J. Agric. Sci. Mansoura Univ., 25 (6): 3699 - 3710, 2000.

EFFECT OF POLUTION ON THE WATER QUALITY OF RIVER NILE IN DAKAHLIA AND DEMITTE.

Ibrahim, Azza H.; F.M. Shehab El-Din and Safaa A. Hassan
Chemistry Dept., Fac. of Agric., Mansoura Univ.

ABSTRACT

River Nile water was known to be clean. But now after discharging industrial effluents T.F.F., municipal agric. waste (Kafr El-Dabbusi) and Electrical Station at Kafr El-Bateekh discharging its waste in River Nile.

Water temperature, E.C., nitrogenous compounds were recorded salinity, total alkalinity, total hardness were also estimated. Heavy metals and total bacteria were measured to all locations under investigation.

INTRODUCTION

River Nile was known as a clean river in the past time, but now it is subjected to human activities that cause pollution. As long as 1000 km from Aswan to Cairo, it received about 3.2 billion cubic meters of Agric. discharges beside 0.4 billion c.m. industrial effluents (El-Motassem, 1987). There were about 37 main drains discharging municipal Agricultural and industrial waste water (Aboul-Ela *et al*., 1990 and El-Sherbini, 1996).

Water quality is a term in its broad sense includes all physical, chemical and biological characteristics of water. The main environmental factors affecting toxicity are; water hardness, oxygen and CO_2 comcen., pH, temp. and salinity (Skidmore, 1974). Agricultural effluents such as fertilizers, pesticides, underground water and sewage wastes change water quality with regard to its physico-chemical and biological properties (Abel, 1989).

The aim of the present work was to show out the effect of pollution in Dakahlia and Demietta states along the River Nile water on water quality.

MATERIALS AND METHODS

1- Samples of water were collected from locations depicted in Table 1.
2- pH was measured directly using pH-meter model Porda Mess 654.
3- Electric conductivity (E.C.). Values were measured at site using conductivity meter WTW LF-91.
4- Nitrite and nitrate: it were determined according to Black (1965).
5- Amonia-N: It was determined by Nesseler's method as described by APHA (1985).
6- Total nitrogen: It was determined by micro-kjeldahl method (AOAC, 1984).
7- Salinity and total hardness: It was measured according to APHA (1985).
8- Heavy metals: Heavy metals were determined according to APHA (1985).
9- Bacteriological examination: Samples of water were examined for total bacterial count as *Echerichia coli* count according to APHA (1985).

Table 1. Locations of investigated samples.

Location	Governorate	Notice
I	Giza	El-Kraimate location This location was chosen as control, as it lies far from sources of pollution, near desert at about 80 km south of Cairo, in Giza Governorate
II	Dakahlia	Awish Al-Hajar location It lies about three Km south east of Talkha Fertilizer Factory and therefore it is far from the factory water discharges
III		Talkha Fertilizer Factory (T.F.F.) location It lies directly close to the north borders of T.F.F. and receives the main outlets of factory drainages. Talkha Fertilizer Factory is considered as an important source of air and water pollution.
IV		Kafr Al-Dabbusi location It lies on Damietta branch of River Nile (25-km north T.F.F.). It receives a mixture of three types of pollutants, which include the sewage, agricultural and industrial effluents.
V	Damietta	Kafr El-Bateekh location It lies in Damietta Governorate and receives the discharge of Electric Power Station.

RESULTS AND DISCUSSION

The level of pollutants increased in the River Nile due to the increasing of industrial, agricultural and sewage effluents. The present study was carried out to measure pollution level via evaluation of water quality in its brood sense, using many parameters, for collected water from investigated location.

Table 2 depicted temp., pH and electrical conductivity

1. Water temperature:

Water temperature is very effective in O_2 solubility , turbidity, biochemical processes of aquatic organisms (Abdel-Hamid, 1996). There is a relationship between temperature, pH and percentage of ammonia in the toxic form of unionized ammonia (NH_3).

Table 2. Temperature, pH value and electric conductivity of water from different locations during winter and summer (1997).

