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Status of soil chemical properties and nutrient contents of some crops cultivated of sahl el-tina north sinai under irrigation with low water quality of el-salam canal

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Abstract

A survey study was carried out on soil chemical characteristics and nutrients content of crops at Sahl El-Tina (North Sinai), irrigated with El-Salam canal water. Soil samples were collected from 0-60 cm depth from ten sites. Soil pH values varied from 7.40 to 8.01, EC of soil ranged from 1.93 to 7.28 dS/m. Dominant soluble cation was Na^+ followed by Ca^{++} then Mg^{++} and K^+. Dominant soluble anion was Cl- followed by SO_4^{--} then HCO_3^-, no CO_3^{--} was found in the last order. Ranges of soil available nutrients (mg/kg) were 6.84 to 66.82 for N, 1.73 to 3.75 for P, 135.5 to 164.00 for K, 1.01 to 14.41 for Fe, 0.05 to 2.99 for Mn, 0.03 to 1.61 for Zn and 0.98 to 5.29 for Cu. Ranges for N P K in plant (%) are 2.79 to 5.11 for N, 0.33 to 0.55 for P, and 1.87 to 4.92 for K. Ranges for Fe, Mn, Zn, Cu in plant (mg/kg) 37.83 to 75.24 (Fe), 25.14 to 50.79 (Mn), 37.00 to 57.79 (Zn). Cu was within the toxic level in all the tested crops, ranged from 36.57 to 78.25.

Key words: Sahl El-Tina, El-Salam canal water , North Sinai , soil chemical.

Introduction

For many years, agriculture and socio-economic development in Sinai were always slow due to limited or scarce water resources. Therefore, the main strategy of socio- economic development of Egypt, since late years of the nineteen eighties was the re-use of agricultural drainage water after mixing it with Nile water. **Hussein and Raouf (2002)** stated that El–Salam canal would be fed with agricultural drainage water to cultivate large areas in northern Sinai.

Mostafa (2003) and Agram and Amer (2012) found that the EC of El-Salam Canal water varies from 1.30 to 2.12 dSm^{-1}. **Shaban and Helmy (2006)** reported that EC of El-Salam irrigation water ranged between 1.43 to 2.14 dS/m. **Ramadan and El-Fayomy (2002)** found increasing EC of soil resulted from the use of low water quality mixed with Nile water.

Hafiz (2001) revealed that the mean values of all available macronutrients, of N, P and K, increased in soil irrigated with low quality water. **El-Sheikh (2003)** showed that available –N and P were greater in soils which received mixed waters as compared with soils which received canal fresh water. **El-Kholy et al. (2000)** studied the contents of Fe, Zn, Mn and Cu in soils irrigated low quality water and found that the contents of these elements increased compared with irrigation with Nile water; increases were 4 folds (Fe) and 20 folds (Zn).

Mostafa (2001a) reported that application of sewage water increased the P-concentration in seeds of broad beans. **El-Banna et al. (2004)** and **Sallam et al. (2008)** noticed a non-significant difference as a result of irrigation with Nile water or El-Serw drain water on N%, P% and K% of wheat straw, nevertheless irrigation with Nile water caused increases in the uptake of N, P and K by wheat grains and straw.

Truby and Raba (1990) reported that irrigation with waste water caused enrichment of Zn in soil and led to increasing its uptake by strawberry and tomatoes. **Mostafa (2001b)** reported that Fe, Zn and Mn concentrations in seed of barley under irrigation with sewage water were greater than those irrigated with Nile water. **Sallamy et al. (2008)** showed that Fe, Zn and Mn contents in wheat grains were highest for plant irrigated with Bahr El-Bakar drain water**.** **Selem et al. (2000)** collected samples of strawberry, tomatoes, eggplant peppers and squash cultivated at different soils at Sharkia Governorate. Data revealed that irrigation with waste water increased micro-nutrients contents (Fe, Zn, Mn and Cu) in leaves and fruits of pants. **Badawy et al. (2013)** studied contamination with metals in plants in Sahl El-Hessania area, Sharqiya irrigated from Bahr El-Baqar drain and El-Salam canal .The concentration of metals in the edible parts for eight plant species grown showed significant increases of Fe, Zn, Mn and Cu concentrations in plants irrigated with Bahr El-Bakr, as compared with those irrigated with El-Salam water.

