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Safety and the quality of Compost, which is produced from Kashy Company, Duhok, Kurdistan Region

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Abstract

This work presents the safety of municipal solid waste (MSW) compost produced by Kashy Company, and its effects on some soil chemical properties and plant growth. In order to investigate the effects of Kashy Compost on soil properties and growth of chard plant, pot experiment was carried out in an optimum growth condition. This experiment was carried out under greenhouse condition at the Faculty of Agriculture, University of Duhok, using three different treatments consisting of control soil, MSW levels selected for this study were (0) control, (%5W/W) MSW, (%10W/W) MSW, and (%15W/W) MSW. The results obtained in this experiment indicate that application of municipal solid waste improves the plant growth. It was also found that application of municipal solid waste had significantly increased soil pH and EC. The results showed that application of MSW in different rates improved plant growth. Shoots dry and fresh weight were found at a maximum when 5% MSW was applied. Application of MSW gave an increased concentration of heavy metals in plant, especially in 15% MSW treatment.

Introduction

Management and decrease the amount of municipal solid wastes considered one of the big issues for the urban places of developed countries, after rapid growth of population. Researchers try to find a solution for people to live in better livelihood [1]. Even in Kurdistan Region municipal solid waste has become a critical issue, and would make problem for next generation. Improper production and usage of municipal solid wastes could lead to water, soil and even air pollution and this affect human and animal health.

Soil considered a fundamental resource basis to continue the life; also, it is essential to industry, agriculture and to food. All communities and societies need to spend time and money to keep soil clean, and free from toxic materials such as heavy metals. New ways were established to decrease the content of pollutants or contaminants in the soil. Soil is important as much as water, food, and even oxygen, because it feed every living organisms in the world, that is why we have to care about soil for better sustainable environment***[2]***.

Earlier studies also showed that heavy metal contents exceed in some types of municipal solid waste compost, which means the contents and types of heavy metals rely on the parent material of municipal solid waste[2]. Majority of researchers and scientists believe that all municipal solid wastes contain heavy metals. Many heavy metals occurred in municipal solid waste compost like cadmium, cobalt, manganese, nickel, lead and zinc [3].

Sometimes scientists and researchers ~~are~~ called heavy metals "trace elements", because plant, animal, and humanneed them in small content. Heavy metals considered metallic elements of the periodic table [4].The main problem of heavy metals is thattheyhave toxic impact on majority of living organisms.While using municipal solid waste compost as manure or fertilizer with some content of heavy metals may affect on human being which transferred through food chain [5]. People believe that changing municipal solid waste to compost can solve most problems world facing regarding poverty. However, the aim of this study is to investigate the effect of municipal solid waste compost that is produced from Kashy Company, Duhok, Kurdistan region on growth and heavy metal content of chard plant.

Material and Methods

A. Site Description

This study was conducted as pot experiment under greenhouse condition between March 15th 2015 and May 10th 2015 at the Faculty of Agriculture, University of Duhok, Kurdistan region, Iraq. Preliminary analyses were done for municipal solid waste (MSW) compost which is presented in Table (1). Municipal solid waste compost taken from Kashy factory was used as a potting mixture at three different rates including: 5% (W/W); 10% (W/W); 15% (W/W) and control containing 100% soil. Clay loam soil was manually mixed with municipal solid waste compost. Twelve plastic pots (12.5 cm diameter) were filled with 1 kilogram of ground and sieved dry clay loam soil mixed with compost. Thirty six chard (*Beta vulgaris subsp. cicla*) seeds were sown in the pots and then the plants were watered when it needs on need. Same amount of water was applied to all treatments using graduated cylinder. Each potting-medium (treatment) was repeated three times (3 replications) and the pots were distributed randomly throughout the greenhouse. By the end of the experimental period (Approximately after about 6 weeks), samples were taken from each pot to determine shoots dry and fresh weight of plant (g/pot), heavy metal concentration in plant, pH and EC.

