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# EFFECT OF IRRIGATION WATER SOURCES ON HEAVY METALS AND PESTICIDES CONTAMINATION IN PLANTS CULTIVATED IN DIFFERENT SOIL TYPES

[47]

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## ABSTRACT

Field experiment was conducted during 1999-2000 and 2000-2001 growing seasons on maize (*Zea mays* L.) and wheat (*Triticum aestivum*) in two-soil types, heavy and light soil, El-Gabal Al-Asfar and Tahanoub, Qalubia governorate, respectively. The results indicated that heavy metal availability was affected by irrigation water source, soil type, chemical properties of heavy metal or concentration and plant cultivate. In heavy soil, data obtained showed that sewage water (SW) significantly induced the availability of Cd, Pb, Ni and Co to maize or wheat plant, while, agricultural drainage water (ADW) reduced Cd, Pb, Ni and Co availability to the lowest value. In light soil, the availability of heavy metal to maize or wheat decreased according to irrigation water sources as follows: - sewage water (SW) > Nile water (NW) > ground water (GW). On the other hand, data showed no detectable amount of pesticide residues in maize or wheat grains during the two studied seasons resulted from all monitored pesticides except HCH, *p,p'*-DDE and heptachlor which were detected in maize grains, while *p,p'*-DDE and heptachlor were found in wheat grains. In maize grains, all detected pesticide residues in plants grown in heavy soil were decreased according to irrigation water sources as follows:- ADW > GW > NW > SW. Grains of wheat grown in heavy soil, were contaminated with *p,p'*-DDE and showed different trend than maize grains which followed the order GW > ADW > SW > NW. In light soil, maize or wheat grains were contaminated with *p,p'*-DDE and heptachlor. The concentration of detected pesticides varied according to irrigation water which followed this order GW > SW > NW.

**Keywords:** Contamination, Heavy metals, Pesticides, Plant

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## INTRODUCTION

A total of 59 industrial out falls as well as a total of 79 agricultural drains located along the entire course of the River are discharging into the Nile (FAO 1996). It creates big complicated pollution problems. The release of metal wastes into environment occurs in many forms including direct discharge of industrial waste water, and urban and agricultural run off and sewage into ground water from waste disposal sites.

Pesticides not only exist in target organism and soil system for considerable period of time but also enter into natural waters by percolation and run off from agricultural land and canals, affecting the quality of various water sources (**Dogheim *et al.*, 1996, and Sayed and Essam 1996**).

Heavy metal and pesticides can then be taken up and concentrated to extremely high level by plant tissues during the growing season which consequently accumulate in fruits (**Alloway, 1995**). Furthermore, the impact of the heavy metal on plant physiological processes, photosynthesis, respiration, carbon allocation and stomatal function are affected (**Darrall, 1989**). Growth, chlorophyll content, transpiration rate and relative water content are affected by heavy metals, (**Gadallh, 1996**). The present study aimed to investigate the accumulation of heavy metals and pesticides residues in certain plants grown in different soil types, which were irrigated with different water sources.

## MATERIAL AND METHODS

Different soil types were pre-irrigated for many years with different water sources, Nile (I and V), sewage (II and VI), ground (III and VII), and agricultural drainage water (IV). Soil classification, chemical, physical properties and organic matter content (OM) are presented in Tables (1 and 2).

Maize and Wheat grains were collected at the harvest stage. Grains were separated, air-dried and ground in a wooden mortar into fine powder and kept at ~ -20°C until analysis.

### Contamination analysis

Heavy metal analysis and their determination were carried out according to **Shaole *et al* (1997)**, and **Allen *et al* (1997)**. Also, pesticide residue analysis was done according to **Pesticide Analytical Manual, (1978)**, for pesticide residues analysis. The residue was dissolved with 1ml of n-hexane for GLC analysis and the calibration curve was established.

## RESULTS AND DISCUSSION

### I-Heavy metal contamination

#### I-1- Cadmium

Data in Tables (3) and (4), indicated that Cd was detected in maize grain during the two growing seasons when plants were irrigated with all irrigation waters in both heavy and light soils. In wheat grain and light soil Cd concentrations (Tables 5 and 6) differed significantly according to soil type and irrigation water source as follows: sewage water (SW) > ground water (GW) > agricultural drainage water (ADW) > Nile water (NW) in heavy soil, and SW > GW > NW in light soil.

