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IMPACT OF WATER QUALITIY ON BARLEY VARIETIES, SOIL PROPERTIES AND THEIR CONTENTS OF HEAVY METALS

Atwa. A. A. E.*; N.I. Talha; E.S. EL-Gizawy and kh. A. Amer**

***Soils, Water and Environment Research Institute Agric. Res.center,Giza,Egypt.**

****Barley Res. Dept., Field Crops Res. Institute, Agric. Res. Center, Giza, Egypt.**

ABSTRACT

Two Lyzimeter experiments were conducted at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, for two seasons, 2010/2011 and 2011/2012 Lyzimeters (100 x 70 x 90 cm) were filled with clayey soil and irrigated with three water treatments since twenty three years ago.

The present study aimed to investigate the effect of irrigation water quality for long-term on productivity of four barely varieties (Giza123, 124, 126 and Giza129). Three irrigation water qualities; Nile water (W_1), polluted drainage water (W_3) and mixed water; W_2 (50% W_1 + 50% W_3) used for irrigation to study its effects on barely contents from four heavy metals Ni, Cd, Pb and Cu and some soil characteristics. A split–plot design with four replicates was used where, water treatments and varieties were allocated to main and sub-plots, respectively.

The obtained results showed that:

- Using poor water quality for irrigation increased ECe, SAR, soluble cations and anions in soil paste extract and DTPA extractable heavy metals in soils (Cu, Ni, Cd and Pb) than that of mixed or good water quality.
- Highly significant differences of yield and yield components among barely varities were found due to irrigation water treatments and its contents of heavy metals.
- Straw heavy metals content were higher than that of grains.
- The results showed that Giza 123 was more tolerant variety to drainage and mixed water and its lower or higher contents of Ni, Pb and Cu.
- No significant differences were found among Cd content for all studied barley varieties.
- The heavy metals content of barley varieties from can be arranged as follow:

With Pb: $v_2 < v_3 < v_1 < v_4$

With Cu: $v_1 < v_2 < v_3 < v_4$

With Ni : $v_2 < v_1 < v_3 < v_4$

Keywords: Water quality, productivity, heavy metals, barley varieties, soil characteristics.

INTRODUCTION

Pollution is defined as any change in physical, chemical or biological conditions of the environment which may harmfully affect the quality of human life including effects upon animals and plants.

The untreated industrial drainage waters contain little or more amount of heavy metals, which may cause enhancement of their level in the Nile and/or agricultural drainage water when they mixed.

A recent study showed a remarkable increase in levels of heavy metals in some Egyptian soils (especially soils lies in the extreme North Delta) in addition appreciable amount of these metals are found in vegetation, water bodies and aquatic organisms in western and middle areas of the Nile Delta (Zein *et al*.1998, El-Sanafawy, 2002).

Use of low quality water in irrigation could be an important consideration when the disposal is being planned in arid and semi arid regions. Using drainage water in irrigation caused high increase in EC and SAR of saturated soil paste extract (Omar *et al*., 2001). Meanwhile, using drainage water in irrigation significantly increase the total and DTPA extractable heavy metals compared with Nile water (Zein *et al*., 2002).

Once the ions have been absorbed through the roots or straw and have been transported to the xylem vessels there is the possibility of movement throughout the whole plants. The rate and extent of movement within plants depend on the metal concerned, the plant organ and the age of plant (Chaney and Giordano, 1977). Mn, Zn, Cd, B, Mo and Cu were classified as intermediate and Cr, Pb and Hg were translocated to least extent The heavy metal pollution of soils is a current environmental problem.A number of factors including climate, atmospheric deposition, the nature of soil on which the plant is grown and the maturity degree of plant at time of harvesting influence the concentration of heavy metals on and within plants (voutsa *et al*. 1996 and Lake *et al*.1984). Heavy metal contents of food plants can be affected by the anthropogenic factors such as the application of fertilizers, sewage sludge or irrigation with waste waters (Devkota and Schmidt, 2000 and frost and ketchum 2000). Heavy metal contamination of agricultural soils can pose long – term environmental problems and are not without health implications (Ferguson 1990). In conclusion, increasing industrialization and urbanization have not only degradation but also caused the contamination of our precious food resources. During recent years, studies on toxic effects of heavy metals especially Cd, on crop plants are being received considerable attention (Boussamo *et al*, 1999). Translocation of Cd from root to shoot has been studied in several plant species, showing that it is likely to occur via the xylem and to be driven by leaf transpiration (Hart *et al*.1998). The studies on the determination of metal concentration in plant species are not important only for their translocation to food chain, but also examination of the soil remediation by phytoextraction of toxic metals. Throughout all countries, the extent of contamination of irrigation water with Cd Pb and Ni were not being able to be determined due to its increasing usage as well as production.