Table (1): Compost Physico-Chemical Characteristics

Parameter	Units	
pH		8.01
EC	(dS m^{-1})	15.3
N	**%**	1.73
C	**%**	27.78
C/N		16.05
O.M	**%**	47.9
Pb	**(mg/kg)**	113.8
Cd	**(mg/kg)**	89.1
Cu	**(mg/kg)**	100.2
Ni	**(mg/kg)**	0.3
Zn	**(mg/kg)**	30.1
Fe	**(mg/kg)**	122.8

B. Soil samples preparation

Each soil sample was removed, air-dried, ground and passed through 2.36 mm sieve. After 6 weeks, plant samples were collected from pots then gently washed under running tap water to remove dust and pollution. All samples were dried by paper tissue. Plant samples were weighed before and after oven-drying in an oven at 70 C° for 48 hours. Finally samples were ground up for analyses. The pH and EC were

measured by using a pH and EC meter respectively in a1:2 soil extract. The pH meter was calibrated by using two buffer solutions (pH 4 and pH 7) [6]. Electrical conductivity (EC) was calibrated by using a standard KCl solution [7]. Heavy metals were measured for plants by using Atomic Absorption Spectrophotometer. Heavy metals extraction was based on digestion in special solution (H_2So_4 and H_2O_2).

C. Statistical analysis

Analysis of variance (ANOVA) was used to test the significant effects of compost on studied parameters following the general linear model (GLM) procedure at ($p < 0.05$). All statistical analyses were performed using the Minitab software package 16. Significant differences between treatment means were tested using Tukey's test.

Results and Discussion

Effect of MSW on soil pH values

Figure (1), illustrates the effect of municipal solid waste compost addition on soil pH. Addition of MSW led to an increase in ~~the~~ pH values of soil. Soil pH value was 7.02 when first mixed with MSW at different rates but increased to 8.4 after 6 weeks. The analysis of variance shows that there was a significant differences (using Tukey's test) between compost rates in influencing soil pH Figure (1). There were no significant difference between application of 5% of municipal soils waste compost and control treatment; however, they are significantly different from 10% and 15% of compost. The lowest soil pH values were examined noticed under application of 5% of MSW and this pH value was significantly different from all other soil pH values except control.

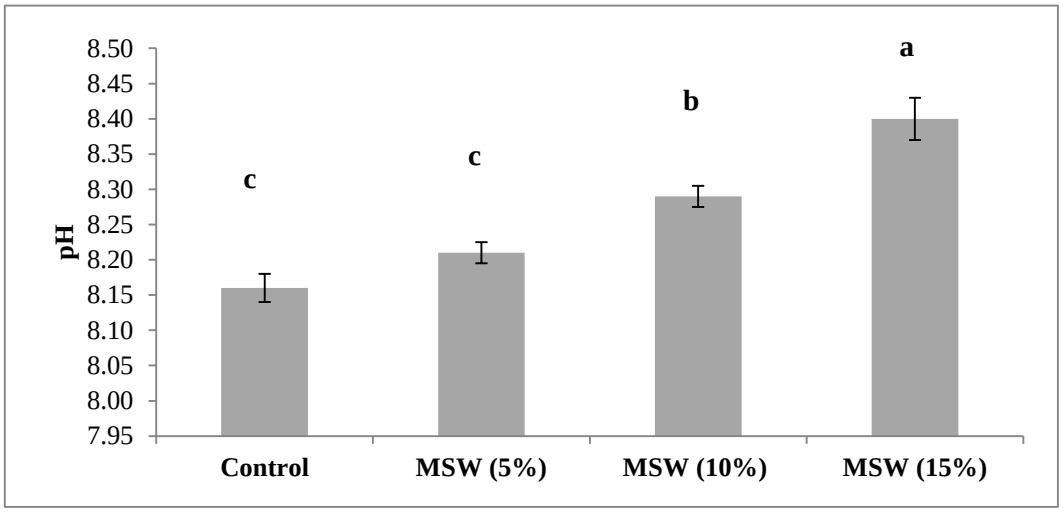

Figure 1.Effect of municipal solid waste compost application on soil pH. Means that do not sharea letter are significantly different. Standard deviation stated by error bars.

Effect of MSW on soil electrical conductivity (EC)

Figure (2) indicates that the application of different rates of MSW changed soil EC. Analysis of variance showed that application of municipal solid waste in different rates was significantly change the electrical conductivity of the soil. The highest level of soil EC was found during application of 15% MSW, while the lowest EC was recorded for the control and 5% of compost application. A significant increase of EC was detected in the 15% treatment. There was a significant difference between 15% MSW and other treatments according to Tukey's test.