Locations[1]	Temperature (°C)		pH value		Electric conductivity (mms/cm)	
	Winter	Summer	Winter	Summer	Winter	Summer
I	20.0 g[2]	29.0 e	7.50 ef	8.30 c	0.140 j	0.180 h
II	19.0 g	25.0 f	7.00 g	7.75 de	0.160 l	0.250 g
III	50.0 b	56.0 a	9.10 b	10.33 a	1.800 b	1.900 a
IV	20.0 g	31.0 e	7.10 fg	7.60 e	0.350 f	0.400 e
V	36.0 d	40.0 c	7.80 de	8.19 cd	0.590 d	0.690 c
F-test	**		**		**	
Overall mean	29.0 b[3]	36.2 a	7.70 b	8.43 a	0.609 b	0.684 a
F-test	**		**		**	

[1] **I : El-Kraimate II: Awish Al-Hajar III: Talkha Fertilizer Factory IV: Kafr Al-Dabbusi V: Kafr El-Bateekh.**

[2] **Within each column (including data for winter and summer), values followed by the same letter(s) are no significant difference (P = 0.05).**

[3] **Within the overall mean row, for each parameter, values followed by the same letter have not significantly different (P = 0.05).**

**** Significant, (P = 0.05).**

Location III and V showed the highest values of temp. (50.0 - 56.0) & (36.0 - 40.0) °C as it is affected by two factories, Talkha Fertilizer Factory (TFF) and Kafr El-Bateekh Electric Station. While, location of Awish Al-Hajar showed the lowest temp. 19.0 - 25.0 in winter and summer, respectively. The last location is not near to any factory.

2. Water pH:

It was observed that pH value elevate with increase in water temp. It ranged between 7.0 to 9.1 and 7.6 to 10.33 during winter and summer, respectively. The highest pH value was recorded for location III (9.1 and 10.33) for winter and summer, respectively. Abdel-Hamid (1994) reported that pH values of fresh water are variable and influenced by presence of nitrogenous pollution plants consuming CO_2 and soil pH. The obtained results were in agreement with those reported by El-Dyasty (1997) (7.6-10.9) for fresh water collected from location II and III.

As the pH has a pronounced effect on toxicity of nitrogen and metal compounds such as solubility of heavy metals. The metals will be more toxic at pH 5-7, while the toxicity decreased at pH 8-9 (Everall *et al*., 1989).

3. Electric conductivity (E.C.):

It was reported by Abdel-Hamid (1996) that E.C. of water increased in the presence of salts. As TFF has a pronounced discharge of salts, it is expected that this location will have a high degree of E.C. as shown from Table 2. Location of TFF was followed by Kafr El-Bateekh Electric Station as its effect on water E.C.

4. Nitrogenous compounds (nitrite, nitrate, ammonia and T.N.):

Table 3 depicted nitrite, nitrate, ammonia and total N. Nitrate and nitrite showed the same trend. Nitrite varied from 0.0241 mg/L in winter and 0.0297 mg/L in summer in location I and 0.0268 mg/L in winter and 0.0320 mg/L in summer in location II, while it showed the highest level in location III (0.0620 mg/L in winter and 0.0623 mg/L in summer) as it is affected by TFF. Location III was followed by location IV and the last was followed by location V. Location IV was affected by agricultural discharge. Nitrate showed the same trend.

The present observations were higher than those recorded for El-Manzalah lake (11 ppb) by Abdel-Hamid and El-Zareef (1996), and Egyptian lakes such as Mariut, Edku and Brollus (Saad, 1990). This phenomena may be attributed to the difference between lakes and running water.

Nitrites are intermediate products in the nitrification process of ammonia to nitrate (Abdel-Hamid, 1996). The toxicity of nitrite may be due to the reaction of nitrite with secondary amines to produce carcinogenic nitrosamine that threated every vital tissue (Mostafa, 1988 and Ali, 1991).

The present results of nitrate did not agree with Zyadah (1995) (1.0 - 5.53 mg/L) in El-Manzalah lakes water. Nitrate showed to be the largest concentration in location III, and the lowest level was found in location IV and V.