The objectives of the present work are to assess the effect of irrigation water quality for long-term on productivity, heavy metals contents of barley varieties and some soil characteristics.

MATERIALS AND METHODS

Two lyzimeter experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, for two seasons 2010/2011 and

2011/2012 to study the effect of irrigation water quality for long –term on the productivity of four barley varieties, (Giza123 (v1),Giza124(.v2), Giza126(v3) and Giza129(v4)) and the content of their, , grains and straw of heavy metals; Pb, Cd, Ni and Cu.

The study was conducted in concrete Lyzimeters (100 x 70 x 90 cm) filled with clayey soil since 1987.

The four barley varieties were planted on 11 November in two seasons at 60kg/fed.Three water treatments were used for irrigation; Nile water W_1 polluted drainage water W_3 and mixed water W_2; (50% W_1 + 50% W_3). Some characteristics of the used irrigation water are presented in Table 1.

The treatments were incorporated in a split –plot design with four replicates. Irrigation treatments and varieties were allocated the main and sub plots, respectively. Phosphorus was applied as super phosphate (15.5% P_2O_5) in one dose before sowing at rate of 15.5Kg P_2O_5 / Fed. Nitrogen was applied as urea (46.5 N%) at rate of 60 Kg N/fed. in two dose and potassium fertilizer was added in the form of potassium sulphate (48% K_2O) at rate of 24 kg K_2O/ fed. after one month of planting. All other agronomic practices were followed as recommended. Plants were harvested in 15 May, and straw and grains yields were weighted in Kg/fed. Representative seed and straw, were collected for analysis, weighted technique was used for samples digestion as described by Chapman and Pratt (1961). Soil samples were taken from each lyzimeter before planting and after harvesting, for chemical analysis; total soluble salts, soluble cations & anions in soil paste extract were determined according to Richards (1969). Soil samples were DTPA extracted and Pb, Cd, Ni and Cu were determined using an Atomic Absorption Spectrophotometer. Soil chemical analysis DTPA exctect before sowing and after harvesting (according to Lindsay and Norvell, 1978) are presented in Table (2). Statistical analysis was carried out using Irristat- Software, Computer Program.

Table (1): Chemical characteristics of Nile and drainage water used for irrigation during the two seasons.

Water qualities	EC, dS/m at 25°c	pH	Cation, meq/L				Anion, meq/L				SAR	Water class
			Ca^{++}	Mg^{+2}	Na^+	K^+	$CO_3^=$	HCO_3^-	Cl^-	$So_4^=$		
Nile water	0.52	7.8	1.8	1.50	1.6	0.3	-	3.1	1.01	1.09	1.25	C_2-S_1
Drainage water	1.70	8.20	4.90	.2.6	9.02	.48	-	3.5	8.3	5.20	4.65	C_3-S_2

Irrigation water	Heavy metal content (mg/L)			
	Cu	Ni	Cd	Pb
Nile water	0.019	.0.008	0.007	0.08
Drainage water	0.290	0.307	0.039	0.800
Critical limits according FAO (1989)	0.200	0.200	0.010	5.000

RESULTS AND DISCUSSION

Nile and drainage waters evaluation:

Chemical characteristics of Nile and drainage water used for irrigation of barley varieties are shown in Table (1) According to Richard's classification, Nile water(C_2-S_1)medium salinity low sodicity (Richards, 1969). While, data of drainage water revealed that the water was in the class of (C_{3-} S_2) high salinity and medium sodicity which can not be used for soils with restricted drainage and crop with good salt tolerance should be selected. It can be concluded that Nile water is of good quality and drainage water of poor quality for irrigation. The mixed water will be intermediate between them in relation to its chemical composition. Also data in Table (1) Showed that the studied heavy metals Cd, Pb, Ni and Cu content of drainage water were greater than of Nile water and higher than the critical limits, according to FAO (1989), i.e., 0.01, 5.00, 0.2 and 0.2 for Cd, Pb, Ni and Cu mg/L, respectively. The high heavy metal contents in drainage water could be attributed to the pollution sources of industrial and municipal wastes discharged to the drainage system. These results are in agreement with those obtained by El-Mowelhi *et al.*, (1995).

Effect of the studied irrigation water qualities on some chemical properties of clay soils:

A- Soil salinity, SAR and soluble ions:

Change in electrical conductivity of soil paste extract (dS/m) soluble cations ; Ca^{+2} , Mg $^{+2}$, Na^+ and K^+ (meq/L) and soluble anions; HCo_3^-, Cl^- and SO_4^{--} ; (meq/L) are listed in Table (2). Comparing the mean ECe values of the studied soils, before planting and after harvesting. The data show that EC values increased from 2.95, 5.12 and 6.10 dS/m to 3.05, 5.35 and 6.56 dS/m as affected by W_1, W_2 and W_3 water quality treatments, respectively. SAR mean values increased from 4.46 and 6.77 to 4.79 and 6.85 as affected by W_2 and W_3 water treatment. The obtained data showed also, that utilization of drainage water for irrigation purposes tend to increase soluble cations and anions Na^+, Mg^{++} , So_4^{--} and Cl^- than before planting. The data also showed that all soluble anions, Cl^- and So_4^{--}mean values, were higher in soil irrigated with poor water quality in harmony with those obtained by Zein *et al*. (2012).

B- DTPA- extracted heavy metals from studied soils:

Data in Table (3) show that all values of DTPA extractable heavy metals of soils can be discendingly arranged according to the effect of water treatments as follow : W_3 > W_2> W_1 before barely planting and after harvesting.

It seems that soil content of DTPA-extractable studied heavy metals has followed the sequence Cu > Pb > Ni > Cd. This trend was different from that found under using drainage water and mixed water Pb > Cu > Ni > Cd. This may be due to that some of available Pb changed to these findings. The obtained results are in agreement with those of Abou El-Roos *et al*. (1991) who found that the behaviour of Cu and Pb differ from that of Cd, CO and Ni in soils irrigated with sewage effluent, they added that in Cd, Cu and Ni metals, the percentages held in primary minerals fraction were increased with time on the expense of the percentage of other fractions, especially that organically complexed. Although the studied soils were still beyond the critical levels, it could be reached this point upon the continuous using of polluted drainage water.

Table (2): Soil chemical analysis before planting and after harvesting under three irrigation water quality.

Water quality	Cation, meq/L				Anion, meq/L				ECe dS/m	pH 1:2.	SAR	SP %	N ppm	P ppm	K ppm
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCo_3-	Cl^-	So_4--							
Before Planting															
W_1	11.11	8.66	9.40	0.32	-	4.38	11.36	13.75	2.95	8.10	2.99	75.90	22	12	396
W_2	16.25	16.8	18.14	0.32	-	5.16	16.10	31.64	5.15	8.18	4.46	76.80	25	15	422
W_3	20.82	13.65	26.0	0.44	-	4.44	16.68	39.79	6.10	8.22	6.77	78.10	29	17	445
After harvesting															
W_1	11.80	8.40	8.47	0.3	-	4.70	10.2	13.6	3.05	8.05	2.61	76.40	25	13	420
W_2	16.70	16.90	19.62	0.31	-	5.60	16.2	31.73	5.35	818	4.79	77.00	27	16	490
W_3	16.5	19.60	29.1	0..41	-	4.60	16.8	44.21	6.56	8.22	6.85	77.30	31	18	510

Table (3): DTPA extractable heavy metal concentrations (mg/kg) before planting (2010) and after harvesting (2012) barley as affected by water quality.

