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Influence of Waste Water Land Disposal on the Chemical Composition of Bermuda Grass Grown Along the Discharge Stream in Arid Land Areas

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ABSTRACT

Effluents discharge from makkah wastewater treatment plant in to the wadi of Uranah were used to assess the effects of inland disposal of conventionally treated wastewater on chemical composition of Bermuda grass .Five trips were made for collecting plant samples .On each trip , samples from five specified cross sections along the sewage water stream at two points (one at each side of stream and 3 m apart) were collected .All plant samples were analyzed for macronutrients (N, P, k, Ca, Mg and Na),micronutrients (Fe, Zn ,Mn .and Cu) and toxic elements (Ni,Cd,Cr and Pb) .

Results revealed that plant content of N , P, K, Ca, Mg, Na, Zn, Mn, Cu, Ni, Pb and Cr decreased while plant content of Fe increased with advanced time of sampling . However , plant content of Cd was not affected by time of sampling .Plant content of K ,Na ,Zn , Ni and Pb decreased while plant content of N and Fe increased along the wastewater stream .However ,plant content of P, Ca ,Mg ,Mn ,Cu ,Cr and Cd were not affected by location .The effect of plant sampling side was not significant for all macronutrients , and toxic elements . On the other hand ,plant content of N ,P ,K ,Ca ,Mg ,Mn ,Cu ,Cr and

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Cd were higher in the shoot than in the root part of the plant .However ,Bermuda grass content of Zn,Ni and Pb were higher in the roots than in the shoots .The plant content of Na was not affected by plant part .

Plant species , or cultivar differences possess natural variability and markedly vary in their metal uptake and tolerance to metal concentration (Page , 1974) .Behjat (1985) described the nature of sludge advantage and limitation of its application to land .Input trails on sand and silt loams , ray grass yields increased slightly from 1.67 to 1.81 t/ A with the application of 71 tons sludge /acre but higher rates caused reduction in yield. Day et. al. (1979) found that wheat irrigated with pump waste water mixture produced taller plants ,more heads per unit area , heavier seeds , higher grain yield and higher straw yields as compared to wheat grown with only pump water .

In another study,Rabie (1984) and Eid (1984) ,found that sludge application up to 15 t/ acre significantly increased dry matter of fababean giving a relative yield of 172% at 15% application rate . When sludge application rate increased to 2%, dry matter of shoots and roots of beans slightly decreased , but they were significatly higher than the control treatment giving a relative yield of 164% .El-Keily (1983) found that the mean fresh weight of eight cuts of alfalfa increased markedly with increasing the amount of sludge addition .The fresh weight increased to 7.4, 9.0 and 11.0 times that of control for sludge addition at rates of 10, 20 and 50g/kg soil , respectively . Saber (1990) showed that sewage water application was effective in increasing the productivity of most crops for 4-years application of sewage water and resulted in an increase in maize from 200 to 2000 kg / fed .

Metallic plant toxicity :

Studies showed that most trace elements are toxic to higher plants if they occcur in soil solution in excessive amounts (Behjat , 1985) . Zn, Cu, and Ni toxicities were more commonly observed with addition of sludge when there was improper management of soil pH or cumulative metal application (Page and Chane ,1975) .Excessive additions of Cu ,Ni ,or Co usually cause injury to plant roots and inhibit translocation of Fe from roots to shoots . Phytoxicity is usually expressed as yellow (chlorotic) young leaves because of metal- induced Fe deficiency (Foy et. al., 1978) .

Crops also vary in the relative toxicity of soil Zn,Cu, and Ni .Soil pH affects the relative toxicity coeffcients for any added soil metals (Michell et al ,1978) for differences in Cd and Zn uptake among maize inbreeds and maize hybrids . Harris et al , (1981) studied the differences in metal uptake among six potato cultivars when they were grown on an old sludge form . Metal uptake was least hazardous when the edible portion of the plants was grain or fruit .