Ammonia level differed according to season and location. It is high in summer than winter, and showed the largest concentration in location III (TFF) (3200.77-3202.03 mg/L), which are considered to be toxic for plant and animals. The water in location III sometimes showed white patches of ammonia floating over water surface due to high value of ammonia that produced from TFF.

All values obtained except in location I and II were higher than the maximum recommended level in wastewater (0.5 mg/L) as reported by EPA (1983).

5. Total N_2:

It could be observed from Table 3 that total N_2 reached its recorded in maximum level at location III in the two seasons. The last location showed more concentration for all nitrogenous compounds as its products are nitrogenous fertilizers and so its discharge will increase nitrogen compounds.

Total N_2 estimated showed to be more than N_2 in different forms of compounds as nitrite, nitrate and ammonia. This may be as a result of different ways of stimulating N_2 in the other forms of nitrogenous compounds.

3

Table 4. Salinity, total alkalinity and total hardness (as mg/L) of water from different locations during winter and summer (1997).

Locations[1]	Salinity		Total alkalinity		Total hardness	
	Winter	Summer	Winter	Summer	Winter	Summer
I	36.13 l[2]	52.25 h	147.42fg	144.81 g	385.60 d	140.70 l
II	55.90	61.37 f	156.78ef	143.09 g	151.47 h	128.10 j
III	974.43 b	1016.96a	861.90 a	421.00 b	422.10 c	417.30 b
IV	378.96 d	398.37 c	348.66 c	336.58 d	501.63 a	275.43 g
V	216.54 e	216.67 e	161.46 e	147.42fg	308.00 e	294.00 f
F-test	**		**		**	
Overall mean	332.39b[3]	349.12 a	335.24 a	238.58 b	353.76 a	251.10 b
F-test	**		**		**	

[1] I : El-Kraimate II: Awish Al-Hajar III: Talkha Fertilizer Factory IV: Kafr Al-Dabbusi V: Kafr El-Bateekh.

[2] Within each column (including data for winter and summer), values followed by the same letter(s) have no significant difference (P = 0.05).

[3] Within the overall mean row, for each parameter, values followed by the same letter have not significantly different (P = 0.05).

**** Significant, (P = 0.05).**

6. Salinity:

Salinity means the total concentrations of all ionic constituent present in water sample (Cloude and Boyd, 1979).

From Table 4, it could be shown that salinity of water samples ranged between 36.13 - 974.43 mg/L in winter and from 52.25 to 1016.96 mg/L in summer. Location III characterized by a high salinity level (974.43 and 1016.96 mg/L), while location I recorded the lowest value (36.13 and 52.25 mg/L). Statistical analysis of salinity revealed presence of significant (P = 0.05) differences among location and between seasons.

The obtained results for water salinity were higher than that given by El-Dyasty (1997), who recorded average values of 35.33, 320.48 and 189.37 mg/L for water salinity of locations II, III and IV, respectively.

7. Total alkalinity:

The total alkalinity includes the total concentrations of OH^-, $CO_3^=$ and HCO_3^- in the water. The results for total alkalinity were illustrated in Table 4. The results revealed that total alkalinity was higher in collected water samples during winter than that during summer. The values of total alkalinity ranged between 147.42 - 861.90 and from 143.09 to 421.00 mg/L in the two seasons, respectively. The highest values (861.0 and 421 mg/L) were found for location III, while the lowest one (143.09 mg/L) was obtained for location II in summer.

The present results were in disagreement with those reported by El-Dyasty (1997), who found that the total alkalinity values were 140.00, 512.12 and 850 mg/L in the water samples taken from locations II, III and IV, respectively.

According to Cloude and Boyd (1979), the water of location III is considered very hard water, whereas they noticed that natural water, which contains more than 300 mg/L of $CaCO_3$ is considered very hard for biological purposes.

8. Total hardness:

Total hardness includes temporary hardness, which caused by carbonates and bicarbonates of calcium and magnesium, in addition to permanent hardness which due to calcium sulphate.