Irrigation water quality	Heavy metal content (mg/kg soil)			
	Cd	Ni	Pb	Cu
	Before planting (2010)			
W_1	0.100	1.82	4.01	6.20
W_2	0.170	2.02	9.10	6.80
W_3	0.180	2.72	11.10	7.80
	After harvesting (2012)			
W_1	0.110	1.85	4.90	6.90
W_2	0.172	2.20	9.20	6.90
W_3	0.185	2.50	11.90	8.45

Effect of water Quality on yield and yield components:

Data in Table (4) show that the seed yield ardb/fed of barley were significantly affected with barley varieties. The higher mean seed yields (18.66, 18.16), (17.52, 17.24) and (, 17.80, 17.14) ardb/fed were obtained with W_1 , W_2 and W_3 in the two seasons, respectively. In same Table data show that the straw yield kg/fed of barely were significantly affected by barley varieties, the higher mean of straw yield of Giza 126 of two seasons under three of water qualities. In same Table data show that the weight of spike (gm)of barely were significantly affected by barley varieties, the higher mean of weight of spike of Giza 124 of two seasons under the Nile water but Giza 126 under mixed and drainage water of tow seasons.

Table (4): Effect of irrigation water treatments on yield and yield components of the tested barley varieties in two seasons.

Varieties	Irrigation water treatments					
	First season			Second season		
	W_1	W_2	W_3	W_1	W_2	W_3
Seed yield (ardb/fed)						
Giza123	17.03 ab	16.63 b	19.60 b	16.33 b	16.12 b	19.11 b
Giza124	18.47 a	15.83 b	16.22 c	18.51 a	15.34 b	15.77 c
Giza126	16.41 b	22.60 a	22.47 a	15.55 b	21.74 a	21.41 a
Giza129	16.70 b	15.43 b	12.92 d	16.25 b	15.75 b	12.28 d
Means	18.66	17.92	17.80	18.16	17.24	17.14
Straw (kg/fed)						
Giza123	3465b	3503.3b	3833.3b	3560.3b	3660.4b	4063.2b
Giza124	3553.3b	3390c	2950d	3637.8b	3540.4c	3127d
Giza126	3803.3a	3903.3a	4233a	3924a	4.084.4a	4487a
Giza129	3078c	3080d	3142c	3263c	3211.8d	3330c
Means	3987.25	3614.15	3539.58	3483.58	3824.25	3751.75
Weight of spike (gm)						
Giza123	1.012b	1.077b	1.237b	1.011b	1.070b	1.241b
Giza124	1.227a	1.050b	1.030c	1.220a	1.050b	1.04c
Giza126	1.011c	1.453a	2.160a	1010c	1.323a	2.150a
Giza129	1.013b	1.060b	1.230b	1.013b	1.070b	1.220b
Means	1.066	1.160	1.410	1.064	1.128	1.413

Heavy metals contents:

Data in Table (5) show that the studied heavy metals Cd, Pb, Ni and Cu content of barley plant under drainage water were greatest than that of Nile water and mixed water. This could be attributed to the pollution sources of industrial (oil and soap factory) and municipal wastes discharged to the drainage system. These results are in agreement with those obtained by Zein *et al*. (2002) and El-Mowelhi *et al*. (1995).

Table, 5 illustrate that the influence of water quality on the studied heavy metals means concentration in straw and grains. On barley varieties especially with irrigated by drainage water (W_3) were as the following order:

In both grains and straw were Cu> Pb > Ni > Cd.

Table (5) reveals also that the highly significant effects of water quality (W_1, W_2 and W_3) especially with Ni and Pb.

The distribution of Cu within plants is highly variable within roots Cu is associated mainly with cell wall and its largely mobile.

Dunman *et al*. (1991) found that the concentration of Ni in plants, generally, reflects the concentration of the element in the soil, although the relationship is clearly more directly related to the concentration of soluble ions of Ni and rate replenishment of this mobile pool. As Ni is easily mobile in plant, berries and seeds are reported to contain elevated Ni concentration (Kabata-Pendias, 2000).