Sauerbeck (1991) and otabbong (1997) found that Cd ,Zn ,and Ni uptake by plants is high , while Pb and Cr uptake is low .They also added that most dicotyledon plants absorb more heavy metals than monocots. Only Cu and Ni were translocated into the fruits and seeds . Roots accumulate Cd , Ni , Zn and Cu but do not enrich Pb and Cr .

Plant species and cultivars :

Crops markedly differ in their metal uptake , and in tolerance to soil when all other factors were held constant (Chaney and Giordano , 1977 ; Sommers ,1980) . Growing on the same sludge amended soils . spinach contains 10 times more Zn than did tall fescue , orchard grass

15 times more Ni than did corn , and orchard grass 5 times more Cu than did tall fescue .

Harris et .al ., (1981) studied the differences in metal uptake among six potato cultivars when they were grown on an old sludge farm .Although these potatoes were grown on sludge farm soil , the unpeeled potato tubers contained only normal Cd levels (mean – 0.28 mg/kg) ; the metal contents though in lower ranges , differed significantly among cultivars.

Mohammed and Battikhi (1997) reported an increase in concentration of N,P,Fe,Zn and Mn in barley grains and straw , and an increase in the growth was obtained .

Effect of sewage water effluent on metal content of plant :

Mahajan et. al . (1978) showed in two – years trials that sewage water and nitrogen significantly increased celery seed yield but when applied separately , sewage water was more effective than nitrogen. Working on turfgrass and using municipal wastewater for 30 weeks , Sidle and Johnson (1972) recommended that turfgrass can be irrigated with sewage effluent at common rates without hazard of nitrogen pollution to ground water .

In a study applying secondary treated municipal effuent to sandy dune soil grown with Rhodes grass , Vaisman et al (1981) found that higher quantites of water or fertilizer did not improve yields further. Wong et.al . (1995) reported no effect of sewage water on plant growth (mangroves) .

Palazzo (1976) stated that the greatest forage yields ,N and P removal occurred when 15 cm/wk of wastewater was applied .Forages grown on the heavier textured soils produced greater yields and removed more N and P than those grown on the lighter textured soils .

Analyses performed in 1974 and 1975 showed reduction in the levels of K in soil and forage , indicating a need for K fertilization for sustained forage productivity .The reduction of K was related to the uptake of this element by the forage and its low concentration in the wastewater .Hook et . al . (1972) had monitored the rate of phosphorus as treated municipal sewage effuent was applied to croplant and forested areas.Ten years of monitoring had indicated a high degree of effciency of the soil plant system to retain and use phosphorus . Larsen (1976) got inconclusive reults that provided a true measure of increased yield or chemical composition of wheat straw due to wastewater application.

Murphey and Bowier (1975) studied the response of pulpwood species to municipal sewage plants .The results proved that average annual increment and fiber length were different for irrigated and control samples at the 1% level of significance . Saha et. al. (1996) mentioned that application of treated effluent sewage water increased considerably the availability of P in water and soil .

Cordonnier and Johnston (1980) used secondary treated municipal wastewater and well water to irrigate soybean field . They stated that the wastewatre treatment yielded 354 kg/ha more than the control and 205 kg /ha more than the well water . The irrigated plants were taller and matured 5-6 days later than the non – irrigated plants .

Williams et. al . , (1980) ,and El- Hassanin et.al ., (1992) indicated that application of sewage effluent to land often resulted in significant accumlation of toxic matals in the soils concentration of Hg ,Zn .Cu,and Se increased more than 100% and Ni, Cr and Pb more than 50% .

Abdl El- Naim (1988) , El- Nennah et al,(1982) and Eid (1984) obtained tremendous increase in the concentrations of both total and DTPA- extractable metals in sandy soils upon utilizing sewage water for irrigation . El – Hassanin et . al . (1992) , found that affer 67 years of sewage water application , total Pb increased 9 times , total Cd 6 times , total Zn 50 times and total B 5 times .

