At a depth of

20.1 meters of each crete, a drainage system was installed, and then different amounts of superabsorbent and compost were used at a depth of 30 cm. After preparation, irrigation was carried out in three stages in the form of flooding irrigation. In the first irrigation period, different amounts of superabsorbent and compost were used in each experimental plot, the second irrigation was after one month and the third one was after the cold winter period. In order to determine the pattern, soil was sampled from depth of 20 cm and was dried at laboratory temperature. Then, the percentage of sand, clay and soil silt was determined using a 2-mm sieve and a hydrometric method (Beykas 1962). Some physical properties of soil, compost and superabsorbent is provided in tables 1-3.

Measurements of heavy metals and pH of the medium

To determine the concentration of heavy metals (iron, zinc, copper and manganese), soil samples were taken from 20 and 40 cm depths. Extracts preparation and determination of absorbable concentrations of heavy elements in soil was performed using DTPA extractors (Lindsey and Neurol, 1978). This solution contains 0.005 molar DTPA and 0.01 molar calcium chloride and pH= 3.7. 10 g soil was weighted using 0.01 gram scale and was transferred to centrifuge tubes with 20 mL extractor solution, and was shaken for 2 hours in appropriate electrical equipment. Afterwards, samples were filtered with Watman filter paper 42. The concentration of absorbable metals was measured by the Varin 220 atomic absorption device.

Table 1. Some of the physical features of examined soi**l**

porosity (percentage)	density: Actual (gr/cm^3)	density: Apparent	Soil pattern	clay	silt	sand
				(percentage)		
۴۴/۱۵	۲/۵۱	۱/۴۰	Sandy clay loam	۲۹/۴۴	۲۵/۲۸	۴۵/۲۸

Table 2. Some of the physical features of examined compost

Sodium	Ec	pH	Cadmium	Manganese	Nickel	Copper	Zinc	Iron
(mg/kg)	(ds/m)							(mg/kg)
۰/۶	۴۲۰۰/۵	۷/۴۶	۳/۸	۵۲۸/۳	۶۹/۷	۳۸۳/۱	۴۴۷/۴	۴۰۶۸/۴

Table 3. Some of the physical features of examined superabsorbent

Water absorption capacity	pH	Specific mass	Moisture content	Particle sixe
(gr/gr)		(gr/cm^3)	(درصد)	(μm)
۲۲۰-۱۸۰	۶/۵	۱/۴۳	¼	۱۵۰-۵۰

Table 4: Concentration of heavy metals, sodium and pH in primary soil

pl	Sodiur	Manganes	Coppe	Zin	Iror	Treatment
					(mg/li	
۷/۲	۲۳/۱	۴/۰	۱/۷	۱/۳	۱۷/۵۶	4 kg compost
۷/	۳۰/۵	۳/۴	۱/۳	۳/۸	۲۶/۱۲	8 kg compost
۷/۲	۱۸/۱	۴/۶	۱/۶	۱/۳	۳۰/۵۹	0.2 kg superabsorbe
۷/۴	۲۰/۶	۶/۰	۲/۲	۱/۷	۳۹/۱۹	0.4 kg superabsorbe
۷/۲	۲۰/۶	۳/	۱/۴	۱/۲	۲۸/۱۵	0.8 kg superabsorbe
۷/۴	۲۰/۶	۳/۸	۱/۷	۹/۷	۳۱/۲۵	Control

The Switzerland pH meter was also used to determine the pH of the samples.

The concentration of heavy metals (iron, zinc, copper and manganese) as well as the pH of the used soil (before adding compost and superabsorbent) are presented in Table 4.

Table 5. Analysis of variance of the treatments effects on concentrations of the examined elements

average of squares					Degrees of freedom	Source of change
pH	Manganese	Copper	Zinc	Iron		
۰/۹۲^{ns}	۰/۱۹^{ns}	۰/۰۹^{ns}	۰/۱۹^{ns}	۰/۰۰۷**	۱	بلوک
۰/۳۹^{ns}	۰/۹۶^{ns}	۰/۷۰^{ns}	۰/۷۳^{ns}	۰/۹۸^{ns}	۵	تیمار
۰/۹۵^{ns}	۰/۷۸^{ns}	۰/۳۲^{ns}	۰/۶۰^{ns}	۰/۸۷^{ns}	۵	بلوک × تیمار
۰/۰۱۱	۰/۷۲	۰/۰۰۱	۱۲۵/۰۰۷	۳۸/۴۷	۲۴	خطای آزمایش
۰/۰۱	۰/۶۰	۰/۰۰۱۲	۱۱۵/۱۶۵	۳۸/۴۶	۳۵	خطای کل

