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UPTAKE OF NUTRIENTS AND HEAVY METALS BY BARLEY PLANT GROWN ON SANDY AND CALCAREOUS SOILS AS AFFECTED BY IRRIGATION WATER SALINITY AND SEWAGE SLUDGE ADDITION

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ABSTRACT: A pot experiment was conducted to study the effect of irrigation water salinity and sewage sludge application on the dry matter yield, and uptake of macronutrients (NPK), micronutrients (Fe, Mn, Zn, Cu) and heavy metals (Ni, Co, Pb, Cd) by barley plants grown on sandy and calcareous soils.

Increasing salinity level of irrigation water significantly decreased the dry matter content, macro and micronutrients uptake for both sandy or calcareous soils. However, the uptake of heavy metals in plants gave an opposite trend, i.e., it was increased by increasing salinity of irrigation water except for Cd which decreased with increasing the salinity level of irrigation water. Addition of sewage sludge increased the dry matter content, NPK uptake, micronutrient (Fe, Mn, Zn, Cu) uptake. This was found true under all salinity level of irrigation water. Heavy metal uptake by plant gave a similar trend to that of macro and micronutrients.

INTRODUCTION

Under North Sinai conditions, as any arid and semi arid regions, soil content of organic matter is generally low. Abdel-Ghaffar (1982) stated that the common range of organic matter in calcareous and sandy soils is usually less than 0.5%. Application of municipal refuse to soils under such conditions is of a special importance to increase their organic matter content because of the shortage in traditional farmyard manure.

Both pot and field experiments proved the efficiency of sewage sludge in increasing the yield crops (El-Shebiny et al., 1995 ; Mehana and Matloub, 1997 ; El-Fayoumy et al., 2000). Sopper (1979) reported that the major factor limiting the long range use of sewage sludge has proved to be the potential hazard due to the presence of heavy metals such as Zn, Cu, Ni and Cd. On the other hand, saline water is widely used in Delta Wadi El-Arish area as the main source for irrigation.

The influence of salinity on the uptake of micronutrients was investigated by Abou-Ellil (1992) and Saleh (1994). They found that the uptake of Fe, Mn and Zn by maize was decreased by increasing salinity level. Helal et al., (1996) found that irrigation water salinity depressed the uptake of heavy metals by plant.

Abd-Alla et al. (1993) found that saline water caused an increase in the extractable Co and Pb in alluvial and calcareous soils. On the other hand, they found that increasing Ca in saline water caused a decrease in extractable Cd in soil.

Crops grown on calcareous soil were found to accumulate significantly less Cd than those grown on more acidic soils. Also, the high Ca content of calcareous soil may reduce Cd absorption. Generally plants grown on clay soils accumulate higher amounts of all metals than those grown on sandy soils.

The present work aimed to study the effect of irrigation water salinity level under application of different rates of sewage sludge on the uptake of some nutrients and heavy metals by barley plant under sandy and calcareous soil conditions.

MATERIALS AND METHODS

The soils used in this investigation were sandy and calcareous soils taken from Delta Wadi El-Arish area. The sewage sludge used was obtained from El-Arish Wast Water Treatment Station.

The main characteristics of the investigated soils and sewage sludge are presented in Tables (1, 2). The soil and sludge materials were air-dried, ground and passed through a 2 mm sieve. Thereafter, the soil samples were uniformly packed in plastic pots of 30 cm height and 25 cm diameter at a rate of 10 kg pot^{-1}.

The experimental design included 20 treatments which were the combinations of 5 irrigation water salinity levels viz, control (tap water, 480 mg l^{-1}), 2000, 4000, 6000 and 8000 mg l^{-1}, and four levels of dried sewage sludge viz, 0, 10, 20 and 30 g kg^{-1} of the air-dried soil. Saline irrigation water samples were prepared by diluting of sea water to reach the required concentrations. Sewage sludge was throughly mixed with the top 15 cm of the soil in each pot before cultivation. The different treatments were arranged in a split plot design with 4 replicates. Superphosphate (15.5% P_2O_5) and potassium sulfate (48% K_2O) at the rates of 30 Kg P_2O_5 and 50 Kg K_2O fed^{-1} were added as basic treatments to all pots to a depth of 15 cm. Five barley seeds were sown on each pot. Ammonium sulfate at a rate of 30 Kg N fed^{-1} was applied after 40 days from sowing. The soil moisture content in the pots was maintained at field capacity. At heading stage (12 weeks after sowing), the plants were