Table 1. Chemical characteristics of soils

| Collected soil* | pH (1:2.5) Suspen | EC $dsm^{-1}$ at 25 C | Soluble cations (meq/l) | | | | Soluble anions (meq/l) | | | O.M % | SP** % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $HCO_3^{-}$ | $Cl^{-}$ | $SO_4^{--}$ | | |
| **Heavy soil :** | | | | | | | | | | | |
| I | 7.40 b | 2.60 e | 13.51 c | 6.95 d | 2.00 a | 7.61 f | 3.20 h | 5.71 f | 21.16 c | 2.88 | 50.67 |
| II | 7.50 a | 2.10 d | 2.43 h | 4.43 f | 0.40 l | 21.20 b | 7.75 b | 14.79 b | 5.92 g | 3.27 | 60.00 |
| III | 7.20 c | 6.90 a | 37.84 b | 20.30 a | 1.60 b | 21.74 a | 4.25 f | 26.56 a | 50.67 a | 1.96 | 53.33 |
| IV | 7.40 b | 3.20 c | 9.46 c | 10.31 b | 0.68 g | 16.30 c | 3.95 g | 14.45 c | 18.34 d | 2.03 | 62.00 |
| **Light soil :** | | | | | | | | | | | |
| V | 7.50 a | 0.85 h | 6.76 f | 1.38 h | 0.48 h | 3.51 h | 7.70 c | 2.02 I | 2.41 I | 1.58 | 18.33 |
| VI | 7.50 a | 1.31 g | 7.03 e | 2.27 g | 0.78 f | 3.91 g | 5.75 d | 3.36 g | 4.88 h | 1.97 | 19.33 |
| VII | 7.20 c | 2.00 e | 4.32 g | 7.77 c | 0.88 e | 15.22 d | 8.85 a | 6.72 e | 12.61 e | 0.54 | 33.33 |

I & V = soil pre-irrigated with Nile water
III & VII = soil pre-irrigated with ground water
** Saturation percentage
II & VI = soil pre-irrigated with sewage water
IV= soil pre-irrigated with agricultural drainage water
The figures followed by the same letters are insignificant

Table 2. Particle size distribution of soil samples

| Collected soil* | Particle size distribution of the studied soil. | | | Textural class |
|---|---|---|---|---|
| | Clay (<0.002) | Silt (0.002-0.02 | Sand (>0.02) | |
| **Heavy soil :** | | | | |
| I | 42.20 | 46.60 | 11.20 | Silty Clay |
| II | 23.10 | 65.70 | 11.20 | Silty Loam |
| III | 39.00 | 61.00 | 0.00 | Si-Cl-Loam |
| IV | 58.00 | 34.00 | 7.40 | clay |
| **Light soil :** | | | | |
| V | 10.00 | 5.98 | 83.60 | Loamy Sand |
| VI | 10.42 | 5.98 | 83.60 | Loamy Sand |
| VII | 10.42 | 5.98 | 83.60 | Loamy Sand |

I & V = soil pre-irrigated with Nile water
II &VI = soil pre-irrigated with sewage water
III & VII = soil pre-irrigated with ground water
IV= soil pre-irrigated with agricultural drainage water

### I-2- Lead

Lead levels were detected in both maize and wheat grains. In maize plants and heavy soils, the highest concentrations of Pb were detected when irrigated with SW followed by NW, GW and ADW. Irrigation with SW caused the highest concentration of Pb, followed by NW and GW in light soil. Lead concentration in wheat grain showed a similar order.

### I-3- Nickel

Concentration of Ni in grains showed different order from that of Cd and Pb contaminants. In heavy soils, the highest content of Ni in both maize and wheat grains was detected when plants were irrigated with SW followed by NW, GW and ADW in maize and wheat grains. In light soil, grains of maize and wheat plants when irrigated with SW showed the highest content of Ni followed by GW and NW.

Table 3. The effect of irrigation water sources on heavy metal accummulation in maize grains compared to soil content (1999-2000 growing season)