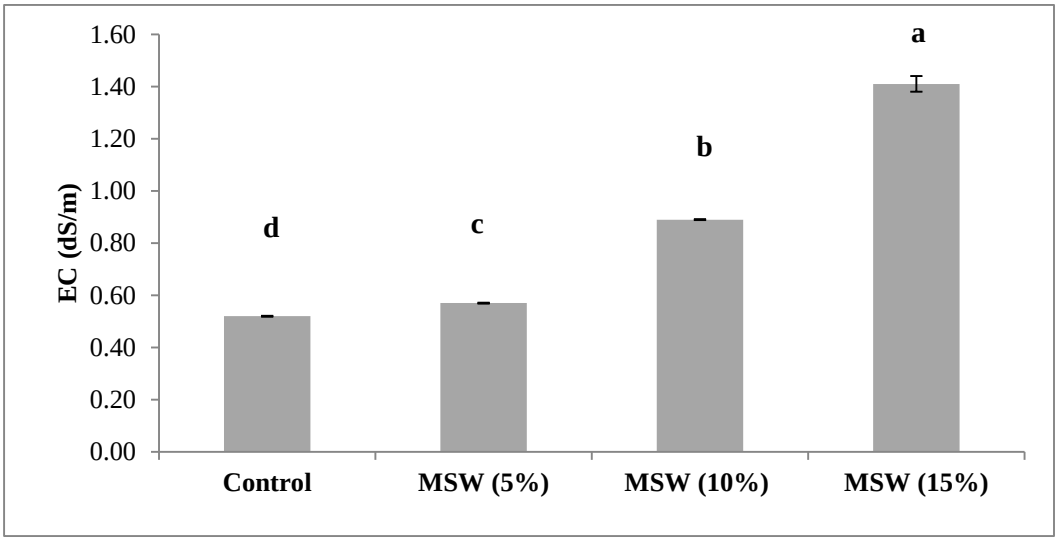

Figure 2.Effect of municipal solid waste compost application on soil EC. Means that do not share a letter are significantly different.Standard deviation stated by error bars.

Effect of MSW on plant growth

The fresh weight of plant (chard) was significantly different among the different rates of compost applications, as shown in Figure (3). The average wet weight of chard ranged from 17 g/potfor 5% to 5g/potfor 15% municipal solid waste compost. There was no significant difference between 10% and 15% application of compost. This may be due to the high EC values for 10% and 15% compost that affected the plant growth. The 5% MSW treatment showed the highest performance of plant growth, this may be due to the lowest harmful effect of compost.

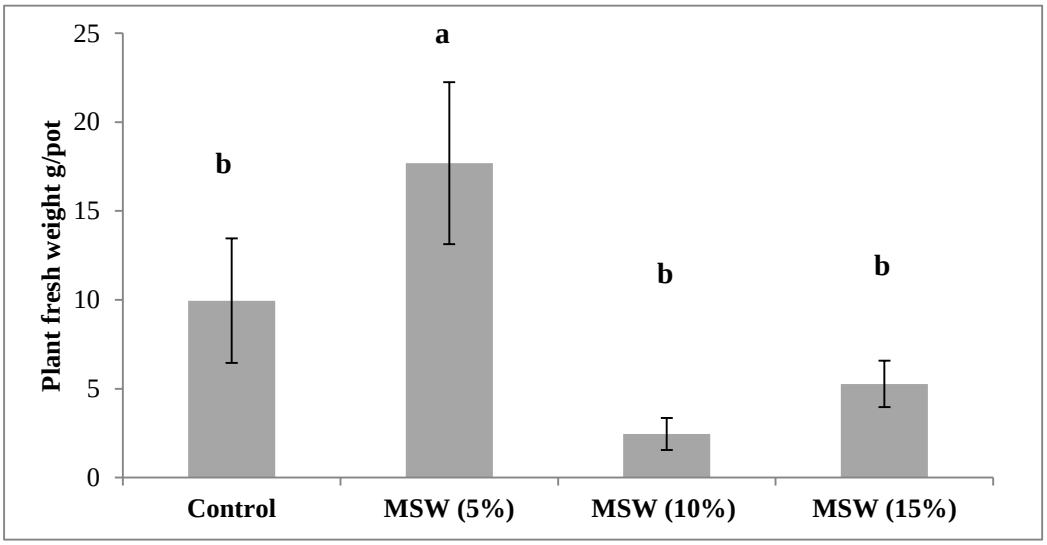

Figure 3.Shows the plant fresh weight per pot. The letters represent significant difference between the treatments. If there is no letter it means there is no significant difference. Also, standard deviation stated by error bars.

