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THE MOVEMENT OF COPPER, ZINC AND MANGANESE IN THE SOIL OF CUT FLOWER PRODUCTION GREENHOUSES AND FIELDS

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Abstract

In the study, the vertical movement and accumulation of Cu, Zn and Mn added to the soil for agricultural practices such as the uses of pesticides and fertilizers in the greenhouses of cut flower production were examined and their changes in the soil profile were determined.
For the comparisons, soil samples were taken from greenhouses and fields both before and after harvest at the depths of 0-5, 5-10, 10-20, 20-40, 40-80, 80-100 cm. The extractable Cu, Zn and Mn contents were determined using DTPA method. The Zn and Mn contents were found to be significantly different in terms of depths, sampling areas and seasons while Cu content did not show significant differences among samples
As a result, it was observed that Zn and Mn added to the soil for agricultural practices leached out of the soil, but Cu tended to accumulate in the soil.

Key words: *heavy metal, greenhouse soils, leaching, accumulation.*

INTRODUCTION

Nowadays, while green-house growing develops, in the world cut flower production is also rapidly increased. Production of cut flower areas which is spread 72% Asian, 13% South American, 9% Europe (AIPH, 2013). While the most exporting countries are Netherlands, Colombia, Ecuador, Kenya, Ethiopia, imports is USA, Germany, England, Russia (Anonymous, 2013). Rose, carnations and chrysanthemums are in the first row among the species that are most income.
Cut flower is produced in the field in summer but, cold periods which is usually plastic and glass greenhouse. According to the soil properties special fertilizers and pesticides applied to plants. Before the sowing they should control pesticides especially gerbera, which is very sensitive species. And they should also applied fertilizer until the time of harvest. The species type of pesticides and fertilizers were varying according to the type of plant.
In the cut flower production, pesticides and fertilizer are used more uncontrolled than agricultural products as food. Remaining on the plants of pesticides is 0.015 to 6% and the other parts are spread environment as chemical contaminants (Yıldız et al., 2005). Chemical contaminants are including heavy metals and they have the structure of fertilizers and pesticides. Phosphorus fertilizer manufactured from phosphoric acid that has include Cd, Pb, Ni and As. Di ammonium phosphate, triple super phosphate and compound fertilizer are have quite high Cd content (Köleli and Kantar, 2006).
Plants need a lot of material to perform many physiological events. That is taking nutrients from the soil through the roots right up to human and animal by the food chain (Tok, 1997). Heavy metal uptake changes according to plant species. Caution exchange capacity, the root surface area, soil pH, organic substances, microorganisms can affect heavy metal uptake (Davies, 1995).
A lot of metal are insoluble form in soil. They convert soluble form by the acidification of the plasma membrane proton pump in the root. Dissolve elements transported by diffusion and mass movement from apoplast to endodermis. If the casparin strip in endodermis closed the apoplast, water and nutrient should moved to the endodermis which is plasma membrane to enter the cell through the cell (simplast or

transmembrane path). Nutrients are moved towards the leaves with simplas transport through the xylem tubes. This event, heavy metals are received by plants and they cause toxicity. Slowdown in growth and development, impaired enzyme activity in root damage, deterioration in storage activities, the decline in photosynthetic activity, a reduction in the uptake of other nutrients and productivity slowdown are observed (Yağdı et al., 2000).
It was known that pesticides are cause the rise of heavy metal concentrations in soil and water resources (Doğan, 2003). The source of copper contamination in the soil and water is copper-based fertilizers and fungicides used agricultural (Oliveiro-Filho et al., 2004).
While vegetable greenhouses in the surface soil (0-40 cm) Cu content creates pollution in 15 years, subsurface soil (40-100 cm) Cu and Cd content reach in 20 years (Huang et al., 2011).
In this study, we will be searched for any clues of the dangers of heavy metal pollution cut flower production areas in the soil, depending on the intensive use of fertilizers and pesticides that leached.

MATERIALS AND METHODS

This study was conducted in the Isparta province of Turkey (30°33’ 18°38” D, 37°47’ 47°27” K). The location of the field is given in Figure 1. Cut flowers have been produced in greenhouses in this area for approximately 15 years.
Research was conducted in greenhouses and fields before harvest and after harvest. Six sampling depths were selected. Soil samples were taken at 0-5, 5-10, 10-20, 20-40, 40-80 and 80-100 cm depths.
Texture analysis was performed according to the Bouyoucos hydrometer method (Gee and Bauder, 1986). Soil reaction and electrical conductivity were determined using EC and pH metres (McLean, 1982) with a glass electrode in a 1:2.5 soil water suspension (U.S. Salinity Laboratory Staff, 1954). Available Cu, Zn and Mn content was determined with DTPA and used A.A.S. The data were analysed with analysis of variance techniques using the Minitab software package (Minitab, 2014).