Cadmium values (Table, 5) of seeds indicated that Cd has the lowest values in all studied heavy metals. This conclusion are in agreement with Alloway (1995) who found that the uptake of Cd decreased when pH was increased, barely showed a similar response.

Page *et al.* (1981) found that relative excess of Cu, Ni and Mn can reduce uptake of Cd by plants. The Cd in plants is relatively very mobilize, although the translocation of Cd through the plant tissues may be restricted because Cd is easily held mainly in exchange sites of active compounds located in the cell walls (Cunningham *et al.*, 1975).

Table (5): Effect of water treatments on heavy metals content (mg/kg) of grains and straw barley varieties (Mean of two seasons) and translocation coefficient (TC%)

Varieties	Heavy metals content (mg/kg dry Wight)											
	Cu			Ni			Cd			pb		
	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3	W_1	W_2	W_3
	Grains											
V_1	17 a	18 a	20 b	0.14bc	0.41 c	0.61 c	0.01b	0.03ab	0.05ab	6.7 c	8.0 b	7.9b
V_2	12 b	19 a	24 a	0.12 c	0.66 a	0.78 b	0.03a	0.04a	0.06a	8.2 a	8.5 a	9.0a
V_3	9 c	11 c	21 b	0.29 a	0.46 b	0.93 a	0.02ab	0.03ab	0.05ab	7.4 b	7.8 b	7.6b
V_4	6 d	14 b	18 c	0.15 b	0.25 d	0.95 a	0.01b	0.02b	0.04b	6.2 d	6.3 c	6.4c
	Straw											
V_1	10 c	52 c	55 c	0.21 c	1.63 a	1.70 a	0.02 c	0.04b	0.07a	8.2 c	8.7 b	8.1 c
V_2	40 a	75 a	82 b	0.93 b	1.35 c	1.40 b	0.05 a	0.06a	0.08a	9.1 a	9.4 a	9.7 a
V_3	10 c	62b	97 a	1.58 a	1.60 b	1.70 a	0.03 bc	0.05ab	0.07a	8.5 b	8.6 b	8.6 b
V_4	15 b	42 d	52d	0.08 d	0.35 d	1.20 c	0.04ab	0.04b	0.05b	7.1 d	7.1 c	7.3 d
	Translocation from straw to grains (%)											
V_1	58.82b	34.61a	36.36a	66.66a	25.15d	35.88d	50.00c	75.00a	71.42c	81.20d	91.95a	97.53a
V_2	20.00d	25.33b	29.26c	12.90d	84.88a	55.71b	60.00b	66.66b	75.00b	90.10a	90.42c	92.78b
V_3	90.00a	17.74c	21.64d	18.35c	28.75c	54.70c	66.66a	66.66b	71.42c	87.05c	90.69b	88.37c
V_4	40.00c	33.33a	34.61b	62.50b	71.42b	79.16a	25.00d	50.00c	80.00a	87.32b	88.73d	87.67d

Data in Table (5) indicate that the barley varieties generally had the lowest content of studied heavy metals under all water treatments. No significant in Cd for all treatments of water quality and barley varieties. V2 variety had the lowest content of Pb, Ni and Cu under all water treatments. The order of barley varieties to concentration of heavy metals decreased as follow:

With Cd : $v_1 < v_2 < v_3 < v_4$
With Pb : $v_4 < v_1 < v_3 < v_2$
With Cu : $v_1 < v_2 < v_3 < v_4$
With Ni : $v_2 < v_1 < v_3 < v_4$

These results very important for classified the common barley varieties to various heavy metals polluted soils. From these sequences we can favor one variety in every soil polluted with one element.

These results are in partial agreement with those obtained by Zein *et al*. (1996) in their study on soybean cultivars. These results may be due to the differences in genetic constitution of the studied genotypes and / or the dilution effect phenomenon. This conclusion is in partial agreement with that of Shalaby *et al*. (1996) who concluded that increasing of heavy metals concentration in plants may attributed either to the higher amounts of these heavy metals added into the used soil through the applied wastes.