**: At 1% level is significant, ns there is no significant difference

Results and discussion

Table 5 shows the statistical analysis of the applied treatments on heavy metals concentrations and pH of the examined soil. According to Table 2, the effect of block on zinc, copper, manganese concentrations and pH of the soil is insignificant and the effect on iron concentration is significant in 1% level. Also, based on these results, effect of treatments on concentrations of all heavy metals and pH in the culture medium was insignificant at 1% level. In this study, the interaction between block and treatment on the examined parameters was insignificant at 1% level. Hosseinpour et al. (2012) reported that the use of compost fertilizer in soil and the duration of its use on the amount of soil absorbable iron and manganese was statistically insignificant at 1% level, but became significant on the amount of soil absorbable zinc and copper at 1% level. These results were inconsistent with the results of the present study, except manganese element. Also, the results of this study about the effect of compost on zinc and manganese concentrations contradict with the results of Eglias-Jimens (1996).

Table 6 shows the comparison of the mean concentrations of heavy metals and pH in the medium by applying various amounts of compost and superabsorbent. According to this table, the highest and the lowest concentrations of iron were observed in 0.2 kg of superabsorbent treatments and 4 kg of compost in each plot, respectively. Also, the results indicate that the highest and lowest copper concentrations are related to treatment of 8 kg of compost and control. About manganese, the highest and lowest concentrations were observed in 4 kg compost and 0.8 kg superabsorbent treatments, respectively. About zinc, the highest and lowest concentrations were observed in 0.4 kg of superabsorbent treatments and 4 kg of compost, respectively. No significant difference was observed for iron, manganese, zinc and copper treatments at the level of 1%.

Marjoy et al. (2012) reported that the concentration of nutrients such as iron, zinc and copper was significantly higher in compost treated soil Due to the use of compost, which contradicts the results of the present study. Also, Abedi Kupai et al (2009) reported that increased concentrations of superabsorbent had no significant effect on iron and zinc concentrations, which is consistent with the results of this study.

The results of this study showed that about pH of soil samples (saturated extract), the highest and lowest values were observed in treatments of 8 kg of compost and 0.2 kg of superabsorbent respectively. There was a significant difference between treatments of 8 kg of compost and 0.2 kg of superabsorbent (1%). No significant difference was observed in other treatments.

In this study, the manganese concentration in soil culture medium (saturated extract) was decreased by increasing the compost volume from 4 kg to 8 kg per plot. An increase was observed in iron, zinc, copper as well as pH parameter. In general, the use of compost caused accumulation of manganese and copper in the soil and the amount of zinc was decreased. According to Iglesias Jimenez (1996), urban waste compost increased the concentration of manganese and zinc in comparison with chemical fertilizers in the soil, which was proportional to the application of compost content. Chen et al. (2010) reported that less than 4% of copper and more than 58.3% of the zinc found in the compost were leached, which can be due to the sharp drop in soil zinc levels in compost treatments.

The results of this study showed that superabsorbent application increased the concentrations of iron, zinc, copper and manganese in soil in comparison with control treatment. Also, increasing the amount of superabsorbent in the soil have increased the amount of iron, manganese, zinc, and copper. PH was increased with the superabsorbent increment from 0.2 to 0.4 kg, and again decreased when the superabsorbent increased to 0.8 kg. Sharifan et al.

Table 6 - Comparison of the average concentrations of (mg/lit) examined elements

pH	Manganese	Copper	Zinc	Iron	Treatment
۷/۴۵^{ab}	۴/۶۹^{a}	۱/۹۲^{a}	۲/۲۶^{a}	۱۶/۷۱^{a}	4 kg compost
۷/۵۳^{a}	۴/۴۴^{a}	۲/۱۶^{a}	۲/۲۹^{a}	۱۸/۶۱^{a}	8 kg compost
۷/۳۹^{b}	۴/۵۷^{a}	۱/۸۷^{a}	۸/۱۶^{a}	۱۹/۳۳^{a}	0.2 kg superabsorbent
۷/۴۷^{a}	۴/۳۸^{a}	۱/۸۸^{a}	۱۰/۱۷^{a}	۱۸/۸۷^{a}	0.4 kg superabsorbent
۷/۴۵^{ab}	۴/۳۱^{a}	۲/۰۶^{a}	۳/۳۳^{a}	۱۸/۰۵^{a}	0.8 kg superabsorbent
۷/۴۹^{a}	۴/۳۲^{a}	۱/۷۳^{a}	۳/۰۲۴^{a}	۱۸/۰۴^{a}	Control

*: The means in each column with common letters do not show significant difference in Duncan's 1% level test.