Figure 1. Location of the study area

RESULTS AND DISCUSSIONS

The physical and chemical properties of the soil samples are presented in Table 1. The soil samples from the greenhouses (S1, S2) and the fields (D3, D4) comprised coarse soils. The pH of the greenhouse soil was found to be 4.8-6.1, while the soil samples from the field were between 5.9 and 6.7. The electrical conductivity of the soil was found to be between 74.5 and 194.3 µmhos/cm for the greenhouse samples and between 50.3 and 104.8 µmhos/cm for the field samples.

Table 1. Some properties of soil samples

Depth cm	pH (1:2.5)				EC (1:2.5) µmhos/cm			
	1	2	3	4	1	2	3	4
0-5	5.5	5.7	6.1	6.3	89.0	152.0	91.7	82.7
5-10	5.2	5.5	6.5	6.6	75.4	194.3	87.3	63.1
10-20	5.5	5.5	6.7	5.9	97.0	127.7	104.8	51.2
20-40	5.1	4.8	6.6	6.7	92.6	122.8	90.0	63.2
40-80	5.9	5.5	6.3	6.2	105.0	113.6	68.2	50.8
80-100	6.1	6.1	6.5	6.1	111.9	101.1	87.7	61.0

Depth cm	TEXTURE															
	Clay (%)				Silty (%)				Sand (%)				Texture Class			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
0-5	6.8	10.2	7.1	9.6	11.5	9.2	15.9	21.9	81.3	80.6	77.0	68.4	LS	LS	SL	SL
5-10	8.6	8.8	9.1	11.1	10.5	10.6	12.2	21.6	80.4	80.6	78.7	67.3	LS	LS	SL	SL
10-20	8.1	9.1	6.5	9.1	12.2	11.5	14.9	19.7	79.7	79.4	78.7	71.2	LS	LS	SL	SL
20-40	8.8	9.1	9.09	9.5	13.6	14.1	13.1	22.0	77.6	76.8	77.8	68.5	SL	SL	SL	SL
40-80	10.5	8.8	5.9	10.5	13.6	13.6	12.6	19.0	76.3	77.6	81.5	70.4	SL	SL	LS	SL
80-100	9.1	9.1	9.7	5.7	11.8	15.6	14.5	12.2	79.0	75.2	75.7	77.6	SL	SL	SL	SL

According to Gallbally and Gallbally (1997) carnations grow optimally at pH values ranging 5.5-7.5, and soil saturation extracts with an electrical conductivity ranging 0.7-1.3 mmhos/cm improve production efficiency and quality. Arı (1993) mentioned that soil texture can vary from sandy loam to sandy clay loam.

Conditions with high pH reduce the nutrient uptake of plants, this includes microelements such as iron, zinc, manganese, copper (Kacar and Katkat, 2010). The study area had a pH value that was suitable for plant nutrient uptake.

Soil Mn Content

The Mn content of the soil is given in Table 2. For both samples the Mn content was reduced depending on the depth of the samples. While the Mn content of the greenhouse soils was found to be between 2.5 and 14.4 mg/kg, the Mn content of the field soil samples were found to be between 2.1 and 4.7 mg/kg. In addition, the Mn content of the greenhouse soils was approximately three times higher than the field samples for the 0–40 cm depth. The Mn content of the soil samples showed significant changes depending on the depth, and they were also found to be significantly different between locations ($P < 0.005$). After harvest, the soil Mn content from the greenhouse was found to be between 1.8 and 12.7 mg/kg, while the Mn content in the field soil samples was between 1.4 and 6.4 mg/kg. For both of the samples taken at the greenhouse before and after harvest, there were no statistically significant differences in the Mn content.

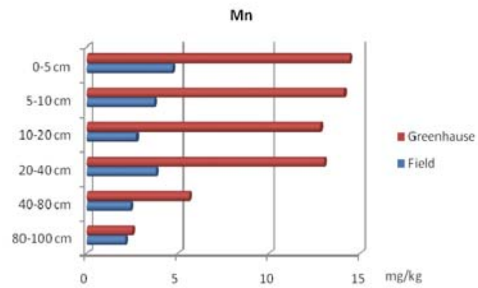

Figure 2. The content of Mn according to depth

According to Lindsay and Norwell (1969) a DTPA extractable Mn content of 14-50 ppm at a depth of 0–10 cm for greenhouse soil was classified as 'adequate'. They also found the extractable Mn to be 4.2 ppm in the field and classified this as 'inadequate' (4-14 ppm).

Alagöz et al. (2006) investigated the properties of soil used to grow carnations in Antalya, Turkey. They found the extractable Mn content for the 0-10 cm and 10-20 cm depths was 2.96-62.16 and 3.49-33.06 ppm, respectively.