The current work is a survey study on the effects of irrigation with this low water quality of El-Salam Canal on some chemical properties and the availability of nutrients of Sahl El-Tina soil at North-Sinai.

Materials and Methods

Sahl El-Tina is located in the south–west of Sinai, It is irrigated with El-Salam Canal (Table 1) the area is on Latitude 31° N. and Longitude 33° E. and its elevation about 23 m. above the sea level. The land is above Lake Manzala and the water table depth varies between 1.12 to 2.20 m.

Soil samples were chosen from ten villages to cover wide soil texture types of the studied area. Soil samples were collected from the depth of 0-60 cm. Then, air dried, crushed, sieved to pass a 2 mm. and subjected to analysis. Samples of plants were also taken for analysis. Soil and plant analyses were done according to (**Dewis and Fried, 1970), Chapman and Pratt (1961), Page et al. (1982), Jackson (1973) and Soltanpour (1985)**.

Table 1 to 3 show data about the samples **Chapman and Pratt (1961)**. Available nutrients in soil were extracted by ammonium acetate (1 M) for K, sodium bicarbonate (0.5M) for P and KCl for N.

Table 1. Chemical properties of El-Salam Canal irrigation water

pH	EC	Chemical properties							
		Soluble ions							
		CO_3^{--}	HCO_3^-	Cl^-	$SO_4^=$	Na^+	K^{++}	Ca^{++}	Mg^{++}
7.6	2.41	- - -	3.55	12.94	8.10	15.53	0.49	4.97	3.65

Elemental ions (mg/l)					
Nutrients					
Macro		Micro			
N	P	Fe	Mn	Zn	Cu
4.17	1.10	0.91	0.94	0.78	0.06

Table 2. Sites of the studied soil samples at Sahl El-Tina district**.**

Soil sample					
No.	**Sites**	**Texture**	**No.**	**Site**	**Texture**
1	Village No.1	Sandy Loam	6	Village No.6	Loamy
2	Village No.2	Clay Loam	7	Village No.7	Clay
3	Village No.3	Clay	8	Gilbana Village	Sandy
4	Village No.4	Clay Loam	9	Village of Abdo Hamada	Clay
5	Village No.1150	Loamy Sand	10	Village of Hamdy El-Bayoumy	Loamy

Table3. Leave samples of cultivated crops irrigated from El-Salam Canal water.

Leaves			***Scientific Latin name*** **(Reuter and Robinson, 1986) & (Martin et al., 1976)**
Season	**crop**	**Stage of collection**	
Winter	**Alfalfa**	Whole Shoot before flowering	***Medicago sativa***
	Faba (field) bean	At pod formation	***Vicia faba***
	Sugar Beat	At tubers formation	***Beta vulgaris***
Summer	**Corn (Maize)**	At teaseling formation	***Zea mays***
	Cotton	At cotton almond formation	***Gossypium hirsutum***
	Tomato	At fruits formation	***Lycopresicon esculentiun***

Results and Discussion

Soil chemical characteristics:

Soil chemical characteristics are shown in Table 4 and Figures 1 to 4

Soil pH

Data of soil pH show that the pH varied from 7.40 to 8.01, which indicat that soils are slightly to moderately alkaline**.** Data also, show that pH of sites of 1, 3, 4, 6 and 9 is slightly alkaline (7.40 < soil pH< 7.87), and in sites 2, 5, 7, 8 and 10 it is moderately alkaline pH (7.90 < soil pH< 8.01). Soils irrigated with good quality Nile water had pH around 7.0 (Wahdan**, 2009)**.