| Soil type | sources* of Irrigation water | Mean heavy metal concentration (ug/g dw) | | | | Maize grains | | | | Mean | CF[1] | | | | Mean of total CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cd | Pb | Ni | Co | Cd | Pb | Ni | Co | | Cd | Pb | Ni | CO | |
| heavy soil | NW | 0.468 e | 31.774 d | 41.450 d | 13.915 d | 0.188 e | 0.574 f | 10.121 c | 0.496 c | 2.845 | 0.402 | 0.018 | 0.244 | 0.036 | 0.175 |
| | GW | 0.879 c | 34.755 c | 52.180 a | 15.033 c | 0.274 c | 0.718 d | 10.615 b | 0.366 d | 2.993 | 0.312 | 0.021 | 0.203 | 0.024 | 0.140 |
| | ADW | 0.926 b | 26.989 e | 47.891 b | 16.446 b | 0.268 d | 0.441 g | 8.950 e | 0.361 e | 2.505 | 0.290 | 0.016 | 0.187 | 0.022 | 0.129 |
| | SW | 1.118 a | 149.723 a | 42.106 c | 24.09 a | 0.484 a | 4.706 a | 14.536 a | 1.079 a | 5.201 | 0.433 | 0.031 | 0.345 | 0.045 | 0.214 |
| | Mean | 0.848 | 60.834 | 45.907 | 17.710 | 0.303 | 1.610 | 11.056 | 0.575 | 3.386 | 0.359 | 0.022 | 0.246 | 0.032 | 0.164 |
| light soil | NW | 0.292 g | 22.161 g | 13.641 g | 5.239 f | 0.137 f | 0.569 e | 4.167 f | 0.258 f | 1.283 | 0.469 | 0.026 | 0.305 | 0.049 | 0.212 |
| | GW | 0.368 f | 23.119 f | 20.227 f | 3.684 g | 0.128 g | 0.884 c | 4.614 g | 0.128 g | 1.439 | 0.346 | 0.038 | 0.228 | 0.035 | 0.162 |
| | SW | 0.585 d | 78.865 b | 37.198 e | 13.807 e | 0.296 b | 3.870 b | 16.150 d | 0.600 b | 5.229 | 0.506 | 0.049 | 0.434 | 0.043 | 0.258 |
| | Mean | 0.415 | 41.382 | 23.689 | 7.577 | 0.187 | 1.774 | 8.310 | 0.329 | 2.650 | 0.440 | 0.038 | 0.323 | 0.042 | 0.211 |
| Toxic limits** | | 5.00 | 100.00 | 100.00 | 50.00 | >100 | >60 | >80 | >115 | CF[2] | 1.0:10.0 | 0.01:0.1 | 0.1:1.0 | 0.01-0.1 | |

*= NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

Cd= Cadmium Pb= Lead Ni= Nickel Co=Cobalt The Figuers followed by the same letters are insignificant.

**Toxic limits : toxic limits to the cultivated plant, according to Anderson *et al* (1973), Tietjen, (1975) and Cottenie *et al* (1976).

CF1 : Concentration factor= metal concentration in plant/ total metal concentration in soil (Kloke *et al* 1994)

CF2 = reference value of CF (according to Kloke *et al* 1994).

Table 4. The effect of irrigation water sources on heavy metal accummulation in maize grains compared to soil content (2000-2001 growing season)

| Soil type | sources* of Irrigation water | Mean heavy metal concentration (ug/g dw) | | | | | | | | Mean | CF[1] | | | | Mean of total CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil | | | | Maize grains | | | | | | | | | |
| | | Cd | Pb | Ni | Co | Cd | Pb | Ni | Co | | Cd | Pb | Ni | CO | |
| heavy soil | NW | 0.471 e | 32.118 d | 41.780 d | 14.004 d | 0.194 e | 0.614 f | 10.455 c | 0.514 c | 2.944 | 0.411 | 0.019 | 0.250 | 0.037 | 0.179 |
| | GW | 0.884 c | 35.081 c | 52.643 a | 15.117 c | 0.283 c | 0.743 d | 10.966 b | 0.379 d | 3.093 | 0.321 | 0.021 | 0.208 | 0.025 | 0.144 |
| | ADW | 0.932 b | 27.359 e | 48.342 b | 16.578 b | 0.277 b | 0.457 g | 9.245 e | 0.375 e | 2.589 | 0.297 | 0.017 | 0.191 | 0.023 | 0.132 |
| | SW | 1.130 a | 152.953 a | 42.812 c | 24.404 a | 0.499 a | 4.871 a | 15.016 a | 1.119 a | 5.376 | 0.442 | 0.032 | 0.351 | 0.046 | 0.218 |
| | Mean | 0.854 | 61.878 | 46.394 | 17.526 | 0.313 | 1.671 | 11.420 | 0.597 | 3.500 | 0.368 | 0.022 | 0.250 | 0.033 | 0.168 |
| light soil | NW | 0.292 g | 22.262 g | 13.683 g | 5.252 f | 0.141 f | 0.589 e | 4.305 f | 0.268 f | 1.326 | 0.484 | 0.026 | 0.315 | 0.051 | 0.219 |
| | GW | 0.368 f | 23.199 f | 20.279 f | 3.690 g | 0.132 g | 0.915 c | 4.766 g | 0.133 g | 1.487 | 0.358 | 0.039 | 0.235 | 0.036 | 0.167 |
| | SW | 0.588 d | 79.573 b | 37.448 e | 13.886 e | 0.306 b | 4.006 b | 16.683 d | 0.622 b | 5.404 | 0.520 | 0.050 | 0.445 | 0.045 | 0.265 |
| | Mean | 0.416 | 41.678 | 23.803 | 7.609 | 0.193 | 1.836 | 8.584 | 0.341 | 2.739 | 0.454 | 0.038 | 0.332 | 0.044 | 0.217 |
| Toxic limits** | | 5.00 | 100.00 | 100.00 | 50.00 | >100 | >60 | >80 | >115 | CF[2] | 1.0:10.0 | 0.01:0.1 | 0.1:1.0 | 0.01-0.1 | |

*= NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

Cd= Cadmium Pb= Lead Ni= Nickel Co=Cobalt The Figuers followed by the same letters are insignificant.

