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CONTAMINATION STATUS OF ORGANIC PESTICIDES IN DIFFERENT SOIL TYPES AS AFFECTED BY IRRIGATION WATER SOURCES

[44]

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ABSTRACT

A field experiment was conducted during the 1999-2000 and 2000-2001 growing seasons to evaluate the effect of irrigation water source on amount of organic pesticide residues in different soil types. The results showed that organochlorine pesticides, *p.p'*-DDE, chlorothalonil, dicofol and HCB were detected at different levels in soil irrigated with all studied irrigation water sources. Another pesticide, i.e. metribuzin was detected in heavy and light soil in maize and wheat fields during the two seasons. The data also indicated that the total pesticide accumulation in heavy soil increased toward the ends of the two summer seasons to its peak in soil irrigated with ADW, while the lowest accumulation was found in soil irrigated with SW. On the other hand, in the winter season, the highest accumulation of detected pesticides was found in heavy soil irrigated with GW. Conversely, the lowest accumulation was observed in the soil irrigated with NW. In general, pesticide accumulation in heavy soil was higher than light soil in both maize and wheat fields. In addition, the accumulation of pesticides in summer season was higher compared with winter season.

Keywords: Contamination, Pesticides, Soil , Irrigation Waters

INTRODUCTION

The pesticide pollution problem has become universal. There are more than 8000 pesticide formulations in common use, with over 500 of them containing 2 or more "active ingredients" (**Sayed and Essam, 1996**).

Although these chemicals are designed to protect plants and enhance productivity, the problems caused by these pesticides have largely been overlooked.

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These pesticides not only exist in target organisms for a 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 (**Nayak *et al* 1995; Helling, 1986; Dogheim *et al* 1996** and **Sayed & Essam 1996**). Pesticides then accumulate in irrigated soil and are taken up and concentrated to extremely high levels by plant tissues during the growing season consequently accumulating in fruits (**Alloway, 1995**).

The present study aimed to survey and follow up certain pesticide residues in different soil types. The impact of irrigation water source on polluting the irrigated soil by pesticides and accumulation was also assessed.

MATERIAL AND METHODS

The field experiment was conducted during the 1999-2000 and 2000-2001 growing seasons on maize (*Zea mays* L.) and wheat (*Triticum aestivum*) in two-soil types, heavy and light soil, in El-Gabal Al-Asfar and Tahanoub, Qalubia governorate. Prior to this study the fields had been irrigated for many years with water from different source: Nile, sewage, ground, and agricultural drainage water. Soil classification, chemical, physical properties and organic matter content (OM) are presented in Tables 1 and 2. Samples were taken from successive depths (rhizosphere zone), air dried, sieved through 2 mm and stored at 4°C until analysis.

The pesticide residue analysis was carried out according to the multi-residue method recommended by the **Pesticide Analytical Manual, 1978**, with slight modifications. The residue was dissolved with 1 ml of n-hexane for GLC analysis and the calibration curve was established.

RESULTS AND DISCUSSION

Results presented in Tables 3-6 show the pesticide residue levels detected in the soil of maize and wheat fields irrigated from different water sources. Chlorothalonil, endrin and *p,p'*-DDE from organochlorine pesticides, the acaricide tetradifon, the fungicide captan and the herbicide metribuzin were the major pesticides detected in soil collected from maize or wheat fields with high variation levels. Dicofol, *p,p'*-DDT and HCH were found less frequently.

Maize field

Pesticide residue levels in soil samples collected from maize fields are presented in Tables 3-4. The organochlorine pesticides *p,p'*-DDE and chlorothalonil were detected at different levels in soils at the beginning of the first season and increased to their peaks at the end of the season. The same pattern was observed in the second season, except endrin which was observed at the end of 1st season and beginning of the 2nd season. The other organochlorine pesticides, dicofol and HCH were found less frequently.