The dry weight of plant (chard) was significantly different among the different rates of compost application, as shown in Figure (4). The average dry weight of chard ranged from 2.3 g/pot for 5% to 0.3 g/pot recorded for 15% municipal solid waste compost. There was no significant difference between 10% and 15% application of compost. The 5% MSW treatment showed the highest performance for plant growth. The plant dry weight increased for 5% treatment compared to control as result of beneficial soil enrichment with nutrients in MSW ***[8]*** **and** ***[9]***. Application of 10% and 15% MSW significantly decreased the dry

weight of plant; this reduction can be explained by the higher EC value for these two higher application rates.

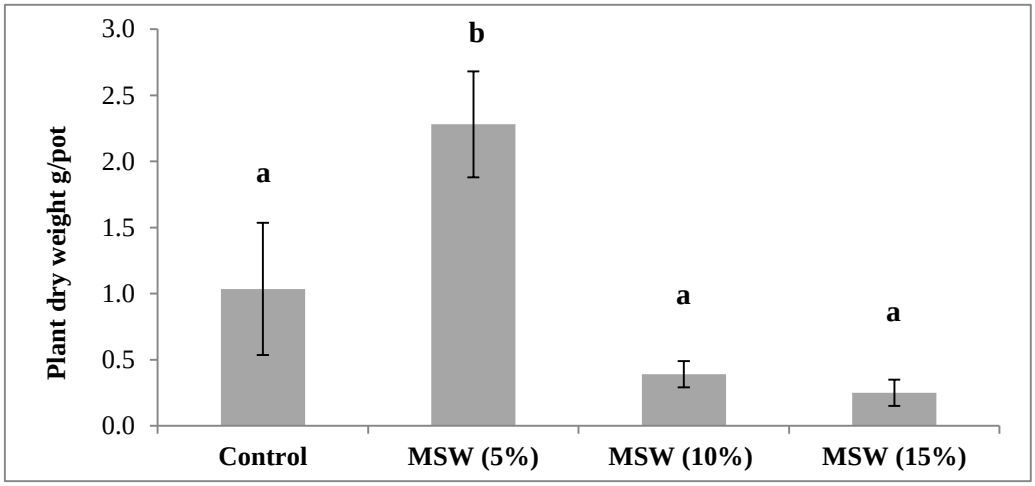

Figure 4.Shows the plant dry weight per pot. The letters represent significant difference between the treatments. If they share same letter it means there is no significant difference between treatments. Also, standard deviation stated by error bars.

Concentration of heavy metals in the plant

Table (2), indicates the concentration of heavymetals present in the plant after application of municipal solid waste compost in soil. Analysis of variance showed significant differences between treatments in plant contents of these four metals, however the four elements were taken up by plants in different rates. In general, 5% municipal solid waste compost and control treatment indicate the lowest concentration of all four elements in plants. While the 15% treatment shows the highest content of each element in plants. As shown clearly the concentrations of heavy metals in plant were different among treatments and increased by increasing the rates of MSW compost. Similar results were obtained by [10] and [11].

Table 2: Effect of municipal solid waste compost application rates on heavy metal concentration (mg kg $^{-1}$) in the plant.

Treatments	Fe	Zn	Cd	Ni
Control	**139.13 (1.1) b**	**5.07 (1.18) b**	**6.21 (2.48) b**	**2.53 (0.15)**
MSW (5%)	175.5 (35.5) b	8.03 (0.67) ab	16.97 (5.02) ab	2.57 (0.15)
MSW (10%)	209.91 (5.31) b	13.65 (0.75) ab	26.45 (0.95) ab	4.05 (0.15)
MSW (15%)	**540 (194) a**	**22.55 (9.19) a**	**59.7 (29.9) a**	**11 (5.50)**
		***ANOVA** summary P-values*		
	0.004	0.012	0.017	0.14

Means in each column that do not share a letter are significantly different at (P< 0.05).
Numbers in brackets referring to standard deviation

Conclusions

It can be concluded from the above results that municipal solid waste (MSW) compost gradually increased the pH and EC values of the soil. The highest plant fresh and dry weights (17 and 2.3 g/pot) were recorded for the 5% treatment respectively. Concentrations of heavy metals estimated in the plant are within the permissible limit under all treatments except for the cadmium concentration under the 10% and 15% MSW compost treatment which exceeded the acceptable limit.

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