Total hardness followed the same trend as total alkalinity (Table 4). The overall means of total water hardness was 353.76 and 251.1 mg/L in winter and summer, respectively.

The maximum level was found in location IV (501.63 mg/L) by rollowed location III during winter (422.10 mg/L). While the minimum value was recorded in location II in both seasons (151.47 and 128.10 mg/L).

The obtained results are in disagreement with those mentioned by El-Dyasty (1997), who gave average values of 116.0, 52.5 and 120.0 mg/L for total hardness in water from locations II, III and IV, respectively.

As recorded by Rishah and Al-Khodary (1994), the contamination leads to elevate of water hardness and consequently affects the fish production.

From Table 4, it was clear that total alkalinity and total hardness showed the same trend especially in winter than in summer. This phenomena may be attributed to the fact that irrigated in Egypt stop in winter leading to little dilution of contaminants in winter than in summer where there will be a flow of River Nile. According to this fact, there would be a decrease in the two parameters in summer.

Location IV showed the most concentration of total hardness during winter than other locations because it is a center of accumulation of sewage, agricultural drainage and location III discharge.

9. Heavy metals:

Pollution of the aquatic environment with heavy metals became a serious problem during the recent years. Heavy metals in water is associated with man's activities, industrial and agricultural discharges. The later two sources are considered the primary reasons of metal poisoning of aquatic environment.

The present study involved the determination of lead, cadmium and zinc in water samples during winter and summer, 1997. The results are recorded in Table 5.

a. Lead:

It is clear that there were no significant differences in lead contents among seasons in all locations. The highest levels were observed in location IV (0.413 and 0.452 ppm), while the lowest ones were recorded in location I and II.

5

The obtained results for lead content in all locations (except location I and II) were above the permissible limit according to Mance (1987), who reported that the critical concentrations of lead in fresh and salt waters ranged from 5 to 20 μg/L, while lead concentrations in location I and II are within the permitted allowance limit. In addition to the Egyptian Law No. 48 (1982) for fresh water quality criteria of River Nile and water canals, shows that the concentration of lead in μg/L must not be more than 50 after drainage of treated liquid industrial waste.

b. Iron:

As shown in Table 5, iron concentration ranged from 0.354 to 1.238 and 0.358 to 1.333 mg/L in water samples collected during winter and summer, respectively. There were no significant difference between iron concentrations of water samples collected from location I and II in two seasons, while there was significance between seasons in locations V. Location IV showed to contain the highest value (1.238 and 1.333 mg/L) followed by location V (1.113 and 0.925 mg/L), while the lowest value was recorded in water samples collected from location I and II.

c. Cadmium:

Table 5 revealed that the levels of cadmium affected by locations and seasons except in locations I and II, which contained approximately the same value in both two seasons. It is clear that were significant differences among seasons, as the overall mean was 0.0126 and 0.018 in winter and summer, respectively. The highest concentration was recorded in location IV in two seasons (0.029 and 0.033 mg/L) and location V during summer (0.032 mg/L).

Cadmium concentrations in the present study in location III, IV and V are above the permitted allowance (0.002 ppm) as reported by Mance (1987) and 0.005 ppm according to WHO (1984), while in the location I and II are within the permissible limit.

d. Zinc:

Concerning zinc content, Table 5 clarified that there were no significant differences between water samples collected from location I and II during the two seasons. The same trend was observed between location III and IV, also during two seasons and location V only in winter. In general, the overall mean was 0.459 and 0.575 mg/L in winter and summer water samples, respectively.

Location V during summer showed to contain the highest level of zinc (1.206 ppm), while the lowest one was detected in location I and II.

Water samples from location I and II had zinc concentration within the allowable limit (0.02-0.05 mg/L) as recorded by WQC (1972), while locations III, IV and V showed to contain zinc level higher than that permissible limit.