The highest level of total detected organochlorine pesticides was found in heavy soil irrigated with agricultural drainage water (ADW) or ground water (GW) followed by sewage water (SW) or Nile water (NW). At the beginning of the first season, total organochlorine pesticides of 0.519, 0.284, 0.244 and 0.216 ppb were detected in heavy soil irrigated with ADW, GW, SW and NW,

Table 1. Chemical characteristics of soils

Collected soil	pH (1:2.5) Suspen	EC dsm^{-1} at 25 C	Solu ble cations (meq/l)				Soluble anions (meq/l)			O.M %	SP** %
			Ca^{++}	Mg^{++}	K^{+}	Na^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}		
Heavy soil*:											
NW	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
SW	7.50 a	2.10 d	2.43 h	4.43 f	0.40 I	21.20 b	7.75 b	14.79 b	5.92 g	3.27	60.00
GW	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
ADW	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:											
NW	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
SW	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
GW	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

* NW = Nile Water, SW = Sewage Water, GW = Ground Water, ADW = Agricultural drainage water
** Saturation percentage The figures followed by the same letters are insignificantly different from each other

Table 2. Particle size distribution in soil samples

Collected soil*	Particle size distribution of the studied soil. Clay (<0.002)	Silt (0.002-0.02)	Sand (>0.02)	Textural class
Heavy soil:				
NW	42.20	46.60	11.20	Silty Clay
SW	23.10	65.70	11.20	Silty Loam
GW	39.00	61.00	0.00	Si-Cl-Loam
ADW	58.00	34.00	7.40	clay
Light soil:				
NW	10.00	5.98	83.60	Loamy Sand
SW	10.42	5.98	83.60	Loamy Sand
GW	10.42	5.98	83.60	Loamy Sand

* NW = Nile water, SW = Sewage water, GW = Gound water, ADW = Agricultural drainage water

respectively. These concentrations increased at the end of the season for all irrigation water sources especially in soil irrigated with GW, followed by soil irrigated with ADW, NW and SW.

In light soils, irrigation with SW showed the highest concentration of total organochlorine pesticide followed by GW and NW reaching 0.170, 0.090 and 0.082 ppb at the beginning of maize season, while at the end of season, soil irrigated with SW showed the highest amount followed by soil irrigated with NW and GW.

Organochlorine pesticide contamination in soil in the second maize season showed the same pattern as the first season, in both heavy and light soil, while at the end of season, in particular, soils irrigated with GW were highly contaminated with organochlorine pesticides with total values of 0.724 ppb followed by ADW (0.629 ppb), NW (0.618 ppb) and SW (0.612 ppb). In light soil, detectable organochlorine pesticide values reached their peaks in soil irrigated with SW (0.197 ppb), whereas the lower concentration was found in soil irrigated with NW (0.139 ppb) at the beginning of season. At the end of the second season, soil irrigated with SW showed the highest contamination (0.407 ppb), while with GW was the lowest (0.348 ppb).

Wheat field

Organochlorine pesticide residues (i.e. chlorothalonil, endrin, *p,p'*-DDE, *p,p'*-DDT, *β*-HCH and dicofol) showed a different pattern in soil taken from maize fields than in soils taken from wheat fields irrigated with the same water sources and at the same sampling times.

The data presented in Tables (5-6) showed that total organochlorine pesticide residues were highest in heavy soil irrigated with GW followed by ADW, NW and SW at the beginning of the 1st and 2nd seasons. At the end of the two wheat seasons, total organochlorine pesticides were highest in heavy soil irrigated with GW followed by ADW, SW and NW in the two growing seasons.

Table 3. Concentrations of pesticides in soil of maize fields irrigated with water from different sources (1999/2000 growing season)