MATERIALS AND METHODS

Plant sampling :

Five trips were made for plant sampling .Plant samples were collected from naturally grown plants at the five specified cross sections at two points (one on each side of stream , approximately 1 meter from the stream . The plant dominating the wastewater stream was Bermuda grass (Cynodon lactylon) (Fig1).It was considered as the representative plant in the study area . The total number of plant samples was ten . The plant samples were placed in paper bags , transferred to the laboratory and placed in an oven at 70 5C for drying . The dry samples were ground , and stored in paper bags in a refrigerator at 45C . A portion of dry material (0.25 g) was taken from each sample and used for the determination of Fe, Mn ,Cr,Pb,Cd ,Cu ,Ni ,P,and K . Another portion of the dry material was used for total nitrogen determination .

Plant analysis :

The total nitrogen and trace metals analyses were perfomed on plant samples .Macro and micro nutrients and heavy metals (Fe ,Mn ,Cr ,Pb, Cd, Cu, Ni, Zn, Ca , Mg ,K, and Na) were determined after extraction using the perchloric nitric digestion procedure of Shelton & Harper (1941) .The concentration of these elements were measured by a Perkin- Elmer 5000 AAS .The procedure of determining the nitrogen involves the digestion and distillation steps according to the kjeldahl method (Jackson, 1967) using Kjeltec auto 1030 analyzer .

RESULTS AND DISCUSSION

Chemical properties of plant :

The summary of analysis of variance for chemical composition of plant , along the wastewater stream was presented in Table (1) .The effect of plant sampling time was significant at ($p<0.01$) for all plant chemical composition elements (except Cd) . The effect of plant sampling location was not significant for the following plant element contents :

P. Cu .Mg ,Mn ,Cu and Cd .However ,the effect of plant sampling location was significant on those plant element contents : N , K, Na , Fe , Zn , Ni , Pb and Cr . The effect of plant sampling side was not significant for all chemical properties of plant .The effect of plant sampling part was significant for all element contents of plant except Na.

Macronutrients in plant (N,P,K,Ca,Mg and Na)

Nitrogen (N) , Phosphorus (P) , Potassium (K) , Calcium (Ca) ,Magnesium (Mg) ,and Sodium (Na) are the major nutrients for plant growth . The total N,P,K,Ca,Mg and Na content of plant are shown in Tables (2 to 5) .