Table (1): Some chemical and physical properties of the soils used

Soil variable	*Sandy soil*	*Calcareous soil*
EC* (dS m^{-1})	0.90	2.80
pH (1 : 2.5 soil : water)	7.70	7.90
Organic C (g kg^{-1})	0.072	0.101
Total nitrogen (g kg^{-1})	0.007	0.009
Total carbonate (g kg^{-1})	2.9	2.9
CEC (c mol kg^{-1})	6.90	16.70
Na HCO3-soluble P (mg kg^{-1})	0.68	2.73
DTPA-extractable elements (mg kg^{-1})		
Fe	2.51	2.63
Mn	1.52	1.62
Zn	0.41	0.42
Cu	0.32	0.36
Ni	0.20	0.23
Co	0.11	0.14
Pb	0.41	0.46
Cd	0.12	0.10
Paricale size distribution		
Coarse sand %	91.50	65.92
Fine sand %	4.82	19.62
Silt %	2.21	12.80
Clay %	1.47	1.66
Texture	Sand	Loamy sand

* In soil saturation extract

Table (2): Main chemical characteristics of the sewage sludge used

Variable	*Value*
EC* (dSm^{-1})	2.9
pH*	7.1
Organic C ($g\ kg^{-1}$)	388
Total nitrogen ($g\ kg^{-1}$)	23.7
C/N ratio	16.4
DTPA-extractable elements ($mg\ kg^{-1}$)	
Fe	69.5
Mn	27
Zn	16
Cu	0.25
Ni	3.02
Co	1.25
Pb	5.2
Cd	0.11

* In sewage sludge water suspension (1 : 10)

harvested, washed with water, and dried at 70°C, and the plant dry weights were recorded, The dried shoots were ground and analyzed for N, P and K according to Page et al., (1982). Fe, Mn, Zn, Cu, Pb, Co, Ni and Cd were determined using an atomic absorption spectro-photometer. After plant harvest, DTPA extractable Ni, Co, Pb, and Cd were measured in the soil by an atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

Dry matter yield

Dry matter yield of barley plant, as affected by irrigation water salinity and sewage sludge application is presented in Table 3.

Regarding main effect of irrigation water salinity level on dry matter yield of barley, data reveal that increasing the salinity level was accompanied by a gradual decrease in the dry matter yield. This finding is in agreement with those obtained by Mostafa (1984). This effect was true with both studied soils.

Table 3 shows also that the addition of sewage sludge under all irrigation water salinity levels resulted in significant increases in dry matter yield. This effect was particularly pronounced at 3% level. The recorded increases in dry mater yield were 18.4 and 4.44% with sandy and calcareous soils over the control values under the highest level of irrigation water salinity (8000 ppm). The promotive effect of sewage sludge in increasing yield of crops have been proved by Mashaly et al. (1993) and El-Shebiny et al. (1995).

On the other hand, it was found that the interaction effect between the two studied factors is significant under both studied soils conditions. This indicate that the depressive effect of irrigation water salinity on dry matter yield can be overcome-to some extent- by addition of sewage sludge.

Table (3): Effect of irrigation water salinity and sewage sludge application on the dry weight of barley plant (gm plant^{-1}) grown in two soils

Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	*Sandy soil*	*Calcareous soil*
Control	0	1.06	1.00
	10	1.37	1.35
	20	1.59	1.58
	30	1.64	1.67
2000	0	1.01	0.98
	10	1.13	0.99
	20	1.19	1.00
	30	1.21	1.10
4000	0	1.00	0.95
	10	1.10	0.97
	20	1.13	0.98
	30	1.15	0.99
6000	0	0.93	0.92
	10	0.98	0.94
	20	1.13	0.95
	30	1.17	0.96
8000	0	0.87	0.90
	10	0.96	0.92
	20	0.99	0.93
	30	1.03	0.94
L.S.D. (0.05)			
Irrigation water salinity level		0.001	0.001
Sewage sludge rate		0.009	0.002
Interaction		0.010	0.004

Macronutrients uptake

Data presented in Tables (4, 5) reveal that N, P and K uptake by barley plant was significantly decreased as a result of increasing irrigation water salinity level. This was true under the two studied soil conditions. These results are in agreement with those obtained by Sameni et al., (1980) who noticed that N uptake by bean plant generally decreased with the increase in the salinity level of the irrigation water. Abdul-Kadir and Panlsen (1982) reported that the increase in NaCl salinity significantly decreased the amount of total N in all organs of wheat plants, presumably due to the antigonism of nitrate by chloride as a major factor. Aslam et al., (1984) found that salinity severely inhibited the absorption of nitrate-N by barley plants.