Time	Soil type	sources* of Irrigation water	Pesticides concentrations (ppb)								
			B-HCH	*P,P*-DDT	*P,P*-DDE	endrin	chorothalonil	dicofol	Total OC**	metribuzin	Total pesticides
Beginning	heavy soil	NW	ND	ND	0.033	ND	0.183	ND	0.216	0.485	6.243
		GW	ND	ND	0.031	ND	0.253	ND	0.284	0.368	7.156
		ADW	ND	ND	0.156	ND	0.262	0.101	0.519	0.667	8.367
		SW	ND	ND	0.031	ND	0.214	ND	0.244	0.770	6.423
		Mean	ND	ND	0.063	ND	0.228	0.025	0.316	0.573	7.047
	light soil	NW	ND	ND	0.000	ND	0.082	ND	0.082	0.220	2.821
		GW	ND	ND	0.000	ND	0.090	ND	0.090	0.347	3.262
		SW	ND	ND	0.017	ND	0.153	ND	0.170	0.451	4.329
		Mean	ND	ND	0.006	ND	0.109	ND	0.114	0.339	3.470
End	heavy soil	NW	ND	ND	0.090	0.252	0.315	ND	0.657	1.264	10.818
		GW	ND	ND	0.165	0.186	0.370	0.181	0.902	1.835	11.133
		ADW	0.008	ND	0.212	0.160	0.275	0.192	0.847	1.093	11.337
		SW	ND	ND	0.118	0.160	0.347	ND	0.625	0.859	10.612
		Mean	ND	ND	0.146	0.190	0.327	0.093	0.758	1.263	10.975
	light soil	NW	ND	ND	0.075	0.135	0.189	ND	0.399	0.645	5.449
		GW	ND	ND	0.068	0.137	0.198	ND	0.371	0.412	4.097
		SW	ND	ND	ND	0.118	0.253	ND	0.403	0.782	6.876
		Mean	ND	ND	0.048	0.130	0.213	ND	0.391	0.613	5.474

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

** Total organochlorine pesticide residues. ND = Not detected

Table 4. Concentrations of pesticides in soil of maize fields irrigated with water from different sources (2000/2001 growing season)

Time	Soil type	sources* of Irrigation water	Pesticides concentrations (ppb)								
			B-HCH	*P,P*-DDT	*P,P*-DDE	endrin	chorothalonil	dicofol	Total OC**	metribuzin	Total pesticides
Beginning	heavy soil	NW	ND	ND	ND	0.106	0.160	ND	0.266	0.683	3.997
		GW	ND	ND	0.034	0.107	0.194	ND	0.335	0.653	4.335
		ADW	ND	ND	0.156	0.072	0.162	ND	0.390	0.743	4.962
		SW	ND	ND	0.019	0.105	0.200	ND	0.324	0.773	4.117
		Mean	ND	ND	0.052	0.098	0.179	ND	0.329	0.713	4.353
	light soil	NW	ND	ND	ND	0.076	0.093	ND	0.139	0.515	0.654
		GW	ND	ND	ND	0.061	0.078	ND	0.169	0.461	0.824
		SW	ND	ND	ND	0.094	0.103	ND	0.197	0.685	1.128
		Mean	ND	ND	ND	0.077	0.091	ND	0.168	0.554	0.869
End	heavy soil	NW	ND	ND	0.060	0.231	0.327	ND	0.618	0.860	9.997
		GW	ND	ND	0.148	0.180	0.396	ND	0.724	1.290	10.163
		ADW	ND	ND	0.186	0.174	0.269	ND	0.629	1.734	10.374
		SW	ND	ND	0.148	0.167	0.297	ND	0.612	0.947	9.802
		Mean	ND	ND	0.136	0.188	0.322	ND	0.646	1.208	10.084
	light soil	NW	ND	ND	ND	0.102	0.246	ND	0.362	0.628	8.237
		GW	ND	ND	ND	0.155	0.252	ND	0.348	0.551	7.309
		SW	ND	ND	ND	0.140	0.222	ND	0.407	0.746	9.597
		Mean	ND	ND	ND	0.132	0.240	ND	0.372	0.642	8.381

* NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water
** Total organochlorine pesticide residues. ND = Not detected

Table 5. Concentrations of pesticides in soil of wheat fields irrigated withwater from different sources (1999/2000 growing season)