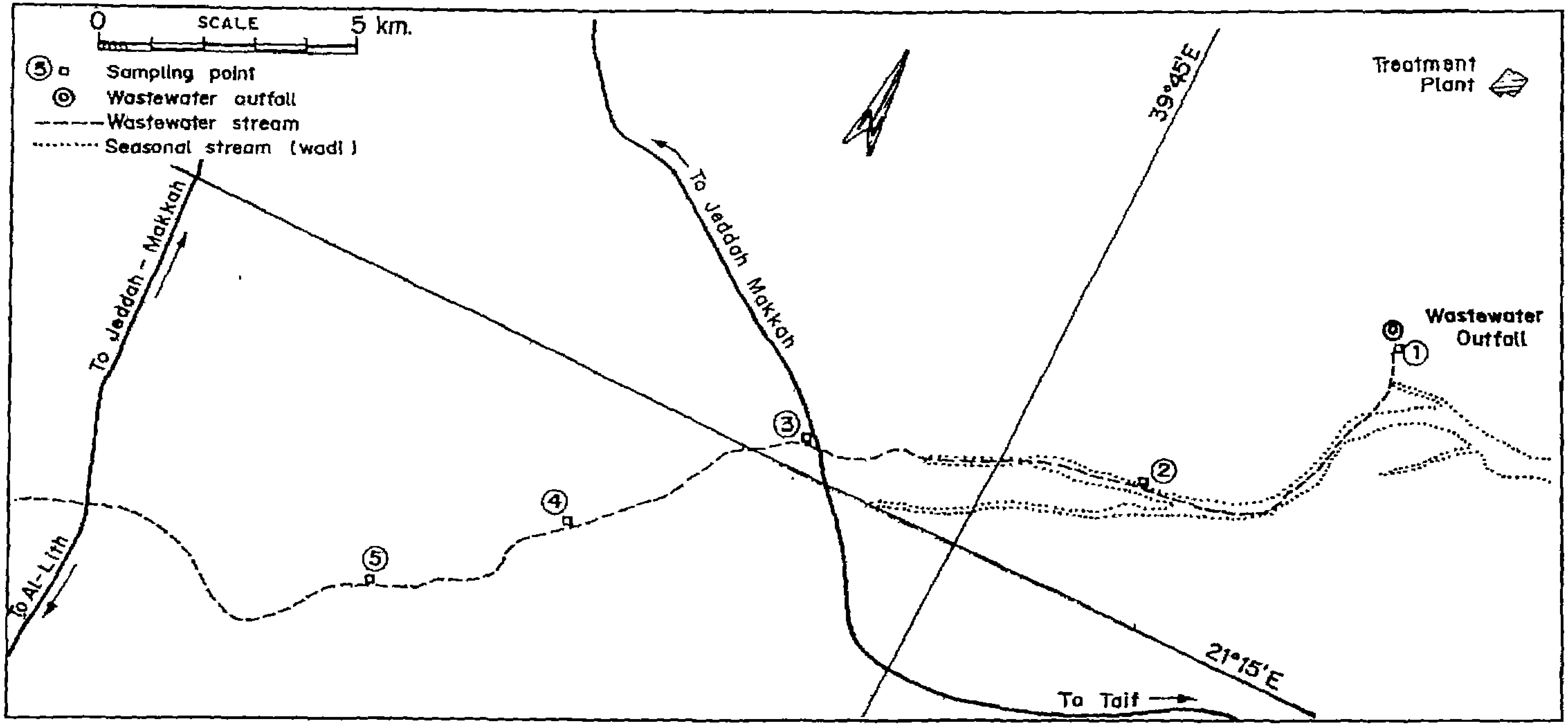

Fig (1): A map of the waste water and plant sampling points along the waste water stream.

Table (1) : Summary of ananlysis of variance for chemiacl composition of plant .

Source	DF	OSL	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg	Sodium (Na)	Iron (Fe)
			g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg
Side (S)	1	OSL	0.055	0.306					
Time (T)	4	OSL	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
Location (L)	4	OSL	0.041*	0.299	0.004**	0.092	0.087	0.005**	0.000**
T×L	16	OSL	0.393	0.067 *	0.037*	0.118	0.370	0.000**	0.000**
Plant Part (P)	1	OSL	0.000**	0.000**	0.000**	0.012*	0.000**		0.000**
T×P	4	OSL	0.000**	0.004*	0.000**	0.001**	0.000**	0.000**	0.319
L×P	4	OSL		0.167	0.123		0.000**	0.000**	
L×T×P	16	OSL			0.069*		0.016*	0.000**	
EMS	49		4.261	0.037	67.314	72.502	8.468	20.515	163724.929

Source	DF	OSL	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
			g/kg	g/kg	g/kg	G/kg	g/kg	g/kg	g/kg
Side (S)	1	OSL		0.164				0.111	
Time (T)	4	OSL	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	
Location (L)	4	OSL	0.000**	0.310	0.376	0.010*	0.000**	0.035*	
T×L	16	OSL	0.000**		0.216	0.003**	0.012*	0.122	0.284
Plant Part (P)	1	OSL	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**	0.000**
T×P	4	OSL	0.000**	0.053*	0.000**	0.001**	0.000**	0.000**	
L×P	4	OSL	0.002**		0.018*	0.002**	0.012*	0.231	
L×T×P	16	OSL	0.000**			0.004**		0.159	
EMS	49		1740.023	2990.046	81.611	496.474	30.745	0.307	

* significant at 0.05 level OSL = observed statistical level
** significant at 0.01 level DF = degree of freedom
EMS = error mean square

The N (130.6 mg/L) and Mg (187.03 mg/L content of sewage effuent exceed the safe limit (N=30 mg /L and Mg =60 mg/L) and may present a problem for plant , animal and human being (Bouwer, 1982) .The effect of wastewater application on growth of plants was studied by many workers . Palazzo (1976) stated that the greatest forage yields, N and P removal occurred when 15 cm/wk (6 in /week) of wastewater was applied .Forages grown on the heavier textured soils produced greater yield and removed more N and P than those grown on the lighter textured soils .In a field experiment where irrigation of calcareous soils with TSWwas practiced , plant tissue analysis indicated normal concentration of Fe , Zn , Mn and Cu and no detectable Cd , Ni , Cr and Pb after 40 years of effluent application . Effuent data indicated no salt or sodium hazard and no Cd , Cr , Ni or Pb accumulation . In general , it was concluded that sewage effluent is a potential source of irrigation water and plant nutrients on southwestern agricultural calcarious soil of the United States .

