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# The Effects of Compost and Superabsorbent on Changes in Some Metals and EC and TDS Parameters in Outflow Drainage

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## Abstract

In order to investigate the effects of compost and superabsorbent on the quality of outflow drainage from the medium, a randomized complete block design with three replications was carried out during 1993-92 in the farm of Faculty of Agriculture, Bu-Ali Sina University, Hamadan. In this study, different levels of colophony superabsorbents were used at three levels (1, 2 and 4 ton/ ha) and compost levels at three levels (non-compost (control treatment), 20 and 40 ton/ ha) were used. In this research, the effects of compost and colophony super-absorbent on the concentration of metals (cadmium, sodium and nickel) were investigated as well as EC and TDS in the drainage from the culture medium. The results showed that the effect of treatments on the heavy metals concentrations (cadmium and nickel), EC and TDS in the drainage of culture medium is not significant ($p<0.01$). In addition, the interaction between treatments and repeated irrigation on studied parameters was insignificant ($p<0.01$). Maximum concentrations of cadmium, nickel and sodium were observed in treatments of 40, 20 ton / ha compost and 4 ton / ha superabsorbent respectively. Also, the maximum EC and TDS values were relevant to 4 ton/ ha superabsorbent.

**Keywords:** Compost, Super Absorbent, Heavy Elements, EC and TDS

## Introduction

In the last century, water consumption has been increased sharply due to the increased population growth and the expansion of human activities in different sectors. Increased water consumption as well as the excessive use of water resources has led to the quantitative and qualitative crisis of water resources in many parts of the world, especially those with naturally inappropriate climates and limited water resources. Recent years in Iran, due to water resources restrictions and limitations, population growth, urban development, industry and agriculture, as well as the implementation and development of multiple sewage collection and treatment plans, application of wastewater in agricultural lands has become especially important and it is in the priorities of Water Resources Management Planning (Hosseinpour et al., 2008). Drajji et al. (2009) reported that superabsorbent polymers absorb large amounts of water or aqueous solutions and swell. These water storage reservoirs absorb irrigation water and rainfall when placed in soil and prevent its subsidence, and after the environment dried, the water inside the polymer is gradually depleted and thus the soil is wet for a long time and without the need for re-irrigation. Additionally, super absorbent polymers affect amount of water penetration in the soil, apparent specific weight and soil structure, as well as evaporation from the soil surface. The main purpose of adding superabsorbent polymers to soil is to increase water storage capacity and reduce irrigation intervals, and water storage capacity depends on soil texture, type and size of polymer and soil minerals. Sharifian et al. (2012) found that the use of superabsorbent polymers increased agricultural productivity, improved qualitative performance, increased water use efficiency, increased water and nutrients storage capacity for a long time, decreased irrigation, and reduced the irrigation expenses. The presence of heat and moisture is defined in the aerobic environment. Recently, besides residuals of agricultural and livestock products, a plethora of other organic materials are produced in large amounts in the form of waste of some industrial plants, particularly the factories affiliated to the agricultural industry, and municipal waste. Which, if used as a compost, will increase soil fertility and prevent environmental problems due to the inappropriate disposal of raw materials of compost production (Silis Pour, 2007, Shah Karami et al., 2013). Ahmadabadi et al. (2011) found that compost have some characteristics such as porosity, favorable ventilation and drainage, high capacity of absorption and maintenance of moisture, the concentration of nutrients in the soil, electrolytic conductivity, material percentages, cation exchange capacity, as well as effect on physical and chemical properties of soil. Aluvy (1990), Chen et al. (2010) reported that with the use of compost in the red soil of China less than 4% copper and more than 58.3% of the zinc found in the compost were leached. They assume the reason for the leaching of compost metals is their attachment to soluble organic materials.

Regarding to previous content, the aim of this study is to investigate the effect of different amounts of compost and colophony superabsorbent on cadmium, nickel and sodium concentrations, as well as EC and TDS in outflow drainage of the culture medium. Considering the fact that the mentioned studies focused on soil and plant, with regard to lack of research on the quality of drainage, we tend to provide desirable variety of treatments, and so we examined different amounts of superabsorbent and compost. Moreover, we investigated the effect of these treatments on the concentration of the parameters studied in drainage.