Time	Soil type	sources* of Irrigation water	Pesticides concentrations (ppb)								
			B-HCH	*P,P*-DDT	*P,P*-DDE	endrin	chorothalonil	dicofol	Total OC**	metribuzin	Total pesticides
Beginning	heavy soil	NW	ND	ND	0.069	0.178	0.315	ND	0.562	0.374	4.489
		GW	ND	ND	0.221	0.139	0.387	ND	0.747	0.481	4.734
		ADW	ND	0.065	0.119	0.114	0.316	ND	0.614	0.829	4.770
		SW	0.05	ND	ND	0.131	0.276	ND	0.457	0.388	4.181
		Mean	0.013	0.016	0.102	0.141	0.324	ND	0.595	0.518	4.544
	light soil	NW	ND	ND	ND	0.093	0.192	ND	0.285	0.423	2.916
		GW	ND	ND	ND	0.104	0.147	ND	0.251	0.236	2.089
		SW	ND	ND	0.08	0.100	0.202	ND	0.382	0.597	3.217
		Mean	ND	ND	0.027	0.099	0.180	ND	0.306	0.419	2.741
End	heavy soil	NW	ND	ND	0.041	ND	0.231	ND	0.272	0.434	3.943
		GW	ND	ND	0.195	ND	0.328	0.101	0.624	0.405	4.751
		ADW	ND	ND	0.039	ND	0.316	ND	0.355	0.734	5.142
		SW	ND	ND	0.038	ND	0.267	ND	0.305	0.847	4.318
		Mean	ND	ND	0.078	ND	0.286	0.025	0.389	0.605	4.539
	light soil	NW	ND	ND	0.000	ND	0.103	ND	0.103	0.265	2.869
		GW	ND	ND	0.000	ND	0.113	ND	0.113	0.399	3.260
		SW	ND	ND	0.022	ND	0.191	ND	0.213	0.496	4.374
		Mean	ND	ND	0.007	ND	0.136	ND	0.143	0.386	3.501

* NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water
** Total organochlorine pesticide residues. ND = Not detected

Table 6. Concentrations of pesticides in soil of wheat fields irrigated withwater from different sources (2000/2001 growing season)

Time	Soil type	sources* of Irrigation water	Pesticides concentrations (ppb)								
			B-HCH	*P,P*-DDT	*P,P*-DDE	endrin	chorothalonil	dicofol	Total OC**	Metribuzin	Total pesticides
Beginning	heavy soil	NW	ND	ND	0.077	0.139	0.211	ND	0.427	0.750	1.330
		GW	ND	ND	0.141	0.153	0.182	ND	0.476	0.612	1.350
		ADW	ND	ND	0.167	0.145	0.134	ND	0.446	0.710	1.378
		SW	ND	ND	0.09	0.129	0.193	ND	0.412	0.725	1.306
		Mean	ND	ND	0.119	0.142	0.180	ND	0.440	0.699	1.341
	light soil	NW	ND	ND	ND	0.093	0.146	ND	0.256	0.393	0.649
		GW	ND	ND	ND	0.125	0.131	ND	0.239	0.355	0.457
		SW	ND	ND	ND	0.138	0.133	ND	0.271	0.620	1.012
		Mean	ND	ND	ND	0.119	0.137	ND	0.255	0.456	0.706
End	heavy soil	NW	ND	ND	0.024	0.132	0.200	ND	0.356	0.717	3.899
		GW	ND	ND	0.195	0.091	0.202	ND	0.488	0.700	4.321
		ADW	ND	ND	0.042	0.134	0.243	ND	0.419	0.780	4.680
		SW	ND	ND	ND	0.131	0.250	ND	0.381	0.912	3.962
		Mean	ND	ND	0.065	0.122	0.224	ND	0.411	0.777	4.215
	light soil	NW	ND	ND	ND	0.076	0.123	ND	0.199	0.541	0.740
		GW	ND	ND	ND	0.095	0.121	ND	0.216	0.484	0.876
		SW	ND	ND	ND	0.117	0.119	ND	0.236	0.719	1.179
		Mean	ND	ND	ND	0.096	0.121	ND	0.217	0.581	0.932

* NW= Nile water, GW= Ground water, ADW= Agricultural drainage water and SW= sewage water
** Total organochlorine pesticide residues. ND = Not detected

In light soil, the highest contamination with total organochlorine pesticides was found in both seasons in samples irrigated with SW at the beginning or the end of the wheat season followed by GW and NW.

As in the maize fields, chlorothalonil was the major detected organochlorine pesticide in the heavy or light soil of wheat fields, followed by endrin and *p,p'*-DDE during the two seasons. Other organochlorine pesticide residues, *β*-HCH and dicofol, were detected in heavy soil irrigated with SW at the beginning and GW at the end of the first season with values of 0.050 ppb and 0.101ppb, respectively.

Generally, the detected organochlorine pesticides residues were higher in heavy soil than in light soil in the two seasons.

In spite of the fact that organochlorine pesticides have been banned since the mid-1970s, the present investigation revealed their presence in agricultural soil. This is in principal due to different factors i.e. their chemical stability, low solubility in water, and dynamic transfer in Nile water from upstream countries which leach out to the other irrigation water sources (GW, ADW and SW).