Table (2) : Effect of sampling time on the chemical composition of plants grown along the wastewater stream and their tests of significance.

Trip No	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Iron (Fe)
	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	mg/kg
1	14.268 A	0.541 A	49.226 A	26.715 A	14.47 A	11.206 A	510.400 C
2	13.817 AB	0.522 A	29.554 B	23.70 A	13.036 A	16.325 B	831.72 B
3	12.755 BC	0.441 AB	11.237 C	26.50 A	8.733 B	16.292 B	1012.97 B
4	12.344 CD	0.380 BC	10.95 C	13.658 B	4.996 C	18.862 B	1441.75 A
5	11.178 D	0.294 C	15.89 C	17.824 B	1.695 D	31.187 A	1485.0 A
Overall Mean	12.872	0.435	23.371	21.679	8.586	18.774	1056.368
LSD	1.312	0.122	5.214	5.411	1.849	2.878	257.135

Trip No	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	197.45 A	121.01A	25.93 A	10.055A	111.85A	31.195 A	1.387 A
2	190.056 B	117.50 A	27.20 A	9.00 AB	51.055 BC	26.314 B	1.285 A
3	37.398 C	91.41 AB	16.55 b	8.048 B	51.00 BC	11.008 C	1.325 A
4	38.925 C	57.235 BC	16.25 B	6.450 C	64.50 B	9.043 CD	1.278 A
5	42.0 C	53.25 C	10.25 C	3.915 D	45.072 C	6.400 D	1. 197 A
Overall Mean	101.166	88.079	19.236	7.494	64.695	16.792	1.294
LSD 0.05	26.508	34.749	5.741	1.908	14.159	3.524	0.352

Trip No .Time of Sampling L. S D=Least significant difference at 5%

Trip No	Time of Sampling		
1	9/5/1991	A	= 1st highest category
2	9/8/1991	B	= 2nd highest category
3	9/11/1991	C	= 3rd highest category
4	10/5/1992		
5	29/9/1992		

Table (3) : Changes in the chemical composition of plants grown along the wastewater stream and their tests of significance .

Location	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg	Sodium (Na)	Iron (Fe)
	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	mg/kg
1	12.26 B	0.354 A	22.501 a	24.515 A	7.815 A	16.455 C	1091.05 B
2	12.158 B	0.458 A	26.818 A	19.969 A	8.92 A	17.916 BC	950.655 B
3	12.801 AB	0.468 A	25.76 A	21.247 A	7.624 A	17.695 BA	937.785 B
4	13.105 AB	0.468 A	24.719 A	24.191 A	8.563 A	20.377 AB	840.50 B
5	14.036 A	0.431 A	17.111B	18.026 A	10.008 A	21.43 A	1461.85A
Overall Mean	12.872	0.436	23.371	21.589	8.586	18.775	1056.368
LSD	1.312	0.122	5.214	5.411	1.461	2.878	257.135

Location	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Mg/kg	mg/kg
1	112.129 A	65.33 A	19.20 A	9.23 A	62.100 A	14.099 B	1.232 A
2	95.428 AB	89.80 A	15.885 A	8.215A	71.491 A	15.727 B	1.428 A
3	84.315 B	100.35 A	19.55 A	7. 541 AB	73.400 A	17.119 AB	1.165 A
4	70.89 B	96.035 A	21.665 A	6.227 B	73.235 A	17.31AB	1.336 A
5	43.067 C	88.88 A	19.88A	6.255 B	43.350 b	19.705	1.311
Overall Mean	81.166	88.079	19.236	7.494	64.715	16.792	1.294
LSD	26.508	34.749	5.740	1.908	14.159	3.524	0.352

LDS = Least Significant difference at 5%   B = 2nd highest category

A = 1st highest category   C = 3rd highest category

Table (4) : Variation in the chemical composition of soil samples collected from both sides of the wastewater stream and their tests of significance .