Table 2. Soil Mn content (mg/kg)

Place	0-5cm	5-10cm	10-20cm	20-40cm	40-80cm	80-100cm	Mean
Greenhouse	14.4a	14.1ab	12.8abc	13.0abc	5.6abcd	2.5d	10.4
Field	4.7bcd	3.7cd	2.7d	3.8cd	2,4d	2.1d	3.2
Mean	9.6	8.9	8.4	7.7	4	2.3	
Sources of variation	P			F			
Place	0.000			55.44			
Depth	0.005			6.15			
Place*Depth	0.043			3.26			

Soil Zn content

The Zn content of the soil in the greenhouses was found to be between 0.5 and 2.7 mg/kg. In the field samples the Mn content was found to be between 0.3 and 1.8 mg/kg. The Zn content of soil was different between the greenhouse and field samples. Moreover, for both the greenhouse and field soil samples there was a reduction in Zn at lower depths. The Zn content of the greenhouse soil for the 0-40 cm depths was three times higher than for the field soils. The reduction was observed from a depth of 80 cm. These depth-dependent changes in the Zn content were found to be statistically significant. The highest average Zn content was found at the 0-5 cm depth. These data show that agricultural practices increased the soil Zn concentrations for all of the depths examined (0-80 cm). The main cause of this increase is thought to be Zn fertilization in order to improve the quality of cut flower production. Kızılok (2000) stated that higher doses of Zn increased the length of the flower stems and the flowering rate (Figure 3). After harvest the greenhouse soil content was 0.7-4.3 mg/kg in the field, while before harvest it was found to be 0.4–2.3 mg/kg, thus a slight increase was observed.

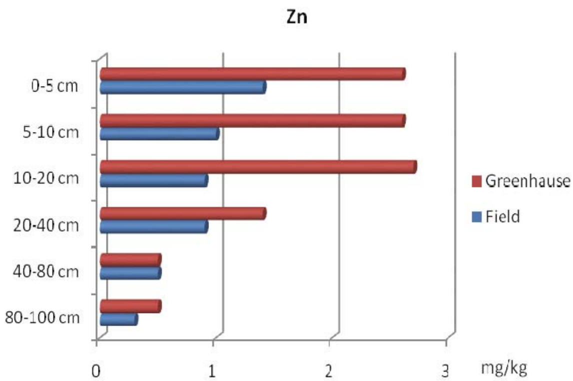

Figure 3. The content of Zn according to depth

Table 3. Soil Zn content (mg/kg)

Place	0-5cm	5-10cm	10-20cm	20-40cm	40-80cm	80-100cm	Mean
Greenhouse	2.6ab	2.6a	2.7a	1.4abc	0.5c	0.5c	1.7
Field	1.4abc	1abc	0.9c	0.9bc	0.5c	0.3c	0.8
Mean	2	1.8	1.8	1.2	0.5	0.4	
Sources of variation	P			F			
Place	0.000			25.25			
Depth	0.001			10.22			
Place*Depth	0.05			3.11			

Soil Cu content

The Cu soil content was found to be 2-2.3 mg/kg for the greenhouse soil samples, and 1.7-2.1 mg/kg for the field samples (Table 4).

The Cu content exhibited a different pattern compared with Mn and Zn: the Cu content did not change according to the soil depth. In addition, the differences between the green-house and field samples were not statistically significant.

The Cu content did not change from the surface to the deeper soil samples due to a lack of activity. Cu according to Zn and Mn still remains by binding strongly to organic

materials of the inorganic exchange in the soil (Kacar and Katkat, 2010). Alagöz et al., (2006) determined that carnations grow in soil with a Cu content of 0.114–5.87 ppm at a depth of 0–10 cm and of 0.142–6.44 ppm at a depth of 10–20 cm.
The content of the soil after harvest was 1.3-2.3 mg/kg for the greenhouse samples and 1.6-2.5 mg/kg for the field samples. Thus, there were no obvious changes observed.

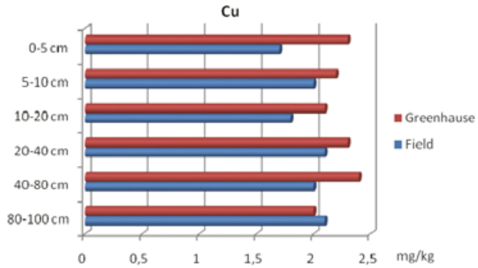

Figure 4. The content of Cu according to depth

Table 4. Soil Cu content (mg/kg)

Place	0-5cm	5-10cm	10-20cm	20-40cm	40-80cm	80-100cm	Mean
Greenhouse	2.3	2.2	2.1	2.3	2.4	2	2.2
Field	1.7	2	1.8	2.1	2	2.1	2
Mean	2	2.1	2	2.2	2.2	2.1	
Sources of variation	P			F			
Place	0.110			2.98			
Depth	0.948			0.22			
Place*Depth	0.889			0.32			

CONCLUSIONS

The results of this study showed that the Mn and Zn content of the soil in cut flower greenhouses significantly increases with depth due to downward washing. However, this was not observed for Cu.
The different Mn, Zn and Cu contents in the soil samples taken from the greenhouses and the fields reflects differences in fertilizer and pesticide application.
In agriculture, many chemicals are used to increase productivity and control pests. The use of chemicals may be uncontrolled, such as in the case of this study. These chemicals are easily washed into the groundwater in sandy soils. To avoid the negative impacts of this process, manufacturer should be informed, and the necessary control procedures should also be applied to non-food agricultural products as well as food products

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