## Materials and methods

### Area of study

This research was conducted at the Faculty of Agriculture, Bu-Ali Sina University of Hamedan during 2013-2014. Hamedan province is located between 33 degrees and 58 minutes to 35 degrees and 48 minutes north latitude and 47 degrees 34 and minutes to 49 degrees and 36 minutes east of the Greenwich Meridian, west of Iran's plateau. The average annual precipitation in Hamedan province is estimated at 317 millimeters, which is 26 percent higher than the average of the country (Parsafar, 2011).

### Statistical design

This research was carried out as a randomized complete block design with six treatments and three replications. Six treatments including compost fertilizer in three levels (application without compost, 20 and 40 tons per hectare) and different levels of colophony superabsorbent in three levels (1, 2 and 4 tons per hectare) were used.

### Culture preparation

18 terraces with 2 m length and 1 m width and a total area of 2 $m^2$ with a slope of about 2% were prepared. Then, drainage systems was installed at a depth of 1.20 m of terraces, and to collect the drainage pipes were used at the end of each terrace. The application of compost fertilizer and superabsorbent treatments in 30 cm depth from surface of the field, and mixing them was carried out altogether on December 18, 2013. After three stages of culture preparation, flooding irrigation was applied. The time

intervals included: autumn irrigation (first irrigation on December 18, 2013), winter irrigation (second irrigation on April 18, 2013) and spring irrigation (third irrigation on April 18, 2013). The depth of water used during the irrigation programs was equivalent to 23 cm, so that it could cover the whole surface of the terraces and also collect drainages. To determine the soil pattern, sample was collected from depth of 20 cm. The soil sample was dried the oven at 150 ° C. Then, 50 g of soil was sieved with 2 mm sieve, and the percentage of sand, clay and silt was determined using hydrometric method (Beykas, 1962). In Table 1, some of the physical characteristics of the soil is provided.

**Table 1: Some physical characteristics of examined soil in the present study in depth of 20 cm**

| Porosity | ($gr/cm^3$) Density | | Soil texture | Clay | Silt | Sand |
|---|---|---|---|---|---|---|
| Percentage | Actual | Apparent | | | Percentage | |
| 44/15 | 2/51 | 1/40 | Sand clay loam | 29/44 | 25/28 | 45/28 |

**Measurement of some metals and of EC and TDS parameters in drainage water from the media**

In order to identify the metals (cadmium, nickel and sodium) in the drainage from the culture medium, drainage samples from each treatment of compost and superabsorbent were collected and transferred to the laboratory, and then filtered by Watt man 42 paper. Filtered drainage samples were used to measure the concentration of heavy metals, EC and TDS. In order to determine the EC of samples an electric conductivity meter was used, and Varian 220 AAS Atomic Absorption Spectrophotometer made in Italia was used to determine heavy metal concentrations (Thomas, 1996). To calculate TDS, the equation (TDS = 640 * EC) was used.

## Analysis of results

In this study, the comparison of the means was done by Duncan's multiple range test in the SAS software. Meanwhile, significance level was considered at the level of one percent (p <0.01).

## Results and discussion

Table 2 shows the statistical analysis of the applied treatments in the present study conditions on the concentration of metals (cadmium, nickel and sodium) and EC and TDS parameters in the drainage from the culture medium during the period of study. According to Table 2, the effect of repeated irrigation on concentration of cadmium, nickel and sodium in drainage water was significant and insignificant on EC and TDS concentrations (p <0.01). Based on these results, the effect of treatments on the concentration of heavy metals (except sodium) and EC and TDS in outflow drainage from the culture medium was insignificant (p <0.01). In this study, the interaction of repeated irrigation and treatment on the parameters was insignificant (p <0.01).

**Table 2. Analysis of variance of the treatments effects on concentration of some metals, EC and TDS in the drainage water from the culture medium**

| average of squares | | | | | Degrees of freedom | Source of change |
|---|---|---|---|---|---|---|
| TDS | EC | Na | Ni | Cd | | |
| (s/cmμ) | (mg/lit) | | (mg/lit) | | | |
| $0/10^{NS}$ | $0/10^{NS}$ | $0/0001^{**}$ | $0/0001^{**}$ | $0/001^{**}$ | 2 | Repeated irrigation |
| $0/14^{NS}$ | $0/14^{NS}$ | $0/009^{**}$ | $0/37^{NS}$ | $0/98^{NS}$ | 5 | treatment |
| $0/91^{NS}$ | $0/91^{NS}$ | $0/60^{NS}$ | $0/82^{NS}$ | $0/50^{NS}$ | 10 | × treatment Repeated irrigation |

**: At a one percent significant level, ns: not significant

Table 3 indicates the comparison of mean concentrations of the examined metals and EC and TDS in the drainage of the medium through the application of different amounts of compost and superabsorbent. According to this table, maximum and minimum concentrations of cadmium were observed in treatments of 8 kg of compost and 0.44 kg of superabsorbent in each terrace, but no significant difference was observed between treatments of cadmium ($p < 0.01$).