Side	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg	Sodium (Na)	Iron (Fe)
	g/kg	g/kg	g/kg	g/kg	g/kg	g/kg	mg/kg
1	13.276 A	0.416 A	23.194 A	21.922 A	8.420 A	18.576 A	1090.976 A
2	12.468 A	0.456 A	23.548 A	21.257 A	8.752 A	18.974 A	1021.760A
Overall Mean	12.872	0.436	23.371	21.589	8.586	18.775	1056.368
LSD	0.586	0.55	2.331	2.419	0.827	1.287	114.973

Plant part	Zinc (Zn)	Manganese (Mn)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Chromium (Cr)	Cadmium (Cd)
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
1	83.954 A	80.358 A	19.832 A	7.376 A	64.737 A	17.691 A	1.349A
2	78.377 A	95.80A	18.64 A	7.611A	64.694A	15.893A	1.24A
Overall Mean	81.165	88.079	19.236	7.493	64.715	16.792	1.294
LSD	11.853	15.537	2.567	0.853	6.331	1.575	0.157

Side of the stream

1- Right

2- Left

L.S.D =Least significant difference at 5%

A = 1st highest category

B = 2nd highest category

C = 3rd highest category

Table (5) : Effect of sampling plant part on chemical composition of plants grown along the wastewater sream and their teats of significance .

Plant part	Nitrogen (N) g/kg	Phosphorus (P) g/kg	Potassium (K) g/kg	Calcium (Ca) g/kg	Magnesium (Mg g/kg	Sodium (Na) g/kg	Iron (Fe) mg/kg
1	20.714 A	0.603 A	35.507 A	23.807 A	9.909 A	18.385A	806.914B
2	5.030 B	0.269 B	11.236B	19.372 B	7.263B	19.164 A	1305.822A
Overall Mean	12.872	0.436	23.371	21.589	8.586	18.775	1056.368
LSD	0.586	0.055	2.331	2.419	0.827	1.287	114.973

Plant part	Zinc (Zn) mg/kg	Manganese (Mn) mg/kg	Copper (Cu) mg/kg	Nickel (Ni) mg/kg	Lead (Pb) mg/kg	Chromium (Cr) mg/kg	Cadmium (Cd) mg/kg
1	58.561B	116.754 A	22.92 A	6.058 B	53.247 B	26.904 B	2.118 A
2	103.770 A	59.404 B	15.552 B	8.929 A	76.184 A	6.680 B	0.470 B
Overall Mean	81.165	88.079	19.236	7.493	64.715	16.792	1.294
LSD	11.853	15.537	2.567	0.853	11.853	1.575	0.157

Plant part :
1- Right
2- Left

L.S.D =Least significant difference at 5%
A = 1st highest category
B = 2nd highest category
C = 3rd highest category

Cordonnier and Johnston (1980) used secondary treated municipal wastewater and well water to irrigate soybean field . They stated that the wastewater treatmeant yielded 354 kg/ha more than the control and 205 kg /ha more than the well water . The irrigated plants were taller and matured 5-6 days later than the non – irrigated plants .

The efffect of plant sampling time on plant content of N, P, K, Ca, Mg and Na was significant . The plant content of these nutrients decreased with advanced time of sampling (from time 1 to 5) (Table 2) . The effect of plant sampling location on plant content of P , Ca and Mg was not significant . However , the N content of plant increased while K and Na content of plant decreased along the wastewater stream (from location 1 to 5) (Table 3) . The effect of plant sampling side was not significant for all macronutrient contents in plant (Table 4) .However , the N,P,K,Ca and Mg were higher in the shoot than the root part of the plant .

