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HEAVY METAL ACCUMULATION IN IRRIGATED SOIL WITH WASTEWATER

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ABSTRACT

It is known that heavy metals form an important polluting group. They have not only toxic and carcinogen effect but also tend to accumulate in living organisms. Using the water discharged into the channel by the farmers in Konya for irrigation, causes to pollution of the fertile soils and affects the plant quality negatively. This study was carried out to determine the heavy metal deposit in the fields irrigated with sewage along the main discharge channel of Konya. As the result of the study, it was determined that using the sewage for irrigation significantly increased heavy metals such as Zn, Cu, Mn, Cr, Ni, Pb, and Cd concentrations of the soils.

Keywords: *sewage, heavy metal, soil, accumulation, toxic effect*

ATIKSU İLE SULANAN TOPRAKLARDA AĞIR METAL BİRİKİMİ

ÖZET

Ağır metaller önemli bir kirletici grup olarak bilinir. Toksik ve kanserojen etkisi yanında canlılarda birikme eğilimi gösterirler. Konya atıksu ana tahliye kanalı civarındaki çiftçilerin kanala deşarj edilen atıksuları tarımda sulama amaçlı kullanmaları ile verimli topraklar kirlenmekte ve bitki kalitesi olumsuz yönde etkilenmektedir Bu araştırma, Konya Ana Tahliye Kanalı boyunca kanalizasyon suları ile sulanan topraktaki ağır metal birikmesinin tespiti amacı ile yapılmıştır. Çalışma sonucunda, sulamanın yapıldığı tarımsal arazide ağır metallerden Zn, Cu, Mn, Cr, Ni, Pb and Cd konsantrasyonlarında önemli artışlar tespit edilmiştir.

Anahtar kelimeler: *kanalizasyon atıksuyu, ağır metal, toprak, birikim, toksik etki*

INTRODUCTION

Beside a lot benefits of technological developments, industrialisation and comfortable social life, these also provide undesirable heavy metal pollution that affects the ecological balance is increasing day by day. This formation is an important ecological pollution, and it has toxic effect even in the very low concentrations.

The agricultural practices that include various activities such as vegetal and animal production using natural water sources incorrectly or unconsciously can be destructive as well as constructive. In the same way, high quality soils, lakes, streams and rivers are also being polluted by heavy metals because of the solid and liquid discharges of the industrial facilities.

In many regions, domestic and industrial sewage water was usually used for irrigation of the agricultural lands without any treatment (Ozdemir and Dursun 2004). The fertility of the soils and the quality of the plant have been negatively affected by the irrigation with polluted water sources. The increase of heavy metal concentration to high toxic levels affects the soil and plant quality and outcome of this effect can be transfered to the animals and human body through the food chain.

High concentrations of heavy metals in the soil disrupt physiologically important functions in plants, cause an imbalance of nutrients and have an adverse effect on the synthesis and functioning of many biologically important compounds such as enzymes, vitamins and hormones (Luo and Rimmer 1995).

Investigation of Xian (1989) showed that the level of the heavy metals in the soil may raise lead level in plants; however, it is not usually possible to find out a close connection between the heavy metal concentrations of the plants and soil, because of the metal bioavailability of the soil, depends on a number of different factors such as plant growth and metal distribution in different parts of the plants.

The soil has high buffering capacity against external factors compared with water and air; however, the problems that arise are so complicated and difficult that they are expensive to tackle when the contaminants added to the system cause decomposition.

Pollution of the biosphere with heavy metals because of industrial, agricultural, and domestic activities poses serious problems in the use of agricultural lands safely (Fytianos et al., 2001).

Heavy metal uptake by plant grown in polluted soils (mostly from anthropogenic activities such as sewage sludge application) has been studied to a con-

siderable extent (Gigliotti et al., 1996). This study is carried out to determine the heavy metal accumulation in the soils irrigated with sewage along the main discharge channel of Konya.

MATERIALS AND METHOD

Soil samples were taken 10 cm depth from the field where wastewater was used for irrigation during January – June months. These sampling points were named as Pump 2 and 3 because of the irrigation pumps.

Three grams from each dry sample was weighed in the reaction containers (for two times to confirm). Some glass perls added. The samples were moistened with some pure water. 21 ml 37 % HCI(extra pure) and 7 ml 65 % HNO_3(extra pure) were added. (If it was covered with foam, it was added slowly). 0.5 mol/lt HNO_3 was put into an absorption container. The acid sample mixture was left overnight at the room temperature. It was boiled at approximately 120 C for two hours. After the sample was cooled, the content of the absorption flask was poured into the other solution, and the container washed with 0.5 mol/l HNO_3. In consequence the solution made up 100 ml by adding pure water. The solution was filtered through 0.45 µm pore size membrane filters before measurement [DIN 38414, part 7]. Then it was analysed using the VISTA AXCCD Simultaneous ICP – AES.