**Toxic limits : toxic limits to the cultivated plant, according to **Anderson *et al* (1973), Tietjen, (1975) and Cottenie *et al* (1976).**

CF1 : Concentration factor= metal concentration in plant/ total metal concentration in soil (**Kloke *et al* 1994**)

CF2 = reference value of CF (according to **Kloke *et al* 1994**).

Table 5. The effect of irrigation water sources on heavy metal accummulation in wheat grains compared to soil content (1999-2000 growing season).

| Soil type | sources* of Irrigation water | Mean heavy metal concentration (ug/g dw) | | | | | | | | Mean | CF[1] | | | | Mean of total CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil | | | | Wheat grains | | | | | | | | | |
| | | Cd | Pb | Ni | Co | Cd | Pb | Ni | Co | | Cd | Pb | Ni | CO | |
| heavy soil | NW | 0.467 e | 31.604 d | 41.284 d | 13.871 d | 0.150 e | 0.675 f | 8.801 c | 0.583 c | 2.552 | 0.321 | 0.021 | 0.213 | 0.042 | 0.149 |
| | GW | 0.876 c | 34.593 c | 51.954 a | 14.991 c | 0.219 c | 0.845 d | 9.231 b | 0.430 d | 2.681 | 0.250 | 0.024 | 0.267 | 0.029 | 0.143 |
| | ADW | 0.923 b | 26.808 e | 47.672 b | 16.382 b | 0.215 d | 0.519 g | 7.783 e | 0.425 e | 2.236 | 0.232 | 0.019 | 0.163 | 0.026 | 0.110 |
| | SW | 1.112 a | 148.132 a | 41.753 c | 23.944 a | 0.387 a | 5.537 a | 12.640 a | 1.269 a | 4.958 | 0.348 | 0.037 | 0.303 | 0.053 | 0.185 |
| | Mean | 0.845 | 60.284 | 45.666 | 17.297 | 0.243 | 1.894 | 9.614 | 0.677 | 3.107 | 0.288 | 0.025 | 0.024 | 0.038 | 0.147 |
| light soil | NW | 0.292 g | 22.109 g | 13.621 g | 5.233 f | 0.110 f | 0.669 e | 3.624 g | 0.304 f | 1.177 | 0.375 | 0.030 | 0.266 | 0.058 | 0.182 |
| | GW | 0.368 f | 23.081 f | 20.203 g | 3.681 g | 0.102 g | 1.040 c | 4.012 f | 0.151 g | 1.326 | 0.277 | 0.045 | 0.199 | 0.041 | 0.141 |
| | SW | 0.584 a | 78.504 b | 37.068 e | 13.769 e | 0.237 b | 4.553 b | 14.043 d | 0.923 b | 4.939 | 0.406 | 0.058 | 0.379 | 0.067 | 0.228 |
| | Mean | 0.415 | 41.231 | 23.631 | 7.561 | 0.150 | 2.087 | 7.226 | 0.459 | 2.481 | 0.353 | 0.044 | 0.281 | 0.055 | 0.183 |
| Toxic limits** | | 5.00 | 100.00 | 100.00 | 50.00 | >100 | >60 | >80 | >115 | CF[2] | 1.0:10.0 | 0.01:0.1 | 0.1:1.0 | 0.01-0.1 | |

*= NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

Cd= Cadmium Pb= Lead Ni= Nickel Co=Cobalt The Figuers followed by the same letters are insignificant.

**Toxic limits : toxic limits to the cultivated plant, according to Anderson *et al.*, (1973), Tietjen, (1975) and Cottenie *et al.*, (1976).

CF1 : Concentration factor= metal concentration in plant/ total metal concentration in soil (Kloke *et al.*, 1994)

CF2 = reference value of CF ( according to Kloke *et al.*, 1994).