Micronutrients and Trace Elelements :

The plant contents of Fe , Zn , Cu ,Mn ,Ni ,Cd, Cr , and Pb , are shown in Tables (2 to 5) .The average plant content of these elements were moderately high and wastewater steam contents of some of these elements (Cr, Cu , Mn , Ni ,Pb and Zn) were likely to exceed the safe limit of the use of domestic wastewater for irrigation .

The toxic elements accumlated in plant tissues may be introduced to the human food (Banin et . al ., 1981) . Heavy metals are known for their harmful effect on soil ,crops , animals , and human beings. Sewage is a major source of heavy metal contamination of crop land , enter sewage as a result of industrial activities .

Application of sewage can be beneficial to crop land . Sewage contains many essential plant nutrients , may act as a soil conditioner and increase water soil holding capacity . Plants grew well along the wastewater stream and showed no symptoms of toxicity due to the prolonged periods of wastewater stream flow .

The heavy metals and other potentially toxic elements present in sewage can be divided into two categories based on whether they present a potentially serious hazard to plants , animals , or humans . The metals , Mn , Fe , Cr , As , Se , Sb , Pb, and Hg pose relatively little hazard crop production and do not accumlate in a toxic level when the sewage is applied to soil within reasonable limit . This is because they are present in relatively low concentration in the soil and /

or have low solubilities . As a result , the availability of these elements to plants is restricted and consequently very little plant uptake occurs . The remaining heavy metals , Cd ,Cu , Mo , Ni and Zn , can accumulate in plants and pose a hazard to animals or humans , and to the plants themselves under certain circumstances .

For example , Cd , a non – essential element , can be a serious hazard to animals and humans if the dietary intake level is increased . Cadmium could cause certain health problems due to the cumulative effect of prolonged low- level exposure in animals and humans (Baker et . al . ,1975) .The possible hazard to humans from elevated concentration of Cd in plants is greater than the possible toxicity to the plants themselves , particularly if dietary levels of Ca , Zn and Cu are low or marginal (Chaney ,1975) .

The effect of plant sampling time on plant content of micronutrient and trace elements (except Cd) was significant . However , Fe content of plant increased and Zn , Mn , Cu , Ni, Pb and Cr contents of plant decreased with advanced time of sampling (from time 1 to 5) (Table 2) . The effect of plant sampling location on content of Mn , Cu, Cr ,and Cd was not significant (Table 3) . However , the plant contents of Fe increased and the plant content of Zn , Ni and Pb decresed along wastewater stream (from location 1 to 5) (Table 3) . The effect of plant sampling side on plant content of micronutrients and trace elements was not significant (Table 4) . The plant contents of Mn , Cu , Cr and Cd were higher in shoot than the root part of the plant . However , the plant content of Fe , Zn, Ni , and Pb was higher in root than the shoot part of the plant (Table 5) .

Trace elements content in plant :

Trace elements content in plant , collected from the study area was studied in relation to the reported literature and their toxic levels . It is obvious that prolonged use of wastewater stream flow for more than ten years (the concentration of Cr , Cu , Mn , Ni, Pb ,and Zn in the sewage water was associated with increase in soil content of trace and micronutrient elements . However , the concentretion of those elements in soil did not reach the critical level causing toxicity of plants (Table 6) . The plant (Bermmuda grass) grew well along the wastewater stream and showed no symptoms of toxicity due to the prolonged flow of wastewater stream .The trace and micronutrient elements were not accumlated in plant tissues to cause serious hazard to plants , animals and humans (Table 7) . The toxic elements accumulated in plant tissues may be introduced to the food chain by means of animals food or human food (Banin et . al ., 1981).

According to criteria of element allowable concertration in plant tissues (Table 7) , most of micronutrient and trace elements were in the permissible range .The accumulation of those elements in vegetable and field crops may represent a real problem , thus further detailed investigation is needed in this respect . Therefore , care should be taken in the recommendation of using such kind of water source in irrigation , particularly with regard to trace elements . Plants markedly differ in their metal uptake , and in tolerance to soil when all other factors were held constant (Chaney and Giordano , 1977 and Sommers , 1980).

Table (6) : Total concentration of soil trace elements considered as phytotoxic (mg/kg) as compared to the concentration of soil elements in the study area .