RESULTS

The variation of heavy metal concentrations of the soil samples irrigated with wastewater throughout the main discharge channel of Konya in January – June months, is given in the figures 1-7.

Concentration of zinc risen steadily every month. The highest level was determined as 52.97 and 94.86 mg kg^{-1} in Pump 2 and 3, respectively (figure 1). The concentration of copper is rather low in January, February, and March. It was at maximum level with 44.58 mg kg^{-1} value in Pump 3 in June (figure 2).

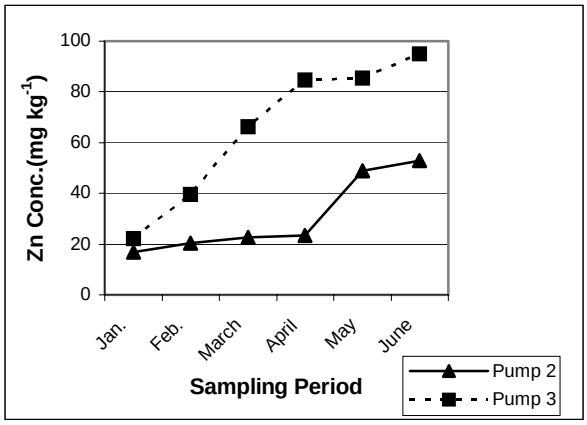

Figure 1. Variation of Zn concentrations in the soil samples according to the months

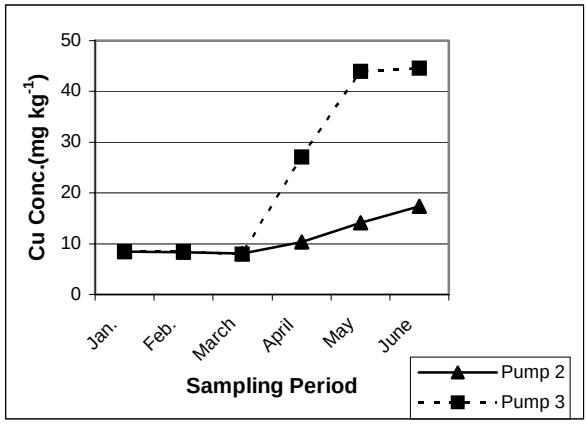

Figure 2. Variation of Cu concentrations in the soil samples according to the months

Concentration of manganese reached to maximum in June, at almost the same level in Pump 2 and 3 (figure 3). Compared with other heavy metal concentrations, chromium concentration was low, but the value of pollution was at maximum as well as others in June (figure 4).

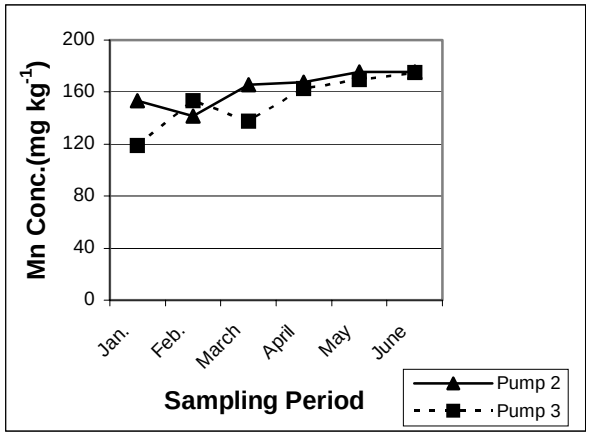

Figure 3. Variation of Mn concentrations in the soil samples according to the months

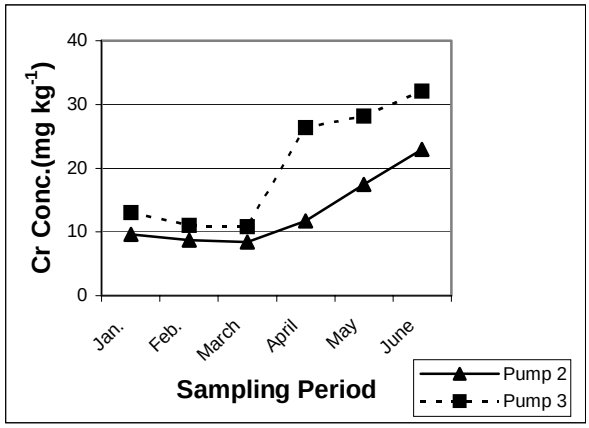

Figure 4. Variation of Cr concentrations in the soil samples according to the months