Table 6. The effect of irrigation water sources on heavy metal accummulation in wheat grains compared to soil content (2000-2001 growing season).

| Soil type | sources* of Irrigation water | Mean heavy metal concentration (ug/g dw) | | | | | | | | Mean | CF[1] | | | | Mean of total CF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Soil | | | | Wheat grains | | | | | | | | | |
| | | Cd | Pb | Ni | Co | Cd | Pb | Ni | Co | | Cd | Pb | Ni | CO | |
| heavy soil | NW | 0.470 e | 31.947 d | 41.613 d | 13.960 d | 0.165 e | 0.716 f | 9.268 c | 0.616 c | 2.691 | 0.351 | 0.022 | 0.223 | 0.044 | 0.160 |
| | GW | 0.881 c | 34.919 c | 52.410 b | 15.075 c | 0.241 c | 0.891 d | 9.720 b | 0.455 d | 2.827 | 0.273 | 0.026 | 0.185 | 0.030 | 0.129 |
| | ADW | 0.929 b | 27.173 e | 48.114 c | 16.511 b | 0.236 d | 0.535 g | 8.195 e | 0.449 e | 2.354 | 0.254 | 0.020 | 0.170 | 0.027 | 0.118 |
| | SW | 1.124 a | 151.341 a | 42.459 a | 24.245 a | 0.430 a | 5.842 a | 13.310 a | 1.341 a | 5.231 | 0.382 | 0.039 | 0.313 | 0.055 | 0.197 |
| | Mean | 0.851 | 61.345 | 46.149 | 17.448 | 0.268 | 1.996 | 10.123 | 0.715 | 3.276 | 0.315 | 0.027 | 0.223 | 0.039 | 0.151 |
| light soil | NW | 0.292 g | 22.212 g | 13.662 g | 5.245 f | 0.120 f | 0.706 e | 3.816 g | 0.321 f | 1.241 | 0.413 | 0.032 | 0.279 | 0.061 | 0.196 |
| | GW | 0.368 f | 23.158 f | 20.253 f | 3.687 g | 0.112 g | 1.097 c | 4.224 f | 0.160 g | 1.398 | 0.305 | 0.047 | 0.209 | 0.043 | 0.151 |
| | SW | 0.586 d | 79.220 b | 37.325 e | 13.846 e | 0.263 b | 4.803 b | 14.788 d | 0.976 b | 5.208 | 0.449 | 0.061 | 0.396 | 0.070 | 0.244 |
| | Mean | 0.415 | 41.530 | 23.747 | 7.593 | 0.165 | 2.202 | 7.609 | 0.486 | 2.616 | 0.389 | 0.047 | 0.295 | 0.058 | 0.197 |
| Toxic limits** | | 5.00 | 100.00 | 100.00 | 50.00 | >100 | >60 | >80 | >115 | CF[2] | 1.0:10.0 | 0.01:0.1 | 0.1:1.0 | 0.01-0.1 | |

*= NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

Cd= Cadmium Pb= Lead Ni= Nickel Co=Cobalt The Figuers followed by the same letters are insignificant.

**Toxic limits : toxic limits to the cultivated plant, according to Anderson *et al.*, (1973), Tictjen, (1975) and Cottenie *et al.*, (1976).

CF1 : Concentration factor= metal concentration in plant/ total metal concentration in soil (Kloke *et al.*, 1994)

CF2 = reference value of CF ( according to Kloke *et al.*, 1994).

**I-4- Cobalt**

Cobalt showed different pattern compared with Cd, Pb and Ni metals. In heavy soil, SW revealed the highest significant concentration in both maize and wheat grains followed by NW, GW and ADW. In light soils, Co content in maize or wheat grains followed the following order, SW > NW > GW.

The mean of total concentration of each metal in maize or wheat grains showed the following descending order in both heavy and light soils, Ni > Pb > Co > Cd. This order is positively correlated with the heavy metal concentration in soil corresponded with what stated by **Said, (1980) and Alloway, (1995)**.

Furthermore, transfer coefficient values (CF) revealed that metal availability was affected by irrigation water source, soil type, heavy metal chemistry or concentration and the cultivate. In heavy soils, data in Tables (3-6) showed that SW significantly alleviates the availability of Cd, Pb, Ni and Co to maize and wheat plants, while, ADW decreased the availability to the lowest value. In light soil, the availability of heavy metal to maize or wheat was decreased according to irrigation water sources as follows: SW > NW > GW. Irrigation with SW highly induced CF value of Cd, Pb, Ni, and Co to maize plant. In the case of GW irrigation, CF value of Cd, Pb, Ni and Co decreased to the lowest value.