Moreover, location IV showed more concentration of heavy metals than other locations because this location receives three types of pollutants

(sewage, agricultural drainage and TFF discharge), in addition to the presence of a pump station before this location directly. The present results cleared that the concentration of heavy metals was higher in summer than winter, because of high temperature which increases the solubility of metals

It is obvious from this data that locations III, IV and V showed more concentration than allowable limit in all heavy metals. This means that the water is hazardous for fish, animal and human.

10. Total bacterial count *Escherichia coli* count:

As shown in Table 6, total bacterial count in all locations was higher during summer than winter samples. It was clear that all locations except location IV were free from *E. coli* and the presence of *E. coli* in the water samples due to the sewage effluents in this location more than in the others. As this location is a center of accumulation of sewage of El-Tawella.

Table 6. Total bacterial count and *Escherichia coli* count (as cell/ml) of water from different locations during winter and summer (1997).

Locations[1]	Total bacterial count		*E. coli* count	
	Winter	Summer	Winter	Summer
I	10333.33 ab[2]	12000.00 ab	0.00 c	0.00 c
II	3700.00 b	12050.00 ab	0.00 c	0.00 c
III	4700.00 b	9533.33 ab	0.00 c	0.00 c
IV	7666.67 ab	7703.33 ab	1000.00 b	1733.33 a
V	24700.00 b	27000.00 a	0.00 c	0.00 c
F-test	**		**	
Overall mean	10220.00 a[3]	13657.33 a	200.00 b	346.67 a
F-test	NS		**	

[1] **I : El-Kraimate II: Awish Al-Hajar III: Talkha Fertilizer Factory IV: Kafr Al-Dabbusi V: Kafr El-Bateekh.**

[2] **Within each column (including data for winter and summer), values followed by the same letter(s) have no significant difference (P = 0.05).**

[3] **Within the overall mean row, for each parameter, values followed by the same letter have not significantly different (P = 0.05).**

**** Significant . NS : Non significant, (P = 0.05).**

From the present results recorded in Table (6) about the different parameters and heavy metals in water samples, it could be concluded that:

Effects of sampling, seasons and locations were significant for more (if not all) studied water parameters.

The variations in the concentration of heavy metals and other pollutions from one sampling site to another may be due to the variation in the quality of industrial, agricultural and sewage wastes being added to the River Nile at different studied locations.

Salinity is correlated positively with pH value, temperature, alkalinity, nitrite and ammonia, but negatively with dissolved oxygen.

Locations I and II lie far from the sources of the pollution and characterized with suitable temperature degree, pH value, high concentration of D.O. On the other hand, low levels of salinity,

alkalinity, ammonia and nitrite. Moreover, the lower level of heavy metals than the permissible limits, so they are considered as control.

Location III lies directly close to TFF and its water characterized with high temperature degree, pH value, salinity, total alkalinity, nitrite and ammonia and subsequently, low concentration of D.O. In addition to the presence of some heavy metals above the permissible limits. Therefore, all above mentioned properties of water at this location reflected on the absence of fish in the water.

Location IV, receives a mixture of three types of pollutants including sewage, agricultural and industrial effluents. Its water characterized with high level of nitrite, heavy metals and presence of *Escherichia coli*.

Location V, it lies near the Electric Power Station and receives the discharges of this station. Therefore, its water characterized with high temperature degree (especially during summer) nitrite and heavy metals.

REFERENCES

Abdel-Hamid, A.M. (1996). Field and Laboratory Analysis Animal Production. An Arabic Textbook, Dar Al-Nashr for Egyptian Universities, Cairo (I.S.B.N. 977-5526-47-7). Deposit No. 11318/96.

Abdel-Hamid, A.M. and El-Zareef, A.A.M. (1996). Further studies of the pollution status on the southern region of El-Manzalah lake. Proc. Food Borne Contamination and Egyptian's Health, Mansoura, Nov. 26-27, pp: 141-150.

Abel, P.D. (1989). Water Pollution Biology. Ellis Horwood, Limited Publishers. Hasted Press: A Division of Jation-Wiley & Sons. New York. Chichester Brishane, Totonto.

Aboul-Ela, T.A.; Fayed, S.E. and Ghazy, M.M. (1990). Zooplankton as a parameter of pollution of the Nile water in Egypt. Proc. Zool. Soc. A.R.E., 21:203-217.