Translocation coefficient from straw to grains:

Once the ions have been absorbed through the grains and have been transferred to the xylem vessels, there is possibility of movement throughout the whole plant, the rate and extent of movement within plants was studied by, Alloway (1995). The data of heavy metal concentration in seeds, straw, of studied barely varieties and coefficient of their translocation (TC%) from straw to seed are presented in Table 5 and seed TC was calculated as follows.

$$\text{Grains TC \%} = \frac{\textbf{Content of heavy metal in grains (mg/kg)}}{\textbf{Content of the same heavy metal in straw (mg/kg)}} \times 100$$

Data in Table (5) illustrate that the studied heavy metals translocation from sraw to grains can be arranged according to mean values of translocation coefficient in the following decreasing order:

Cd > Cu > Ni > Pb

It shows that Cd was the largest values of TC % while Pb was the least in translocation from sraw to grains in all types of water treatments (W_1, W_2 and W_3). The results are in good agreement with those of Zein *et al*. (2002) and Chaney and Giordano (1977) who classified Pb as one of the least translocated elements with plant. They added that, under conditions of optimal growth, pb precipitates on root cell wall in the insoluble amorphous form. Zhen – Guo Shen *et al*., (2009). found that application of EDTA (as an organic conditioner) to the soil significantly increased the concentrations of Pb and enhancing Pb accumulation in the plants while the Cu, Cd and Ni concentration and translocation coefficient indicate that Ni values increased due to drainage water treatment than other treatment due to its higher content of polluted drainage water from oil and soap factory (used Ni as a catalyst in one processes of manufacturing). The obtained results are in good agreement with that of (Zein *et al*., 2012) and Chancy and Giordano (1977) for heavy metal translocation

Conclusion

Considering the previous discussions and conclusions, it seems that there is an obvious need for more research work to be carried out on the risk assessment of heavy metals contaminated soils. As mentioned by Eissa and El-Kassas (1999) the danger of distribution wastes by such factories containing high concentration of heavy metals affects the survival in the suffering areas. The safest policy would appear to minimize inputs of heavy metals to soil wherever to save our life and economy and restrict heavy metals bioavailability in the soil – plant animal pathway. Abo El-Naga *et al*. (1999) and Zien *et al*.(1998 and 2009) recommended that attention must be earnestly given to protect the environment and commitments and the latest law issued 1994 in Egypt, must be obligatory under taken for these factories to prevent them from polluting agricultural soil by wastes. They added that apart from the roles played by pollution control and soil chemistry, plant breading can make a vital contribution through the selection and utilization of crop genotypes which accumulate the least heavy metals

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تأثيرنوعية مياه الرى على أصناف الشعيرو خواص التربة ومحتواهما من العناصر الثقيلة

عـادل احمـدابراهيم عطـوه* وناصـر ابـراهيم طلحـه* وعيـد سـليمان الجيـزاوى* و خيرى عبدالعزيز عامر**

***معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – جيزة – مصر**

****قسم بحوث الشعير – معهد المحاصيل الحقلية- مركز البحوث الزراعية – جيزة – مصر**

أقيمت تجربتين بمحطة البحوث الزراعية بسخا – كفر الشيخ – مصر لموسمى٢٠١٠ /٢٠١١ و٢٠١٢/٢٠١١ تهدف إلى دراسة تأثير نوعية مياه الرى للمدى البعيد على إنتاجية اربعة أصناف من الشعير هى جيزة ١٢٣ وجيزة١٢٤ وجيزة١٢٦وجيزة ١٢٩وخواص التربةالكيمائية وكذلك على محتوى التربة واجزاء النبات من العناصر الثقيلة وهى النحاس الرصاص والكادميوم، النيكل . وقد أجريت الدراسة فى أحواض أسمنتية (١٠٠ × ٧٠ × ٩٠ سم) وضعت بها تربة طينية وتروى الأحواض بثلاثة نوعيات من المياه منذ عام ١٩٨٧ وهذه النوعيات هى مياه النيل (مياه ذات نوعية جيده ًًًW1ًً) و مياه صرف (ذات نوعية رديئة W_3) ومياه مخلوطة (٥٠ % W_1 + ٥٠% W_3) W_2 وزعت المعاملات فى قطع منشقة فى أربع مكررات حيث وضع الرى فى القطع الرئيسية والأصناف فى القطع الشقية.