According to the accumulation of heavy metals in soil (saturated extract) and treatments of 4 and 8 kg of compost, 0.8 kg of superabsorbent and control, the magnitude of metals was observed in this order: iron> manganese> zinc> copper. Also, by applying 0.2 and 0.4 kg of superabsorbent treatments in each plot, a magnitude of metals was observed in same order: iron> zinc> manganese> copper.

(1391) reported that the capacity for conservation of water and nutrients for a long time and reduction of water washing are some of the superabsorbants benefits, increased capacity to maintain water and food for a long time, reduce the washing of water and food in the soil. In this study, the use of superabsorbent has also led to an increase in the accumulation of elements in the soil, which can be due to the reduction of leaching of these elements. Furthermore, Zohourianmehr and Kabiri (2008) found that moisture absorbing materials are hydrophilic networks which can both absorb water and maintain large amounts of water or aquatic solutions.

Figures 1-5 show the variation of the applied treatments during different irrigation periods in the present study conditions on the concentrations of iron, zinc, copper, manganese and pH in soil medium (saturated extract). The compost treatments (control, 20 and 40 tons per hectare) are indicated with letters A, B, C and superabsorbent treatments (1, 2 and 4 tons per hectare) are indicated with letters D, E and F, respectively for the simplicity.

Figure 1: Changes in iron content in the soil due to different amounts of compost and superabsorbent during irrigation periods

Figure 2: Changes in zinc content in the soil due to different amounts of compost and superabsorbent during irrigation periods

Figure 3: Changes in copper content in the soil due to different amounts of compost and superabsorbent during irrigation periods

Figure 4: Changes in copper content in the soil due to different amounts of compost and superabsorbent during irrigation periods

According to fig. 1 (a) and (b), the iron content is reduced sharply in compost treatments with continued irrigation. No significant difference was found between different treatments of compost and superabsorbent. Among different treatments of compost and superabsorbent, maximum amount of iron in soil was 8 and 0.4 kg, respectively.

According to fig. 2 (a) and (b), there is a different function between compost and superabsorbent treatments, from the zinc content point of view. In the case of compost treatments, zinc content has been reduced by continuous irrigation. In various superabsorbent treatments, zinc content have been increased more than the initial level, with irrigation continuation. With increasing compost and superabsorbent application, the highest zinc content in the soil was related to the control treatments and 0.4 kg.

Figure 3 (a) and (b) show that there is a different function between compost and superabsorbent treatments from copper content point of view. In the case of compost treatments, the copper content has been decreased during irrigation. In superabsorbent treatments, all treatments (4 tons per hectare of superabsorbent) have been decreased with continuous irrigation. By increasing the compost and superabsorbent application, 8 and 0.4 kg treatments had the maximum copper content in the soil, respectively.

According to fig. 4 (a) and (b), the compost and superabsorbent treatments are similar in terms of manganese content. In the case of various treatments of compost and superabsorbent, the amount of manganese has decreased with continuous irrigation. By increasing use of compost and superabsorbent, the maximum manganese content is related to 4 and 0.4 kg treatments, respectively.

Iron, manganese and zinc show the same behavior among compost treatments independent of irrigation time. This behavior was also the same for iron and manganese among superabsorbent treatments.

Figure 5: Changes in soil pH due to different amounts of compost and superabsorbent during irrigation.

According to fig. 5 (a) and (b), pH has been generally changed between 7/35 and to 7/30 in the compost and superabsorbent treatments. In compost treatments, pH have been gradually decreased and acidified with continuous irrigation. In superabsorbent treatments during irrigation (except spring irrigation), it has also been decreased. With increased use of compost and superabsorbent, the maximum pH is related to treatments of 4 and 0.4 kg.