Ali, O.M. (1991). Study on the pollution in El-Manzalah lake. Nat. Conf. of the Environment of Lake El-Manzalah, Portsaid, 27-29 October.

A.O.A.C., (Association of Official Analytical Chemists), (1984). Official Methods of Analysis of the Association of Official Analytical. 13th Edition, S. Whelms (Editor), Association of Official Analytical Chemists, Inc.

APHA, (American Public Health Association), (1985). Standard Methods for the Examination of Water and Wastewater. 6th Edition, New York, American Public Health Association, 1193.

Black, C.A. (1965). "Methods of Soil Analysis". Part 2. USA, Madison, Wisconsin, USA.

Cloude, E. and Boyd (1979). Water quality in warm water fish ponds. Department of Fishiers and allied aquaculture. Aubum University, Agricultural Experiment Station.

Egyptian Law No. 48, (1982). Concerning Protection of River Nile and Water Canals Against Pollution. Official Journal, A.R.E., 25:7-49. (Arabic Language).

El-Dyasty, M.H. (1997). Effect of some industrial pollution on biology of some freshwater fish. M.Sc. Thesis, Fac. of Science, Mansoura Univ., Egypt.

El-Motassem, M. (1987). High Aswan Dam: Benefits and Side Effects. Ropert No. (97), High Aswan Dam Institute, Water Research Center, Qanater, Cairo, Egypt.

EPA (1983). Methods for Chemical Analysis of Water and Wastes. U.S. Environmental Protection Agency, EPA-690-4-79-020, Cincinnati, OH.

El-Sherbini, A.M.H. (1996). Design of montoring networks for water quality management in the river nile. Ph.D. Thesis, Fac. of Sci. Irrigation and Hydraulics Dept., Ain Shams University.

Everall, N.C.; Macforlane, N.A.A. and Sedgwick, R.W. (1989). The interactions of water hardness and pH with the acute toxicity of Zn to the brown trout, Salmo Trutto. J. Fish Biol., 35:27-36.

Mance, G. (1987). Pollution threat of heavy metals in aquatic environments. Elsvier Applied Science Publishers LTD, London and New York, 372.

Mostafa, M.H. (1988). Pollution sources and health hazards. Symp. Environ. Sci. (UNARC), Alex, 48-55.

Rishah, A. and Al-Khodary, R. (1974). In: G.H. Al-Samra, Editor of Pan Arab Symp. on Pollution, Cairo, 22-25, April, 1972, ALEFCSO.

Saad, M.A.H. (1990). State of the Egyptian delta lakes, with particular reference to pollution problems. Regional Symp. Environ. Stud. (UNARC), Alex, 275-292.

Skidmore, G.R. (1974). Factors affecting the toxicity of pollutants to fish. J. Vet. Res., 94:456-458.

WHO (1984). Guide lives for drinking water quality Geneva.

WQC (1972). A Report of The Committee on Water Quality Criteria. NAS. Wash. DC.

Zyadah, M.A.I. (1995). Environmental impact assessment of pollution in lake Manzalah and its effect on fish. Ph.D. Thesis, Fac. of Sci., Damietta, Egypt.

تأثير التلوث على جودة مياه النيل فى محافظتى الدقهلية ودمياط

عزة حسنى إبراهيم ، فوزى محمود شهاب الدين وصفاء أحمد حسن

قسم الكيمياء – كلية الزراعة جامعة المنصورة

أجريت هذه الدراسة لمعرفة جودة مياه النيل فى منطقة الكريمات بالجيزة (I) ومنطقة أويش الحجر بالدقهلية (II) ومقارنة تلك المنطقتين بمنطقة طلخا بعد مصنع سماد طلخا (III) ومنطقة كفر الدبوسى (IV) (25 كم شمال مصنع السماد بعد محطة الرفع) على نهر النيل التى تخلط مياه الصرف الزراعى والآدمى بمجرى النيل وكذلك منطقة كفر البطيخ (V) بعد محطة كهرباء كفر البطيخ0