From these results, it can be concluded that, there were relative differences in heavy metals uptake between maize and wheat. This may be due to plant cultivate and various factors including surface area of the roots, root cation exchange, root exudates and rate of evapotranspiration. These factors affect the mass flow of the soil solution in the vicinity of the root and thus the movement of ions to the root absorbing surface **(Alloway, 1995)**. Also, CF values showed that Cd was readily translocated to plant grains more than other pollutants, followed by Ni, Co or Pb. Also, **Lehoczky *et al* (2000)**, indicated that lettuce leaves Cd concentration was 1.4 – 16 times as much as the total Cd content of soil. That could be attributed to the increased apoplastic Cd binding, **(Hart *et al* 1998)**. The previous Cd data, showed that Cd highly accumulated in maize and wheat grains which were planted in heavy soil or light soil irrigated with SW followed by GW > ADW > NW. This may be related to the high $Cl^-$ and low $Ca^{++}$ of SW (Table 1), which increased Cd uptake **(Wenzel *et al* 1996)**. Increasing Ni concentration in maize or wheat grains more than Pb or Co, may be affected by its higher concentration in soil **(Wild, 1988)**, or because Ni is one of the most soluble and mobile among heavy metals in the soil solution **(EPA, 1995)**. While, Pb is more strongly adsorbed by soils and forms insoluble crystalline compounds **(Santillian and Jurinak, 1975)**. In addition, the levels of pollutants accumulation in maize or wheat grains were affected by irrigation water sources as follows: SW > NW > GW > ADW. This may be due to low pH values **(Marzouk, 2003)** of SW, which induce the availability and movement of heavy metal cations from the bulk soil to the root surface **(Alloway, 1995)**, or to its high pollutants content **(Marzouk, 2003)**. In addition, the high organic wastes of SW, mobilizes heavy metals, and related to the different origins of organic materials which differ in their content of functional groups and in their ability for mobilizing different elements

**(Badran, 1999)**. Also, the high content of organic wastes give rise to intense microbiological and biochemical activity in the rhizosphere, which enable roots to mobilize some of the metals **(Alloway, 1995)**. This is in agreement with **Kiranjit *et al* (1998)**, who reported that crops irrigated with SW had higher concentration of Co, Pb, Ni, and Cd than those irrigated with GW.

Data of CF values (Tables 3-6) revealed that although heavy soil pollution was higher than light soil, Cd, Pb and Co uptake of maize or wheat, grown in the light soil was higher than in heavy soil at both seasons. This may be attributed to that the decrease of soil particle size of heavy soil would increase total soil adsorbed surface areas compared with light soil, consequently adsorption, **(Yujun *et al* 1996)**. Pollutants were therefore more available to plant grown in light soil. Also, this is in agreement with **Wild, (1988)**, who reported that the amount of metal absorbed by a plant is affected by concentration and speciation of the metal in the soil solution, and the movement of the metal from the bulk soil to the root surface. **Vassilev *et al* (1999)**, indicated that uptake of Cd by winter barley was higher in plants grown in sandy loam soil than in clay loam soil. In contrast, Ni availability in light soil was lower than in heavy soil that may be due to that Ni is one of the most soluble and mobile of heavy metals in the soil. From these results it could be concluded that heavy metals availability and accumulation in the grown plant is affected by soil heavy metal or organic matter (OM) contents, soil chemical and physical properties (especially clay %), leachability of element (depending on chemical and physical properties of the element), and microbial activities. In addition, heavy metal content of irrigation waters, pH, salinity and organic wastes content changed with time were also affected.

However, detected pollutant levels in maize or wheat grain were below the phytotoxicity limits as mentioned by **Anderson *et al* (1973)**, and **Cottenie *et al* (1976)**.

**II- Pesticide residues contamination**

Accumulation of pesticide residues in maize and wheat grains are presented in Tables (7) and (8) showed no detectable amounts of pesticide residues found in maize or wheat grains during the two seasons for all monitored pesticides except HCB, *p,p'*-DDE and heptachlor. These three compounds were detected in maize grains, while *p,p'*-DDE and heptachlor were found in both maize and wheat grain.

In maize grains, all pesticides residues in plants grown in heavy soil, decreased according to the irrigation water sources as follows:- ADW > GW > NW > SW. At the first season, the residues of HCB, *p,p'*-DDE and heptachlor were 0.85, 8.5 and 1.85 ppb; 0.75, 7.3 and 1.45 ppb; 0.68, 7.05 and 1.4 ppb or 0.6, 5.335 and 0.9 ppb in grains of maize planted in heavy soil, respectively. HCH and heptachlor were detected in the second season similar to the above mentioned order. *p,p'*-DDE was not detected when all irrigation water sources were used except ADW. Data of total pesticide levels in maize grains were detected when irrigated with ADW, followed by GW, NW and SW at the two seasons. In light soil, the detected HCB, *p,p'*-DDE and heptachlor concentrations showed different patterns, and followed the order of

Table 7. Concentration of pesticides in maize grains during 1999/2000 and 2000/2001 growing seasons.