The depressive effect of irrigation water salinity on K uptake by plant is in agreement with that obtained by El-Sawaby and Amer (1977). The data also show that the N, P and K uptake by barley plant was significantly increased by sludge addition to the soil.

With respect to the interaction between irrigation water salinity level and sewage application, data reveal that addition of the sludge can overcome the deleterious effect of irrigation water salinity.

Micronutrient s uptake

The uptake of Fe, Mn, Zn and Cu as affected by irrigation water salinity level and sewage sludge application is presented in Tables (6, 7). The Fe, Mn, Zn, and Cu uptake significantly decreased as a result of increasing irrigation water salinity level in both soils. However, the magnitudes of increase are relatively low in calcareous soil. These results are similar to those obtained by Abou-Ellil (1992) and Saleh (1994) who found that the content of Fe, Mn and Zn in maize shoots was decreased with increasing salinity levels.

Tabl (4): Effect of irrigation water salinity and sewage sludge application on macronutrient uptake (mg Plant^{-1}) by barley plant grown in a sandy soil

Treatment		*Uptake (mg / pot)*		
Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	N	P	K
Control	0	17.3	3.07	40.2
	10	22.7	4.11	52.5
	20	26.6	4.93	63.4
	30	27.7	5.41	37.1
2000	0	15.8	2.73	41.7
	10	17.7	3.28	44.2
	20	18.9	3.69	45.0
	30	19.4	3.87	35.8
4000	0	14.7	2.50	39.5
	10	16.4	2.86	40.9
	20	17.2	3.16	41.8
	30	17.6	3.36	31.3
6000	0	12.4	2.14	31.3
	10	13.2	2.35	33.2
	20	15.5	2.94	38.5
	30	16.3	3.16	40.1
8000	0	11.1	1.74	27.8
	10	12.4	2.02	31.0
	20	12.9	2.28	32.2
	30	13.6	2.58	33.6
L.S.D. (0.05)				
Irrigation water salinity level		1.30	0.40	2.63
Sewage sludge rate		0.41	0.13	0.92
Interaction		1.62	0.50	2.86

Table (5): Effect of irrigation water salinity and sewage sludge application on macronutrient uptake (mg Plant^{-1}) by barley plant grown in a calcareous soil

Treatment		Uptake (mg plant^{-1})		
Irrigation water salinity (mg l^{-1})	Sewage sludge (g kg^{-1})	N	P	K
Control	0	16.2	2.30	35.7
	10	22.0	3.24	48.5
	20	26.1	3.95	57.4
	30	27.9	4.51	61.3
2000	0	15.1	1.96	34.4
	10	15.4	2.18	40.0
	20	15.7	2.30	35.4
	30	17.4	2.64	39.1
4000	0	13.4	1.52	32.5
	10	13.9	1.65	33.4
	20	14.2	1.86	33.9
	30	14.5	1.98	34.6
6000	0	12.0	1.10	29.6
	10	12.4	1.32	30.6
	20	12.6	1.43	31.2
	30	13.0	1.63	31.6
8000	0	11.1	0.90	28.4
	10	11.5	1.01	29.3
	20	11.7	1.21	29.7
	30	12.0	1.41	30.1
L.S.D. (0.05)				
Irrigation water salinity level		1.01	0.12	1.30
Sewage sludge rate		0.20	0.01	0.02
Interaction		1.30	0.14	1.36

Table (6): Effect of irrigation water salinity and sewage sludge application on micronutrient uptake (µg Plant^{-1}) by barley plant grown in a sandy soil