وقد عنيت الدراسة بدراسة درجة الحرارو و pH والتوصيل الكهربى سيفاً وشتاءاً بعينات المياه0 كما سجلت قيم النتريت والنترات والأمونيا وكذلك النتروجين الكلى وكذلك الفحص الميكروبى0

وقد أثبتت النتائج أن المنطقة المتاخمة لمصنع سماد طلخا قد إحتوت على أعلى المستويات من الملوحة والقلوية والعسر الكلى تلتها المنطقة الرابعة "كفر الدبوسى"0

كما شملت الدراسة تقدير بعضا من العناصر الثقيلة وهى الرصاص والحديد والكادميوم والزنك حيث كانت المنطقة الرابعة "كفر الدبوسى" هى الأعلى فى كمية الرصاص والحديد والكادميوم يليها كفر البطيخ "المنطقة الخامسة" الأعلى فى الزنك وأقل المناطق كانت الأولى والثانية "الكريمات وأويش الحجر0

Table 3. Nitrite, nitrate, ammonia and total nitrogen (as mg/L) of water from different locations during winter and summer (1997).

Locations[1]	Nitrite		Nitrate		Ammonia		Total nitrogen	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
I	0.0241 j[2]	0.0297 h	1.49 d	1.58 c	0.44 b	0.56 b	2.41 c	2.52 c
II	0.0269 I	0.0320 g	0.33 f	0.52 e	0.45 b	0.59 b	1.32 c	1.58 c
III	0.0620 b	0.0623 a	10.12 b	11.06 a	3200.77 a	3202.03 a	3214.53 b	3218.50 a
IV	0.0471 b	0.0585 c	0.25 f	0.29 f	1.92 b	2.16 b	2.30 c	2.52 c
V	0.0447 f	0.0490 e	0.25 f	0.28 f	0.88 b	0.93 b	1.14 c	1.52 c
F-test	**		**		**		**	
Overall mean	0.0429 b[3]	0.0463 a	2.49 b	2.75 a	640.89 a	641.25 a	644.34 a	645.33 a
F-test	**		**		NS		NS	

[1] **I : El-Kraimate II: Awish Al-Hajar III: Talkha Fertilizer Factory IV: Kafr Al-Dabbusi V: Kafr El-Bateekh.**
[2] **Within each column (including data for winter and summer), values followed by the same letter(s) have no significant difference (P = 0.05).**
[3] **Within the overall mean row, for each parameter, values followed by the same letter have not significantly different (P = 0.05).**
**** Significant . NS : Non significant, (P = 0.05).**

Table 5. Heavy metals (mg/L) of water from different locations during winter and summer (1997).

Locations[1]	Lead		Iron		Cadmium		Zinc	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
I	0.011 a[2]	0.013 d	0.354 d	0.358 d	0.001 d	0.002 d	0.032 c	0.034 c
II	0.016 d	0.031 d	0.361 d	0.362 d	0.003 d	0.004 d	0.035 c	0.038 c
III	0.222 b	0.241 b	0.389 c	0.767 c	0.010 c	0.018 b	0.660 b	0.795 b
IV	0.413 a	0.452 a	1.238 a	1.333 a	0.029 a	0.033 a	0.777 b	0.803 b
V	0.126 c	0.145 c	1.113 ab	0.925 bc	0.020 b	0.032 a	0.792 b	1.206 a
F-test	**		**		**		**	
Overall mean	0.157 a[3]	0.176 a	0.691 a	0.750 a	0.016 b	0.018 a	0.459 b	0.,575 a
F-test	NS		NS		**		**	

[1] I : El-Kraimate II: Awish Al-Hajar III: Talkha Fertilizer Factory IV: Kafr Al-Dabbusi V: Kafr El-Bateekh.
[2] Within each column (including data for winter and summer), values followed by the same letter(s) have no significant difference (P = 0.05).
[3] Within the overall mean row, for each parameter, values followed by the same letter have not significantly different (P = 0.05).
**** Significant . NS : Non significant, (P = 0.05).**