Elements	Concentrations as given by various authors						Concentration detected in soil collected in the study area
	a	b	c	d	e	f	
Cd	-	5	8	5	3	-	0.334
Cr	-	100	75	100	100	-	28.15
Cu	60	100	100	100	100	125	29.33
Mn	3000	-	1500	-	-	-	579.75
Ni	-	100	100	100	100	100	13.40
Pb	-	100	200	100	100	400	18.16
Zn	70	300	300	400	300	300	33.582

Data collected from

A = Kovalskiy,1974

B = El-Bassam and Tietsen ,1977

C = Linzon , 1978

D = Kabat – Pendias , 1979

E = Kloke ,1979

F = Kilagishi and yamane , 1981

Table (7) : Total concentration of trace elements in mature plant tissue for various species (mg/kg)as compared to the concentration of elements found in the plant (shoots of Bermuda grass)collected from the study area .

	Trace element level reported *			Concentration detected in plant collected in the study area
	Deficient	Normal Range	Cytotoxic	
Fe	50	50-250	Not Known	-
Cd	-	0.50-0.2	5.30	1.29
Cr	-	.01-.05	5.30	16.79
Cu	2-5	5.30	20-100	19.23
Mn	15-25	20-300	300-500	88.07
Ni	-	0.1-5	10-100	7.5
Pb	-	5-10	30-300	64.7
Zn	10-20	27-100	100-150	101.16

* Data collected from Bergaman and Cumakon (1977) ; Davis et al . (1979) ; Gough et al .(1979) ; Hondenberg and Finck (1975) ; Jones (1972) ; Kabatpendias and Pendias (1979) ; Kitagishi and Yamane (1981) ; Mengel and Kirky (1978).

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تأثير استخدام مياه الصرف الصحى على التركيب الكيميائى لحشيشة البرمودا النامية على إمتداد مجرى الصرف الصحى فى أراضى المناطق الجافة

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ملخص

تم دراسة استخدام مياه الصرف الصحى المعالجة فى محطة مكة المكرمة على التركيب الكيميائى لحشيشة البرمودا النامية على امتداد المجرى المائى فى منطقة جافة . تم عمل خمس رحلات ميدانية لجمع العينات النباتية ، وفى كل رحلة تم جمع العينات من خمسة محاور عرضية على إمتداد مجرى الصرف عند نقطتين (واحدة على كل جانب من المجرى المائى يفصلهما ثلاثة أمتار)، تم تحليل جميع العينات النباتية من حيث محتواها من العناصر الكبرى (النيتروجين ، الفوسفور ، الكالسيوم ، المغنسيوم ، الصوديوم) والعناصر الصغرى (الحديد ، الزنك ، المنجنيز ، النحاس) ، والعناصر السامة (النيكل ، الكادميوم ، الكروميوم ، الرصاص) .

أظهرت النتائج أن محتوى نبات حشيشة البرمودا من N,P,K,Ca,Mg. Na, Zn, Mn, Cu, Ni, Pb, Cr قد نقص بينما زاد محتوى النبات من الحديد مع طول مدة استخدام مياه الصرف الصحى ، ولوحظ عدم تأثر عنصر الكالسيوم بتلك المدة . وقد لوحظ نقص محتوى النبات من عناصر البوتاسيوم ، الصوديوم ، الزنك ، النيكل ، الرصاص وزاد محتواه من النيتروجين والحديد على امتداد مجرى الصرف الصحى ، ومع ذلك لوحظ أيضا عدم تأثر بعض العناصر بموقع أخذ العينات ولم يؤثر الجانب الذى أخذ منه العينات علي جميع العناصر الكبري والصغري والسامة ،ومن ناحية أخري فقد لوحظ زيادة بعض العناصر في السيقان عن جذور النبات مثل النيتروجين ، والفسفور والبوتاسيوم والكالسيوم والماغنسيوم ، المنجنيز ، النحاس ، الكروميوم ، الكادميوم ، إلا أن العكس كان صحيحاً مع عناصر الزنك ، النيكل ، الرصاص حيث زادت فى الجذور عن السيقان .