Although chlorothalonil residues fluctuated in different irrigation water sources, it was the major detected organochlorine product in maize or wheat soil. This is in fact due to its direct application to soils (as seed dressing). Chlorothalonil is also nonvolatile and stable under normal field conditions, (Farm Chemicals Handbook, 1995). On the other hand, the presence of endrin residue in soil, may be attributed to the presence of this product in different irrigation water sources (**Marzouk, 2003**), high stability reaching up to 12 years in soil compared to 112 days in water (**EPA, 1999**). The concentration of *p,p'*-DDT residues was less than *p,p'*-DDE in the soil which could be attributed to that DDT is transformed to DDE and DDD but DDE is more stable (**Zhang *et al* 2002**). This is in agreement with **Mowafy, (1995)**, who reported that DDT persisted over 20 years and its derivative DDE persisted even longer in soil. In spite of HCH analog residues present in different irrigation water sources, HCH_s residues were not detected in soil (except *β*-HCH at the beginning of wheat 1999/2000 growing season), which may be due to its high stability in water (> 100 years) compared to soil (> 2.7 years), (**EPA, 1999**). Furthermore, *β*-HCH is the major isomer of HCH_s and more resistant to biodegradation (**Zhang *et al* 2002**).

The data indicated that organochlorine pesticide contamination in heavy soil irrigated with GW at the end of the maize season and the beginning of the wheat seasons was higher than in soil irrigated with ADW > NW > SW. This could be attributed to the high organochlorine pesticide content in GW from August to November, (**Marzouk, 2003**). Soil irrigated with SW was less contaminated with organochlorine pesticide residues than ADW or NW. This could be explained on the basis of the high OM content of SW which gives rise to intense microbiological and biochemical activity in the rhizosphere and consequentially pesticide biodegradation (**Alloway, 1995**). Also heavy soil irrigated with GW showed the highest organochlorine pesticide contamination level at the end of the wheat beginning of the maize season, followed by soils irrigated with ADW > SW > NW. This may be due to the high con-

centration level of organochlorine pesticides in GW during these months, (March and April), higher than in ADW, SW or NW (**Marzouk, 2003**), which could be due to the increasing in soil temperature in summer as reported by **Kenneth, (1982)**.

Moreover, in light soil, although GW was the most contaminated with organochlorine pesticide, SW irrigated soil was highly contaminated with organochlorine pesticides at the beginning and the end of the wheat and the beginning of the maize season, followed by GW > NW. This may be attributed to the high OM content of SW which induced organochlorine pesticide adsorption on soil particles, or to the acidity of SW which tended to increase the persistence of organochlorine pesticide compounds (**McDougall, 1995**). At the end of the maize and the beginning of the wheat season (summer months), soil irrigated with SW showed the highest contamination level followed by NW and GW [that was positively related with OM content of irrigated soil (Table 1)]. In addition, total organochlorine pesticide contamination in heavy soils was higher than in light soil. **Kenneth, (1982)**, reported that most organochlorine pesticides persist for months or even years especially when applied to clay soils or to soils rich in organic matter. In addition the volatility of these compounds may limit their persistence in light soil.

The data in Tables 3 through 6, illustrate that total organochlorine pesticide levels were higher during the period from the end of maize and the beginning of wheat than the period from the beginning of maize and the end of wheat growing seasons in all irrigated heavy and light soil for the two studied seasons.

Other pesticide contamination

The herbicide metribuzin was detected in heavy and light soils in maize and wheat during the two seasons.

In maize fields metribuzin herbicide reached its peak in heavy soil with SW irrigation at the beginning of the two maize seasons. The lowest concentration of the herbicide was found in soils irrigated with GW. At the end of the maize season in both years, the highest concentration of metribuzin residue was found in soil irrigated with ADW. The level was the lowest when the soil was irrigated with SW. In wheat fields, irrigation with SW caused the highest levels of metribuzin, while when the soil was irrigated with GW the level was the lowest. In light soil, metribuzin residue decreased according to the following order, SW > NW > GW in both maize and wheat fields in the two years.