| Soil type | sources* of Irrigation water | Pesticide concentration (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1999-2000 | | | | 2000-2001 | | | |
| | | HCB | *P,P*-DDE | heptachlor | Total | HCB | *P,P*-DDE | heptachlor | Total |
| heavy soil | NW | 0.680 | 7.050 | 1.400 | 9.130 | 0.600 | ND | 1.000 | 1.600 |
| | GW | 0.750 | 7.300 | 1.450 | 9.500 | 0.640 | ND | 1.450 | 2.090 |
| | ADW | 0.850 | 8.500 | 1.850 | 11.200 | 0.700 | 0.285 | 1.800 | 2.785 |
| | SW | 0.600 | 5.335 | 0.900 | 6.835 | 0.550 | ND | 0.840 | 1.390 |
| | Mean | 0.720 | 7.046 | 1.400 | 9.166 | 0.623 | 0.071 | 1.273 | 1.966 |
| light soil | NW | 0.650 | ND | ND | 0.650 | 0.650 | ND | 1.040 | 1.690 |
| | GW | 0.700 | 4.275 | 1.750 | 6.725 | 0.700 | 0.200 | 1.050 | 1.950 |
| | SW | 1.250 | 6.000 | 1.900 | 9.150 | 0.850 | ND | 1.150 | 2.000 |
| | Mean | 0.867 | 3.425 | 1.217 | 5.508 | 0.733 | 0.067 | 1.080 | 1.880 |
| | MRL** | -- | 100.00 | 20.00 | -- | -- | 100.00 | 20.00 | -- |

* NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

** Maximum residues limit (according to Codex, 2000). (--) = not listed ND = Not detected

Table 8. Concentration of pesticides in wheat grains during 1999/2000 and 2000/2001 growing seasons.

| Soil type | Sources* of Irrigation water | Pesticide concentration (ppb) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1999 – 2000 | | | | 2000 - 2001 | | | |
| | | HCB | *P,P*-DDE | heptachlor | Total | HCB | *P,P*-DDE | heptachlor | Total |
| heavy soil | NW | ND | 1.364 | 2.235 | 3.599 | ND | 1.415 | 1.100 | 2.515 |
| | GW | ND | 1.815 | 2.550 | 4.365 | ND | 1.945 | 1.400 | 3.345 |
| | ADW | ND | 1.505 | 2.750 | 4.255 | ND | 1.730 | 1.530 | 3.260 |
| | SW | ND | 1.490 | 2.400 | 3.890 | ND | 1.660 | 1.300 | 2.960 |
| | Mean | ND | 1.544 | 2.484 | 4.027 | ND | 1.688 | 1.333 | 3.020 |
| light soil | NW | ND | 1.335 | 1.650 | 2.985 | ND | 1.300 | 0.950 | 2.250 |
| | GW | ND | 1.570 | 2.050 | 3.620 | ND | 1.840 | 1.650 | 3.490 |
| | SW | ND | 1.455 | 1.850 | 3.305 | ND | 1.545 | 1.100 | 2.645 |
| | Mean | ND | 1.453 | 1.850 | 3.303 | ND | 1.562 | 1.233 | 2.795 |
| | MRL** | -- | 100.00 | 20.00 | -- | -- | 100.00 | 20.00 | -- |

* NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water

** Maximum residues limit (according to Codex, 2000) (--) = not listed ND = Not detected

SW > GW > NW in the 1st and the 2nd seasons. Irrigation with SW caused high contamination of maize grains, with total concentration of 9.15 and 2.0 ppb, while NW was the lowest (0.65 and 1.69 ppb at 1st and 2nd seasons), respectively. This is because of the organic waste contents of SW which enhanced the activity of microorganisms, (**Buyanovsky *et al* 1995**), and consequently the degradation of lindane and DDT to their metabolites i.e. HCB and *p,p'*-DDE, respectively, (**Abu-Arab, 2002**).

Grains of wheat grown in heavy soil, were contaminated with *p,p'*-DDE and showed different trend than maize grains and followed the order of GW > ADW > SW > NW. Heptachlor contamination showed different order as follows:- ADW > GW > SW > NW. Illustrated data of total detected pesticides in GW irrigation showed the highest contamination followed by ADW, SW and NW. Values were 4.365 and 3.345 ppb, 4.255 and 3.26 ppb, 3.89 and 2.96 ppb and 3.599 and 2.515 ppb at the first and second seasons, respectively.

In light soils, wheat grains were contaminated with *p,p'*-DDE and heptachlor. The concentration of detected pesticides varied according to irrigation water with the order of GW > SW > NW. HCB was not detected in wheat grains grown in heavy or light soil under the conditions of all irrigation water sources. Data of total detected pesticides indicated that GW irrigation contaminated wheat grain, whereas, NW was the lowest.