Treatment		*Uptake (µg plant^{-1})*			
Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	**Fe**	**Mn**	**Zn**	**Cu**
Control	0	49	55.2	31.5	7.21
	10	237	72.8	41.2	10.00
	20	280	88.4	49.8	12.24
	30	300	94.0	56.4	13.45
2000	0	159	50.1	26.0	6.16
	10	188	52.1	26.1	7.23
	20	205	52.6	26.5	8.09
	30	217	52.2	26.3	8.71
4000	0	152	45.1	22.7	5.4
	10	171	47.5	22.7	6.27
	20	180	47.0	21.8	6.67
	30	189	46.2	21.5	7.24
6000	0	136	39.3	18.7	4.65
	10	147	40.1	18.9	5.19
	20	172	44.2	20.5	6.33
	30	184	45.3	20.5	6.79
8000	0	120	35.3	15.1	3.74
	10	134	37.5	15.0	4.42
	20	145	37.7	14.1	4.75
	30	154	38.4	13.8	5.25
L.S.D. (0.05)					
Irrigation water salinity level		12.12	3.12	1.80	1.03
Sewage sludge rate		9.6	0.20	0.01	0.02
Interaction		20.3	3.32	1.90	1.06

Table (7): Effect of irrigation water salinity and sewage sludge application on micronutrient uptake (µg $Plant^{-1}$) by barley plant grown in a calcareous soil

Treatment		Uptake (µg $plant^{-1}$)			
Irrigation water salinity (mg l^{-1})	Sewage sludge (g kg^{-1})	Fe	Mn	Zn	Cu
Control	0	238	39.6	22.1	13.30
	10	210	53.7	33.2	18.76
	20	174	64.0	41.6	22.59
	30	123	68.8	47.6	24.55
2000	0	151	37.3	18.3	11.89
	10	120	37.7	18.7	12.03
	20	116	39.1	19.6	12.26
	30	115	43.3	21.9	13.52
4000	0	127	34.4	16.4	10.14
	10	119	35.5	17.4	10.39
	20	115	36.2	17.6	10.71
	30	107	36.8	17.9	10.88
6000	0	112	31.5	14.1	8.89
	10	107	32.5	14.5	9.14
	20	103	32.2	14.8	9.39
	30	96.6	33.1	15.1	6.32
8000	0	106	29.0	10.9	7.84
	10	101	30.1	11.6	8.09
	20	97.5	31.0	11.9	8.21
	30	88.2	32.1	12.2	8.38
L.S.D. (0.05)					
Irrigation water salinity level		3.21	0.700	2.30	0.21
Sewage sludge rate		1.11	0.001	0.01	0.01
Interaction		4.33	0.702	2.40	0.23

The uptake of of Fe, Mn, Zn and Cu by barley plant as affected by sewage sludge application is presented in Tables (6, 7).

Data indicate that in sandy soil, the uptake of the micronutrients by plant significantly increased as a result of sewage sludge application. This was generally true except for Zn uptake under high salinity levels of 4000 and 8000 mgl^{-1}. Similar promotive effect was obtained in the calcareous soil except for Fe uptake under all salinity levels. This clarifies the role of soil organic ligands, produced by decomposition of added sludge, in maintaining high levels of micronutrients in soil solution by forming soluble complex, available to growing plants (Hue, 1988 ; Dahdoh et al., 1999). In general, the sandy soil manifested the highest values of micronutrient uptake and this was true under all levels of irrigation water salinity and sewage sludge. Similar results were obtained by El-Desouky (1999) who found that organic matter application has a great influence on Mn and Cu uptake by both maize and wheat plants irrigated by saline water. The obtained results may be due to the high pH values of calcareous soil comparing to sandy one (Table 1). These findings are in good agreement with those obtained by King et al., (1974) who found that levels of Cu and Zn in the corn tissues were increased by additions of sewage sludge though, their concentrations were below toxic levels to crops or animals. Soon et al., (1980) indicated that the sewage sludge application increased Zn concentration in corn stovers. It is interesting to mention that Fe uptake was significantly decreased as a result of sewage sludge addition to calcareous soil. This was true under all irrigation water salinity levels. Similar results were found by Ismail et al., (1996) who found that the availability of Fe decreases upon the application of sewage sludge. This effect may be due to fixation and precipitation of iron, particularly in the case of pH over neutral conditions.

On the other hand, many researchers attributed this effect to antagonistic relationship between Fe and one or more of the other elements such as Mn and Zn (Dahdoh et al., 1994).

Concerning the interaction between irrigation water salinity levels and sewage sludge rates, data in Tables (6, 7) show that the addition of sludge under all irrigation water salinity levels resulted in increases in the micronutrient uptake and Cu by barley plant except for Zn in the sandy soil and Fe in the calcareous soil.