Soil EC_e

Generally it can be noticed from the values of soil EC (Table 4 and Figure 2), ranged from 1.93 to 7.28 dS/m. According to soil salinity classification (Table 5) soils at Sahl El-Tina are saline.

Salinity development is due to continuous irrigation with this low water quality. **Wahdan (2009)** reported that EC dS/m of soils irrigated with Nile water rang of 1.0 to 2.5. **Ramadan and El-Fayomy (2002)** reported similar findings in their research.

Soluble ions of soil

Values of soluble cations Ca^{++}, Mg^{++}, Na^{+} and K^{+} (mmole/L) as well as soluble anions of HCO_3^{--}, Cl^{-} and SO_4^{--} are presented in Table 4.

Cations:

Data show that, the dominant cation was Na+ followed by Ca^{++} and then Mg^{++}, while K^{+} was the least. Their ranges were 5.43to 24.78 me/l for Ca^{++}, 3.29 to 22.98 mmole/L for Mg^{++} , 8.60 to 46.77 mmole/L for Na^{+}, 0.88 to 4.04 mmole/L for K .

Wahdan , (2009) stated that soil irrigated with water of River Nile contained soluble cations with mean values of 3.62 , 3.25, 4.84and 0.19 mmole/L for Ca^{++} , Mg^{++}, Na^{+}, and K^{+} , respectively. Therefore, water of El- Salam canal caused an increase in soluble catinos of soil from 1.5 to 6.8 folds for Ca^{++} , from 1.0 to 7.1 folds for Mg^{++} , from 1.8 to 10 folds for Na^{+} and from 4.6 to 21.3 folds for K^{+} . These trends agree with the findings of **Hafiz (2001)** and **El- Sheikh (2000)**.

Anions:

Data show that, the dominant anion was Cl^{-} followed by SO_4^{--} then HCO_3^{--} with no CO_3^{--} . Their general ranges mmole/L were 1.10 to 1.67 for HCO_3^{--} , 9.30 to 44.66 for Cl^{-} and 8.16 to 41.21 for SO_4^{--}.

Selem et al.(2000), stated that soil irrigated with the water of River Nile contained soluble anions with mean values (mmole/L) of 2.05, 1.93 and 1.00 for Cl^{-} , SO_4^{--} and HCO_3^{-} , respectively. Therefore, El-Salam caused increases of soluble anions of 4.50 to 21.8-folds for Cl^{-} and 4.2 to 21.4 -folds for SO_4^{--} and 1.1 to 1.7-folds for HCO_3^{-} relative to the corresponding values of anions soils irrigated with the River Nile. These results agree with those of **Zein et al (2002)**.