From the above mentioned data, it is clear that, although heptachlor was not detected in each of the irrigation water sources or soil, it was detected in maize and wheat grains. This may be due to the short half life of heptachlor in water (< 1 day) and soil (120 – 240 days), (**EPA, 1999**). Heptachlor is probably taken up rapidly and accumulated in the edible aerial tissue as mentioned by **Mattina *et al* (2000)**. HCB was detected in maize grain in spite of its absence in the different irrigation water sources or soils, that may be due to that heptachlor is metabolized in plant mainly to HCB (**Abou-Arab, 2002**). In addition, HCB is transported by the atmosphere in lower concentrations, in sufficient amounts to produce significant contributions to the global distribution of HCB (**Bro – Rasmussen, 1986**). Moreover, detection of *p,p'*-DDE in maize and wheat grains is probably related to its existence in irrigation water and grown soil, (**Marzouk, 2003**).

The total detected pesticides in grains of maize planted in heavy soil and irrigated with ADW were high, while SW was the lowest. Besides, the high OM in SW induce the microbial activities and pesticide biodegradation more than in ADW irrigated soil as discussed before (**Huang *et al* 2001**). Although in light soil, irrigation with SW caused the highest contamination in maize grain because of the high organic contents of SW and soil. Organic compounds increased soil retention of pesticides, and give rise to intense microbiological and biochemical activities in the rhizosphere, which enables roots to mobilize some of the chemical compound (**Alloway, 1995**). Furthermore, wheat grown in heavy or light soil, and irrigated with GW caused the highest pesticide contamination to grains, while NW was the lowest. This may be attributed to the high organochlorine pesticide contamination of GW or irrigated soil.

However, all detected pesticides in maize or wheat grains were below the maximum residue limits (MRL,) reported by **Codex, (2000)**.

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مجلة حوليات العلوم الزراعية ، كلية الزراعة ، جامعة عين شمس ، القاهرة ، م٥٠ ، ع(٢)، ٦٨٩-٧٠٤ ، ٢٠٠٥

# تأثير مصادر الرى المختلفة على مستوى الاتساخ ببعض العناصر الثقيلة ومتبقيات المبيدات فى النباتات النامية بالأراضى المختلفة

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أجريت هذه التجربة خلال موسم ١٩٩٩-٢٠٠٠، ٢٠٠٠-٢٠٠١ لتقييم مدى تأثير مصادر مياه الرى المختلفة على مستوى التلوث ببعض العناصر الثقيلة ومتبقيات المبيدات فى نباتات الذرة والقمح النامية بكل من الأراضى الثقيلة (منطقة طحانوب) والخفيفة (منطقة الجبل الأصفر) بمحافظة القليوبية. أوضحت النتائج أن مياه الصرف الصحى تزيد معنوياً من إتاحة عناصر الكادميوم والرصاص والنيكل والكوبالت للامتصاص بواسطة كلاً من نبات الذرة أو القمح. بينما أنخفض معدل الامتصاص الى أقل معدلاته عند الرى بمياه الصرف الزراعى. أما فى الأراضى الخفيفة فقد اختلفت مقدرة النباتات على امتصاص العناصر تبعاً لمصدر الرى كما يلى:- مياة الصرف الصحى > مياة النيل > مياه الآبار.

كما أظهرت نتائج تحليل كل من حبوب الذرة والقمح عدم وجود أى متبقيات من المبيدات خلال موسمى الدراسة باستثناء مركبات الهكساكلوروبنزين، بارا-بارا- د.د.إى، والهبتاكلور بحبوب الذرة، ومركب بارا-بارا- د.د.إى، والهبتاكلور بحبوب القمح. فى الأراضى الثقيلة فقد اختلفت تركيزات متبقيات المبيدات التى تم استكشافها بحبوب الذرة تبعاً لمصدر الرى، وفقاً للترتيب التالى:- مياه الصرف الزراعى > مياه الآبار > مياه النيل > مياه الصرف الصحى، بينما فى حالة نبات القمح أختلف تركيز متبقيات المبيدات تبعاً لمصدر الرى كما يلى:- مياه الآبار > مياه الصرف الزراعى > مياه الصرف الصحى > مياه النيل، وفى الأراضى الخفيفة احتوت حبوب الذرة أو القمح على متبقيات مبيد بارا-بارا د.د.إى، الهبتا كلور وأختلف تركيز كل من هذه المتبقيات تبعاً لمصدر الرى كما يلى:- مياه الآبار > مياه الصرف الصحى > مياه النيل.

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