وأوضحت النتائج مايلى :

- زاد إستخدام مياه الصرف فى الرى من قيم التوصيل الكهربى SAR ، ECe والكاتيونات والأنيونات الذائبة فى مستخلص عجينة التربة المشبعة وكذلك محتوى التربة المستخلص ب DTPA من العناصر الثقيلة عن تلك المستخدم فيها المياه المخلوطة أو مياه النيل فى الرى .
- وجد أن هناك تأثير عالى المعنوية لنوعية المياه المستخدمة فى الرى على المحصول ومكونات المحصول وكذلك محتوى بعض أصناف الشعير من العناصر الثقيلة المدروسة.
- كان محتوى أجزاء النبات من العناصر الثقيلة تبع الرتبة القش> الحبوب.
- أوضحت النتائج أن صنف جيزة ١٢٣ كان أكثر الأصناف تحملا لإستخدام المياه المخلوطة، ومياه الصرف وكان الاقل فى محتواه من الرصاص ، النيكل،النحاس ولايوجد هناك فروق معنوية مع عنصر الكادميوم لكل الأصناف تحت الدراسة .
- أظهرت النتائج أن قلة محتوى الأصناف من العناصر الثقيلة أخذ الترتيب التالى :

مع الرصاص : جـ١٢٩> جـ١٢٣> جـ١٢٦> جـ١٢٤

ومع النيكل : جـ١٢٩> جـ١٢٣> جـ١٢٤>جـ ١٢٦

ومع النحاس : جـ١٢٩>جـ١٢٦>جـ١٢٤>حـ١٢٣

- أوضحت النتائج أن الرى بمياه النيل أعطت أعلى إنتاجية فى أصناف الشعير ومكونات المحصول وكان لتاثيرالتركيب الوراثى (الصنف) معنويا على جميع الصفات التى تم دراستها

خلال موسمى الزراعية وتفوق جيزة ١٢٦على باقى الاصناف فى معظم الصفات التى تم دراستها.

- كان تاثير نوعية مياه الرى معنويا على الصفات التى تم دراستها فقد أوضحت النتائج أن معاملات الرى بمياه النيل سجلت أفضل النتائج يليها المياه المخلوطة ثم مياه الصرف التى اعطت أقل القيم للصفات المدروسة .
- كان تاثير التفاعل بين التركيب الوراثى ونوعية مياه الرى معنويا على الصفات التى تم دراستها وبدراسة تاثير نوعيات المياه على كل صنف أوضحت النتائج أن الاصناف التى تم دراستها تاثر كل منها معنويا بنوعية مياه الرى فى صفات المحصول ومكوناته حيث كانت أفضل النتائج عند الرى بمياه النيل وأقلها عندالرى بالمياه المخلوطة اومياه الصرف.
- سجلت كل الأصناف التى تم دراستها درجة مقاومة لملوحة مياه الرى المخلوطة فى المحصول ومكوناته وعلية يمكن التوصية بزراعة أى منها بالمناطق التى تستخدم المياه المخلوطة فى الرى. أتضح أن العناصر الثقيلة المدروسة وهى النيكل والرصاص والكادميوم والنحاس تتراكم فى نبات الشعير بكميات كبيرة وهذا يجعلة أن يكون دليل مفيد للدلالة على مدى جاهزية العناصر فى الأراضى الملوثة بالعناصر الثقيلة ويمكن أستخدامة فى استخلاص هذه العناصرمن الأراضى الملوثة بها .

قام بتحكيم البحث

أ.د / السيد محمود الحديدى — **كلية الزراعة – جامعة المنصورة**

أ.د / فاروق ابراهيم زين — **مركز البحوث الزراعية**