The results of this study revealed that the highest concentration of nickel was observed in 4 kg of compost in terrace, which had no significant difference with other treatments (except 0.2 kg of superabsorbent treatment) in each terrace ($p < 0.01$). Also, the lowest concentration was observed in 0.2 kg of superabsorbent treatment in terrace, which showed no significant difference with other treatments (except 4 kg compost in each terrace). In the case of sodium, the maximum concentration was observed in 0.25 kg of superabsorbent treatment in terrace, which showed a significant difference with other treatments. Additionally, minimum amount of this concentration was observed in 4 kg of compost in terrace, which did not show any significant difference with other treatments (except 0.8 kg of superabsorbent treatment) in each terrace.

Maximum and minimum values of EC and TDS were observed in drainage samples in 0.8 kg of superabsorbent and 8 kg of compost treatments, 0.2 kg of superabsorbent in each terrace. There was a significant difference in each terrace between the maximum value of superabsorbent in 0.8 kg and other treatments (except control) ($p < 0.01$). Also, there was a significant difference between the minimum values (8 kg of compost, 0.2 kg of superabsorbent in each terrace) and other treatments (except 0.8 kg of superabsorbent treatment) in each terrace.

Based on the accumulation of metals (cadmium, nickel and sodium) in the outflow drainage, the order of metals was observed by applying 4 kg of compost, 8 kg of compost, 0.2 kg of superabsorbent, 0.4 kg of superabsorbent, 0.8 kg of superabsorbent in each terrace and control was sodium> nickel> cadmium.

In this study, the concentration of nickel and EC and TDS parameters in the outflow drainage of culture medium was reduced by increasing the amount of compost from four kg per terrace to 8 kg per terrace. However, cadmium and sodium increased.

**Table 3. Comparison between means of metals (mg / L), EC and TDS in the outflow drainage from the medium**

| TDS (s/cmμ) | EC (mg/lit) | Na | Ni | Cd | Treatment |
|---|---|---|---|---|---|
| 497422[b] | 777/2[b] | 23/54[b] | 0/17[a] | 0/0641[a] | 4 kg compost |
| 491520[b] | 768[b] | 30/64[b] | 0/14[ab] | 0/0648[a] | 8 kg compost |
| 491520[b] | 768[b] | 25/94[b] | 0/13[b] | 0/0626[a] | .02 kg superabsorbent |
| 502898[b] | 785/78[b] | 25/14[b] | 0/16[ab] | 0/0617[a] | .04 kg superabsorbent |
| 635378[a] | 992/78[a] | 40/73[a] | 0/15[ab] | 0/0626[a] | .08 kg superabsorbent |
| 576142[ab] | 900/22[ab] | 29/29[b] | 0/14[ab] | 0/0646[a] | control |

* means in each column with common letters do not differ significantly in the Duncan multi-range test ($p < 0.01$).

Figures 1-5 show effect of applied treatments during different irrigation periods on concentration of metals (cadmium, nickel and sodium) and EC and TDS in the drainage from the culture medium. The compost treatments (control, 20 and 40 ton/ha) are indicated with A, B and C and superabsorbent treatments (1, 2 and 4 ton/ha) are indicated with D, E and F, for simpler expression.

Figure 1: The changing process of cadmium in outflow drainage according to different amounts of compost and superabsorbent during irrigation.

Figure 2: The changing process of Nickel in outflow drainage according to different amounts of compost and superabsorbent during irrigation.

Figure 3: The changing process of Sodium in outflow drainage according to different amounts of compost and superabsorbent during irrigation.

With respect to Figures 1, 2 (a) and (b), with continuous irrigation, cadmium and nickel levels in compost and superabsorbent treatments have initially increased and then decreased significantly. There was no significant difference between different compost and superabsorbent treatments. Among different treatments of compost and superabsorbent, maximum amount of these elements in drainage was observed in 8 and 0.4 kg in winter irrigation, respectively.