Overall conclusion

In this study, the effects of different compost and superabsorbent treatments is investigated on the concentration of iron, zinc, copper, manganese and pH parameters in soil. For this purpose, an experiment was conducted in a randomized complete block design manner, with six treatments and three replications. Treatments included: three levels of compost fertilization (application without compost, 20 and 40 tons per hectare), and different levels of chlorophyll containing superabsorbent in three levels (1, 2 and 4 tons per hectare). The results showed that the effect of investigated treatments on the concentration of examined elements and the soil pH (soil extracts) are insignificant at 1% level. The highest concentrations of iron, zinc, copper and manganese were detected in treatments of 1 and 2 tons per hectare superabsorbent, 40 and 20 tons per hectare of compost respectively. The highest and lowest pH values were related to treatment of 40 tons per hectare compost and 1 tons per hectare superabsorbent. Also, the results showed that various compost treatments contain high iron and manganese contents and various superabsorbent treatments contain high iron and zinc content. Comparison of heavy metals showed that the highest concentration in the treatments was related to iron. With continued irrigation, the amount of iron and manganese in compost and superabsorbent treatments has been greatly reduced. Also, in compost treatments, the amount of zinc has been reduced by irrigation continuity. In the various superabsorbent treatments, zinc levels had an increase over the initial level with continuous irrigation. In the compost and superabsorbent treatments, the amount of copper was reduced (except 4 tons per hectare treatment) during irrigation periods. Regarding compost treatments, with continued irrigation, the amount of pH has been gradually decreased and acidified. About superabsorbent treatments during irrigation (except spring irrigation), it has also been decreased.

Resources

1. Ahmadabadi. Z, Ghajar Sepanloo. M and Rahimi Alashti. S, 2011. The useful effect of Compositus on different physical and chemical characters of soil. Agriculture science, technology and natural resources magazine, water and soil science, year 15, No.4, pp. 125-138.

2. Parsafar, N. 2011. Studying the effect of urban wastes and refined wastewater on some physical characteristics of soil, drainage water and the quantitative-qualitative characteristics of potato. Master thesis, Hamadan Bu-Ali Sina University. 117 pages.

3. Sharifan, H. Mokhtari, P. and Hezar Jaribi, A. 2012. Studying the effect of super absorbent polymer on the changes of kostiakov-lewis infiltration equation in stream irrigation, water and soil journal (Agriculture science and industry), Vol. 27, No.1, pp. 205-212.

4. Hosseinpour, Rahimeh and Ghajar Sepanloo, Mehdi (2012). “Studying the combined effect of urban waste Compositus and the chemical fertilizer on the absorption capability of micro-elements in soil and lettuce”. The research magazine of water and soil protection, Vol.19, No.3.

5. Toolabi, Z. 2011. “Different amount of wastewater’ Mud on the aggregation of zinc, copper, cadmium, lead and nickel on different parts of some vegetables. Master thesis. Bu-Ali Sina University, Agriculture faculty.

6. Abedi Kopayi, Jahangir and Mesforosh, Mahsa (2009) “The evaluation of super absorbent Polymer usage on the performance of water consumption and saving the food elements in greenhouse cucumber”. Irrigation and drainage magazine, No.2. pp. 100-111.

7. Marjavi, Alireza (2012). “The evaluation of urban Compositus on the chemical characteristics of soil and the quantitative-qualitative characteristics of sugar beet”, sugar beet (1) 18:14-1.

8, Abedi-koupai J and Asadkazemi J, 2006. Effect of hydrophilic polymer on the field performance of an ornamental plant (Cupressus arizonica) under reduced irrigation regimes. Iranian Polymer Journal 15(9): 715-725.

9, Alloway BJ, 1990. Heavy Metal in Soil. Blackie and Son Ltd, London, 339 P.

Bauycos GJ, 1962. Hydrometer methods improved for making particle size of soils. AgronomyJournal 56: 464-465.

10, Chen G, Zeng G, Du C, Huang D, Tang L, and Wang L, et al. 2010. Transfer of heavy metals from compost to red soiland groundwater under simulated rainfall conditions J Hazard Mater 181(1-3):211-6.

11, Dowdy RH, Latterell JJ, Hinesly TD, Grossman RB and Sullivan DL, 1991. Trace elementsmovement in an Aeric Ochraquaf following 14 yearsof annual sludge applications. Journal of Environmental Quality 20: 119-123.

12, Finck A, 1992. Dunger und dungung. Verlag chemie, Weinheim, New York, 438 P.

13, Iglesias-Jimenez E and Alvarez CE, 1993. Apparent availability of nitrogen in composted municipal refuse. Biol. Fertility Soils 16: 313-318.

14, Iglesias-Jimenez E, 1996. City refuse compost as a source of micronutrients for plants. C.Rodriguez-Barrueco (ed), Fertilizers and Environment. Pp: 517-521.

15, Lindsay WL and Norvell WA, 1978. Development of a DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of America 42: 421-428.

16 Schiradoe T, Vergara I, Schalska EB and Pratt PF, 1986. Evidencefor movement of heavy metals in a soil irrigated with untreated waste-water. Journal of Environmental Quality 15: 9-12.

17, Zohurian-Mehr M J and Kabiri K, 2008. Superabsorbent polymer materials: A review. Iranian Polymer Journal 17(6): 451-477.