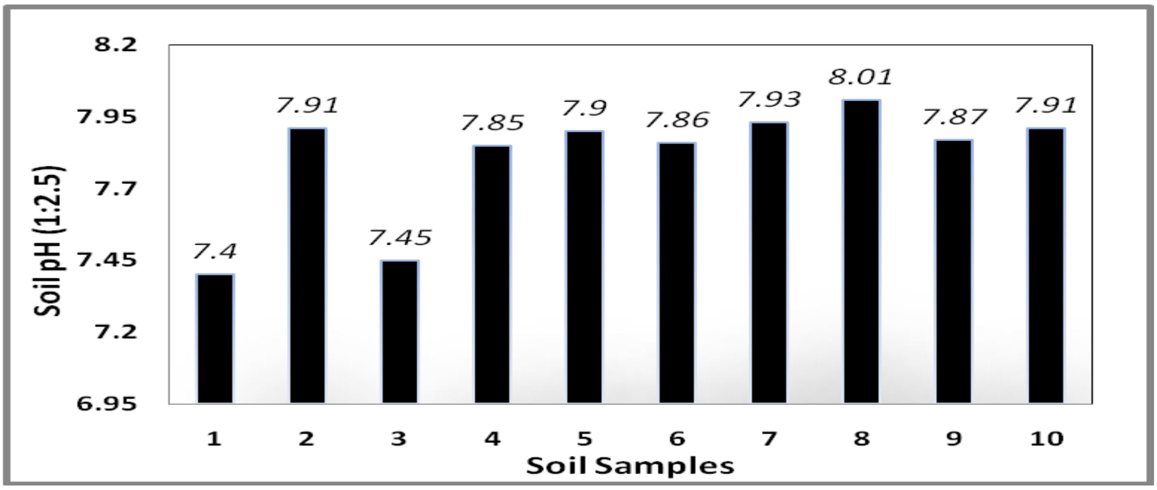

Fig (1): pH of different soil sites at Sahl El-Tina district irrigated with low water quality of El-Salam Canal.

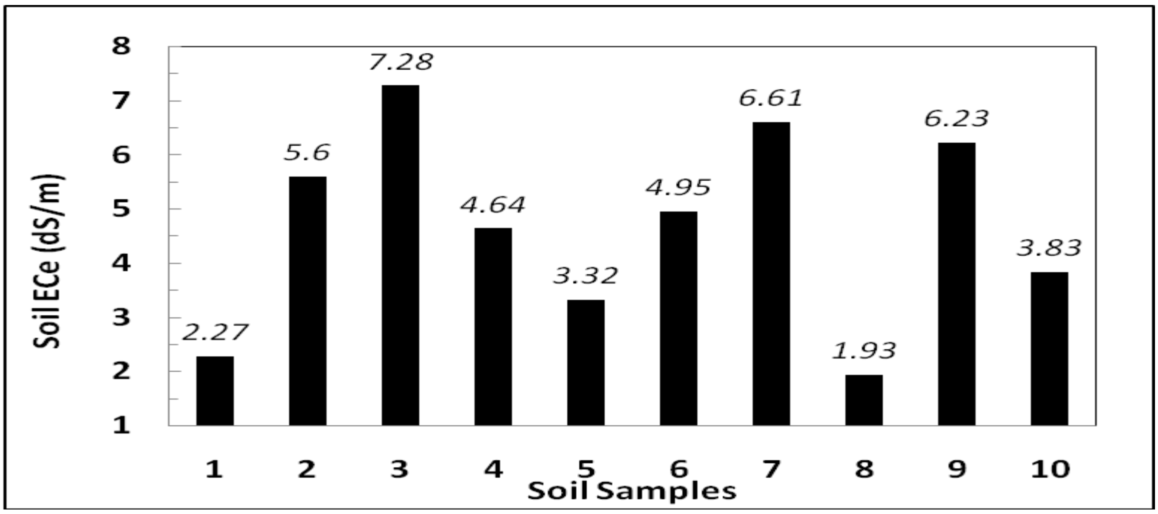

Fig (2): EC (dS/m) of different soil sites at Sahl El-Tina district irrigated with low water quality of El-Salam Canal.

Table 4. Status of some chemical properties and available of some elemental ions of soil at Sahl El-Tina district irrigated with low water quality of El-Salam Canal.

Soil sample No	Chemical properties									
	pH (1:2.5)	ECe (dS/m)	Soluble Ions of soil paste (me/l)							
			Cations				Anions			
			Ca^{++}	Mg^{++}	Na^{+}	K+	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}
1	7.40	2.27	5.74	3.29	11.42	2.15	-	1.26	12.20	8.16
2	7.91	5.60	19.96	9.31	22.18	3.32	-	1.63	34.18	26.44
3	7.45	7.28	23.22	22.98	28.61	3.75	-	1.10	41.25	41.21
4	7.85	4.64	12.35	14.48	21.39	3.00	-	1.53	24.10	22.50
5	7.90	3.32	6.30	3.65	22.76	1.86	-	1.38	23.59	9.53
6	7.86	4.95	12.28	11.19	25.72	1.88	-	1.60	29.20	21.06
7	7.93	6.61	24.78	17.80	30.80	4.04	-	1.64	37.46	33.06
8	8.01	1.93	5.43	4.59	8.60	0.88	-	1.67	9.30	8.60
9	7.87	6.23	11.08	10.00	46.77	1.73	-	1.48	44.66	18.69
10	7.91	3.83	7.86	4.27	25.68	1.19	-	1.42	26.9	10.68