Heavy metals uptake

Tables (8, 9) show that the uptake of Pb, Co, Ni and Cd decreased significantly in barley plants as irrigation water salinity level increased under both soils conditions. However, the decrease was different among the metals.

This finding is not in agreement with that obtained by Abd-Alla et al., (1993) who found that increasing salinity of irrigation water increased both of Co and Pb in the soil. Sewage sludge application rate significantly increased uptake of the heavy metals by barley plant. However, the uptake of these metals by barely plants grown on calcareous soil was lower than that for sandy one.

The inhibitory effect of irrigation water salinity on the Cd uptake by barley plant under calcareous soil conditions may be due to the abundance of Ca ion under such conditions. Abd-Alla et al. (1993) found that increasing calcium leads to a decrease in the extractable amounts of cadmium and this effect was more pronounced with a calcareous soil irrigated with high salinity water.

Table (8): Effect of irrigation water salinity and sewage sludge application on heavy metal uptake (µg Plant^{-1}) by barley plant grown in a sandy soil

Treatment		*Uptake (µg plant^{-1})*			
Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	**Ni**	**Co**	**Pb**	**Cd**
Control	0	5.22	4.80	5.89	1.97
	10	7.01	6.33	8.11	2.94
	20	8.49	7.44	10.78	3.15
	30	9.12	7.72	11.35	3.49
2000	0	4.20	4.16	5.37	1.75
	10	4.94	4.72	6.09	2.02
	20	5.41	5.03	6.45	2.17
	30	5.71	5.19	6.64	2.29
4000	0	3.87	4.05	5.12	1.65
	10	4.38	4.54	5.71	1.89
	20	4.69	4.72	5.91	2.01
	30	5.03	4.84	6.13	2.30
6000	0	3.32	3.65	4.67	1.41
	10	3.69	3.90	5.02	1.56
	20	4.44	4.54	5.83	1.90
	30	4.88	4.75	6.12	2.02
8000	0	2.75	3.18	4.32	1.29
	10	3.31	3.57	4.79	1.50
	20	3.58	3.75	5.06	1.61
	30	4.10	3.98	5.31	1.74
L.S.D. (0.05)					
Irrigation water salinity level		0.03	0.02	0.21	0.02
Sewage sludge rate		0.01	0.01	0.01	0.01
Interaction		0.05	0.04	0.23	0.03

Table (9): Effect of irrigation water salinity and sewage sludge application on heavy metal uptake (µg $Plant^{-1}$) by barley plant grown in a calcareous soil

Treatment		*Uptake (µg $plant^{-1}$)*			
Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	**Ni**	**Co**	**Pb**	**Cd**
Control	0	4.30	3.93	4.36	1.45
	10	6.08	5.33	8.01	1.98
	20	7.43	6.27	9.82	2.35
	30	8.02	6.65	10.77	2.56
2000	0	3.82	3.58	4.04	1.39
	10	3.95	3.65	4.33	1.43
	20	4.10	3.72	4.96	1.49
	30	4.62	4.15	5.63	1.66
4000	0	3.66	3.35	3.76	1.30
	10	3.77	3.45	3.99	1.31
	20	3.83	3.52	4.24	1.39
	30	3.93	3.58	4.64	1.43
6000	0	3.36	3.18	3.29	1.24
	10	3.47	3.26	3.50	1.29
	20	3.55	3.32	3.75	1.32
	30	3.64	3.36	3.96	1.36
8000	0	2.82	3.03	3.08	1.17
	10	2.93	3.12	3.28	1.22
	20	2.99	3.18	3.45	1.26
	30	3.09	3.23	3.73	1.30
L.S.D. (0.05)					
Irrigation water salinity level		0.02	0.01	0.21	0.09
Sewage sludge rate		0.01	0.01	0.12	0.01
Interaction		0.032	0.03	0.33	0.11

It was found that the interaction between irrigation water salinity level and sewage sludge application was significant in both studied soils.

DTPA-extractable heavy metals

Data presented in Table 10 show the interactive effect of irrigation water salinity level and sewage sludge application rate on DTPA-extractable heavy metals from the two soils after harvesting. Data reveal that irrigation water salinity significantly increased the DTPA-extractable Pb, Co and Ni for both studied soils. However, the opposite was found to be generally true for Cd. The promotive effect of water salinity may be due to increasing the solubility of these metals under salinity conditions. In this concern, Abd-Alla et al., (1993) found that DTPA-extractable Co and Pb were increased as a result of increasing irrigation water salinity level.