Finally, although fenpropathrin was detected in the different irrigation water sources during the summer and winter months, there was no detectable amount in heavy or light soil in the two growing seasons. This could be attributed to the alkaline pH of the soil, as fenpropathrin is not stable in alkaline conditions, (**Farm Chemical Handbook, 1995**).

In addition, results revealed that metribuzin residue in soil planted with wheat was higher than soil with maize which could be attributed to the wide use of metribuzin to control grass and broadleaf weeds in wheat field. In addition, the leachability of metribuzin in wheat fields (winter season) was lower than in maize fields (summer season) (**Tyler, 1981**). However, data of the total detected pesticides in soil indicated that pesticide accumulation was related to soil physical

and chemical properties, organic matter content and the contamination level of irrigation water as discussed before.

The data for total pesticides accumulated in heavy soil showed that during the end of the two summer seasons (i.e. the end of maize season and the beginning of wheat season) the accumulation of all pesticides increased to a peak in soil irrigated with ADW. The lowest accumulation during summer season was found in soil irrigated with SW.

On the other hand, in the winter season (i.e. beginning of maize and the end of wheat season), the highest detected total amount pesticides was found in heavy soil irrigated with GW in maize and wheat fields. In contrast, the lowest levels were observed in soils irrigated with NW. This is due to the higher pesticide content of irrigation water in ADW (21.28 and 2.24 ppb) and GW (18.61 and 1.96 ppb) than in SW (13.96 and 1.55 ppb) or NW (16.71 and 0.58 ppb) during summer and winter seasons, respectively. The high content of OM in soils irrigated with SW and NW (3.27 and 2.88 %) compared to ADW or GW (2.03 and 1.96 %) induce microbial activity (**Alloway, 1995**) and pesticide degradation (**Saad *et al* 2000 and Huang *et al* 2001**). In general, pesticide accumulation in heavy soil was higher than light soil in both maize or wheat fields because of the greater OM%, clay content and surface area of heavy soil than of light soil (Tables 1 and 2) which enhances the adsorption and persistence of pesticide (**Kenneth, 1982**). In addition, accumulation of pesticide in summer season was high compared with winter season. This could be attributed to soil temperature (**Kenneth, 1982**), pesticide contamination of irrigation water (higher in summer than winter season) (**Marzouk, 2003**), in addition to the effect of the pH values which tend to increase the level of most pesticide, especially organochlorine (**McDougall *et al* 1995**).

The accumulation of detected pesticides in light soil differed also according to irrigation water sources and soil OM content as follows: NW > GW > SW in summer, and SW > GW > NW in winter at the two seasons of maize and wheat. This order varied from summer to winter according to the total pesticide content of irrigation water and soil OM content.

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مستوى الاتساخ بالمبيدات العضوية فى أنواع التربة المختلفة تبعاً لمصادر الرى المختلفة

[٤٤]

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أجريت هذه التجربة خلال موسم ١٩٩٩-٢٠٠٠، ٢٠٠٠-٢٠٠١ لتقييم مدى تأثير مصدر مياه الرى على مستوى الاتساخ بالمبيدات العضوية فى الأراضى المروية المختلفة. أظهرت النتائج أن الرى بمياه الآبار، الصرف الزراعى احدث أعلى مستوى للاتساخ بمتبقيات المبيدات الكلورونية بأنواع التربة المختلفة خلال موسمى الدراسة، بينما الرى بمياه الصرف الصحى المعالج أظهر أقل مستوى للاتساخ مقارنة بمصادر الرى الأخرى. كما وجدت متبقيات كل من مبيد الكابتان الفطرى، ومبيد الحشائش الميتروبيزين عند نهاية زراعة الفجل وبداية زراعة القمح. لوحظ أعلى تركيز للكابتان بالأصص التى تم ريها بمياه النيل، بينما أدى الرى بمياه الصرف الزراعى الى أعلى مستوى لاتساخ التربة بمبيد الميتروبيزين. كما لم يلاحظ أى آثار من متبقيات مبيد الفينبروباثرين الذى تم استكشافة بمياة الرى. بصفة عامة، من خلال النتائج المتحصل عليها يمكن الإشارة الى أن الرى بمياه الصرف الزراعى، مياه الآبار سببت أعلى متسويات الاتساخ بمتبقيات المبيدات.

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