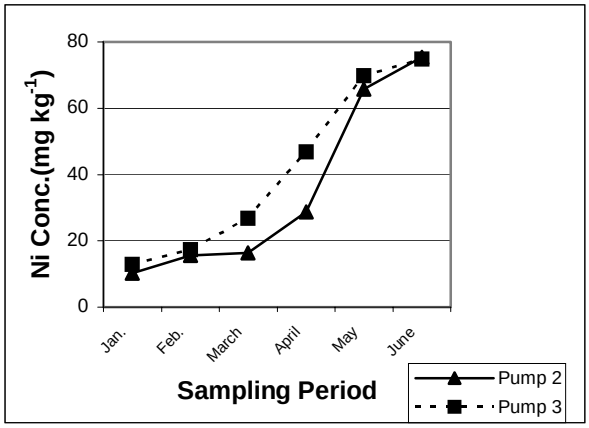

Figure 5. Variation of Ni concentration in the soil samples according to the months

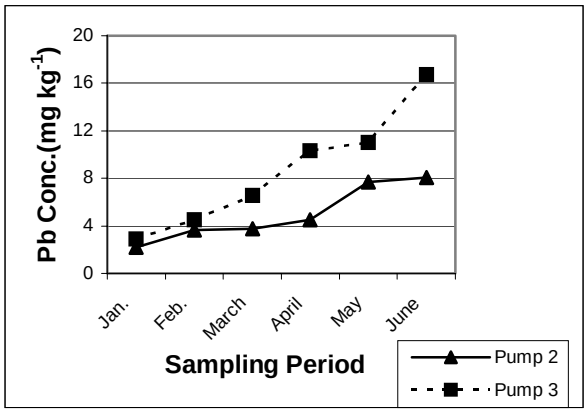

Figure 6. Variation of Pb concentrations in the soil samples according to the months

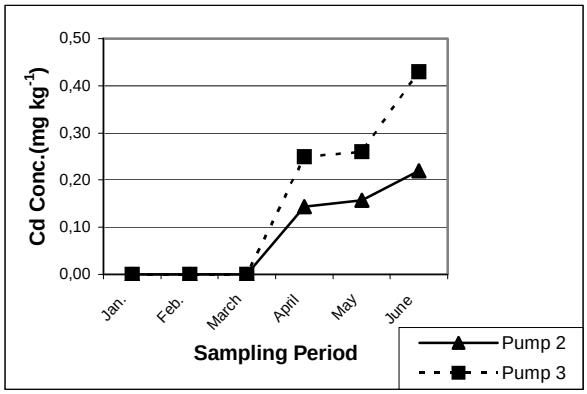

Figure 7. Variation of Cd concentrations in the soil samples according to the months

Concentration of nickel reached to the highest value in May and June. It reached to 65.77 and 69.70 mg kg^{-1} in May, and 75.37 and 74.79 mg kg^{-1} in June in Pump 2 and 3, respectively (figure 5). Concentration of lead reached to the highest level, 16.74 mg kg^{-1} in the Pump 3 in June (figure 6).

Concentration of cadmium was determined after March. It reached to the maximum level in June. The highest value was 0.43 mg kg^{-1} in the soil sample taken from Pump 3 (figure 7).

DISCUSSION AND CONCLUSIONS

It is known that heavy metals form an important polluting group. They have not only toxic and carcinogen effect but also tend to accumulate in living organisms. Because of the farmers in Konya using the water discharged into the channel for irrigation, the fertile soils are being polluted and the plant quality negatively affected. Some researchers investigated the effects of the application of sewage. As the result of comparison made between the lands on which the irrigation with and without sewage was applied, they determined that the metals accumulated are caused by sewage discharges (McGrath et al. 1988).

As a result of the investigations they carried out in the lands under the effect of sewage discharges for nine years, Cd, Cu, Ni, Pb, and Zn contents rose, and the relationship between heavy metals content in the soil and plant was linear increase (Machelett et al. 1990). In lime into local sewage application the level of chromium, copper, lead, mercury, nickel, and zinc contents rose, but these heavy metals contents were at normal level in the plant structure (Maclean et al. 1987).

After investigating the heavy metal accumulation in the soil and the fibres of tobacco plant with the sewage discharge application, Zn, Cu, Mn, Ni, and Cd metals increased significantly and Fe level decreased as a result of increasing sewage application (Adamu et al. 1989). In the investigations carried out on soil pollution and heavy metal taking of the maize plant irrigated with sewage and corn yield, Cd, Cu, Pb, and Zn contents of the plants increased; and this increase was clearer in the cadmium and zinc than the copper and lead (Metz and Wilke 1992).

In the other studies, it was determined that the sewage of the main discharge channel of Konya used for irrigation caused the heavy metal concentration in the soils to increase. It was also determined that the sewage application increased the amount of heavy metals such as Zn, Cu, Mn, Cr, Ni, Pb, and Cd in the soil. The heavy metal pollution reached at the highest level in May and June, in which times the irrigation is made most. Unless the necessary precautions are taken, metal accumulation will reach at higher levels, and it will render the agricultural lands unproductive; and it will be more difficult for the farmers to use these lands. As soon as possible, wastewater treatment plant must be construct at begging of the discharge channel and the treated water must be used for the watering.

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