Fig. 3 (a) and (b) indicate that in the compost and superabsorbent treatments, with continuous irrigation, the amount of sodium increased. It should be noted that this sodium increment in the treatments have decreased during the second irrigation process and then increased in the next irrigation. Among these treatments, the maximum amount of sodium in the drainage was observed in 8 and 0.8 kg treatments.

Independent of irrigation duration, some heavy metals such as cadmium and nickel show the same behavior among compost treatments. This behavior among other heavy metals such as cadmium and nickel in superabsorbent treatments was also the same.

Figure 4: Alterations of EC in the outflow drainage according to different amounts of compost and superabsorbent during irrigation.

According to Figures 4, 5 (a) and (b), compost and superabsorbent treatments generally have different functions for EC and TDS. In the case of compost treatments, salinity and TDS levels were decreasing with continuous irrigation. In the case of superabsorbent treatments, salinity and TDS have been increasing with continuous irrigation. Considering the use of different amounts of compost and superabsorbent, maximum salinity and TDS in drainage was observer in control treatments and 0.88 kg during autumn irrigation. The similar function of TDS with salinity is due to the existence of a relationship between these two parameters (TDS = 640 * EC).

## Overall conclusion

In this study, the effects of different compost and superabsorbent treatments on the concentration of cadmium, nickel, sodium, and EC and TDS parameters were evaluated in the drainage from the culture medium. For this purpose, an experiment was conducted in a randomized complete block design with six treatments and three replications. Treatments included three levels of compost fertilizer (no compost, 20 and 40 ton/ ha) and different levels of colophony superabsorbent at three levels (1, 2 and 4 ton/ ha). The results showed that the effect of investigated treatments on concentrations of cadmium, nickel, EC, and TDS of drainage outflow were insignificant ($p < 0.01$). The maximum concentrations of cadmium, nickel and sodium were observed in 40 ton / ha compost, 20 ton / ha compost and 4 ton / ha superabsorbent treatments respectively. The maximum and minimum amounts of EC and TDS were observed in 4 ton/ ha superabsorbent, 40 ton/ ha compost and 1 ton/ ha superabsorbent treatments. Moreover, the results showed that different compost treatments contain large amounts of cadmium and nickel, and various superabsorbent treatments contain large amounts of sodium. The results revealed that during different irrigation periods, cadmium and nickel, and EC and TDS parameters have almost the same performance in terms of different compost and super absorbent values . Also, the results showed that different compost treatments contain large amounts of sodium, and various superabsorbent treatments have large amounts of EC and TDS.

**Reference**

1. Ahmadabadi, Zahra (2010), "The effect of using organic fertilizer (vermi Compositus) on some physical characteristics of soil", second national conference of agriculture and sustainable development (the future opportunities and challenges).
2. Parsafar, Nasredin (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. Seyed Draji, S., Golchin, A and Ahmadifar, Sh. (2009) "The effect of different surfaces of a super absorbent polymer and the saltiness of soil on the capacity of maintaining water in three layers of gravel, loam and clay", soil and water magazine, Vol.24, No.2, pp.306-316.
4. Silspour, Mohsen (2007), "urban wastes' Compositus and the standards of heavy metals in them". Agriculture and sustainable development, No.2, pp 18-23.
5. Shahkarami, Masoud (2012). "The effect of wastewater and Compositus fertilizer on some physical and chemical characteristics of soil in which basil is planted", Master thesis, irrigation and drainage field, agriculture faculty, Hamadan Bu-Ali Sina University.
6. Sharifan, Hossein (2011), "Studying the effect of sea water amount on the water absorbing level by super absorbent hydro-gel", national conference of using sea water.
7. Alloway, B.J. (1990) "Heavy Metal in Soil". Blackie and Son Ltd, London pp 339.
Azzam, R.A.I., 1980. Tailoring polymeric gels for soil reclamation and hydroponics. Communications in Soil Science and Plant Analysis 16(10): 1123-1138.
8. Bauycos, G. J. (1962). "Hydrometer methods improved for making particle size of soils". Agron. J. 56: 464-465.
9. Chen YX, Zhu GW, Tian GM., Chen HL. (2003) "Phosphorus and copper leaching from dredged sediment applied on a sandy loam soil: column study". Chemosphere 53(9):1179-87.
10. Thomas, G. W. 1996. Soil pH and soil acidity in methods of soil analysis. Klute, A. (ed). Philos. Trance. R. Soc. London, 294b: 41.