On the other hand, sewage sludge application significantly increased the DTPA-extractable heavy metals. This may be due to the decrease in soil pH along with the release of metals from decomposed sludge material (Shaver et al., 1980). However, the levels of the investigated metals were within the ranges previously reported in. soils treated with sewage sludge (Bin-Shiha, 1990)..

Table 10 also indicates that the interactions between irrigation water salinity level and sewage sludge application were significant on the DTPA-extractable heavy metals in both studied soils.

Table (10): DTPA-extractable heavy metals (mg Kg-[1]) in the two studied soils after plant harvesting, as affected by irrigation water salinity and sewage sludge application

Treatment		Sandy soil				Calcareous soil			
Irrigation water salinity (mg l^{-1})	*Sewage sludge (g kg^{-1})*	Co	Ni	Pb	Cd	Co	Ni	Pb	Cd
Control	0	0.21	0.15	0.33	0.23	0.16	0.10	0.26	0.16
	10	0.28	0.19	0.39	0.25	0.17	0.11	0.29	0.17
	20	0.30	0.26	0.46	0.27	0.19	0.13	0.33	0.19
	30	0.34	0.29	0.57	0.29	0.20	0.14	0.36	0.22
2000	0	0.29	0.18	1.21	0.21	0.17	0.11	0.32	0.12
	10	0.35	0.20	1.29	0.22	0.19	0.13	0.37	0.13
	20	0.39	0.26	1.36	0.23	0.22	0.15	0.42	0.14
	30	0.42	0.36	1.42	0.27	0.24	0.17	0.47	0.16
4000	0	0.35	0.23	1.39	0.18	0.23	0.14	0.39	0.10
	10	0.39	0.29	1.45	0.26	0.25	0.17	0.42	0.11
	20	0.42	0.35	1.56	0.23	0.29	0.19	0.49	0.12
	30	0.46	0.39	1.73	0.25	0.36	0.22	0.56	0.13
6000	0	0.39	0.29	1.56	0.15	0.27	0.17	0.43	0.08
	10	0.42	0.33	1.56	0.19	0.32	0.19	0.59	0.09
	20	0.46	0.39	1.62	0.21	0.37	0.23	0.57	0.10
	30	0.48	0.46	1.79	0.22	0.39	0.27	0.67	0.11
8000	0	0.43	0.36	1.68	0.11	0.32	0.21	0.49	0.06
	10	0.47	0.39	1.72	0.13	0.37	0.26	0.56	0.07
	20	0.52	0.49	1.79	0.15	0.42	0.29	0.63	0.08
	30	0.56	0.56	1.86	0.17	0.47	0.37	0.73	0.09
L.S.D. (0.05)									
Irrigation water salinity level		0.01		0.01		0.01		0.001	
Sewage sludge rate		0.01		0.001		0.01		0.001	
Interaction		0.03		0.011		0.03		0.003	

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إمتصاص العناصر الغذائية والمعادن الثقيلة في نبات الشعير النامي في أرض رملية وأخري جيرية تحت تأثير ملوحة مياه الري وإضافة مخلفات المجاري

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أقيمت تجربة أصص لدراسة تأثير ملوحة مياه الري وإضافة مخلفات المجاري علي محصول المادة الجافة ، إمتصاص العناصر الغذائية الكبرى والصغرى والمعادن الثقيلة فى نبات الشعير النامي في أرض رملية وأخري جيرية.

أدت زيادة ملوحة مياه الري إلي نقص معنوي في محصول المادة الجافة وإمتصاص العناصر الكبري والصغري تحت الدراسة ، بينما كان العكس صحيحاً بالنسبة لإمتصاص المعادن الثقيلة فيما عدا الكادميوم الذى إنخفض إمتصاصة في النبات مع الزيادة في ملوحة مياه الري وذلك فى كل من الأرض الرملية والجيرية.

أدت إضافة مخلفات المجاري إلي زيادة محصول المادة الجافة وإمتصاص العناصر الكبرى (NPK) والعناصر الصغرى (Fe, Mn, Zn, Cu) تحت جميع مستويات ملوحة مياه الري تحت الدراسة. إمتصاص المعادن الثقيلة في النبات أعطي إتجاه مشابه لإمتصاص العناصر الغذائية الكبري والصغري.