Soil sample No	Available of elemental Ions (mg/kg. soil)						
	Nutrients Ions						
	Macro-nutrients			Micro-nutrients			
	N	P	K	Fe	Mn	Zn	Cu
1	7.86	3.59	144.67	6.83	1.17	1.40	5.29
2	6.84	2.70	164.00	13.43	2.33	1.03	1.07
3	7.76	3.00	151.00	8.25	1.09	1.61	3.66
4	27.45	2.76	140.64	9.40	1.84	1.05	4.74
5	32.51	3.55	135.50	12.34	1.95	0.67	1.08
6	42.23	2.70	141.15	11.55	1.42	0.84	1.16
7	36.65	3.58	143.10	9.38	1.79	0.73	4.26
8	60.40	2.26	139.55	14.41	2.99	1.39	0.98
9	41.55	1.73	143.70	1.93	0.79	0.39	4.55
10	66.83	3.75	139.90	1.01	0.05	0.03	1.34

Table 5. Ranges of salinity of the studied soils at Sahl El-Tina area and their classification according to FAO/UNESO, 1973.

Soil ECe (ds/m) classes as **(FAO/ UNESCO, 1973)**		soil sites	Effects on growing crops
EC< 2.0	**Salt Free**	**8**	**Salinity effects are mostly negligible.**
2.0< EC < 4.0	**Slightly Saline**	**1-5-10**	**Salinity effects are mostly negligible except for the most sensitive plants.**
4.0< EC < 8.0	**Moderately Saline**	**2-3–4-6-7-9**	**Yields of many crops restricted.**

Available macro-nutrients of soil

Values of available macro-nutrients of N, P and K (mg/kg. soil) are presented in Table 4 and Fig3.

Available N:

Avail.-N mg/kg recorded low levels in soils 1 to 3 with values of 6.84 to 7.86. In the other sites, the values were high, ranging from 27.45 to 66.83. These variations can be due agriculture activities in soils of 4 to 10 **(Azam et al., 1990).**

Available P:

The values of available –P in sites of 2, 4, 6, 8 and 9 are < 3 mg/kg. Values in the other sites are between 3.55 to 3.75. According to **Soltanpoor (1985)** soil of < 3 mg/ P/kg are classified as low-P while those of 3-9 are medium P-soils. Low available –N and available-P soils can be supplemented with organic manures rich in N and P as well as N and P-fertilizers.

Available K:

Soils had values of available-K rang from 135.5 to 164 mg/kg. **Soltanpour (1985)**, considered 120 mg/kg available K as high.

Wahdan (2009) reported that soils irrigated with the good quality Nile water, 24 to 32 mg/kg available N, 3 to 9 mg/kg available P and 125 to 142 mg/kg available K. In the current study, ranges of available N, P and K (mg/kg) were 6.84 – 66.83, 1.73 - 3.75 and 135.5-164.0.

Available micro-nutrients of soil

Values of available micro-nutrients of Fe, Mn , Zn and Cu are presented in Table 4 and Figure 4.

Available Fe:

Most soils except soil of sites 9 and 10 had high of available-Fe (> 5 mg Fe/kg) which is considered high according to **Soltanpour, (1985)**. **Shaban (1998) and El-Sheikh (2000**, recorded available–Fe of 0.14 to 3.51 in soils irrigated with good quality Nile water.

Available Mn:

Except soil of site 10, the majority of the tested soils had values of available – Mn ranging from 0.79 to 2.99 mg /kg and therefore they had high available– Mn > 1.0 mg. /kg .soil, **(Soltanpour 1985)**. **Shaban (1998) and El-Sheikh (2000)**, recorded available–Mn were of 0.08 to 1.48 mg/kg in soils irrigated with Nile water. Thus El- Salam Canal water caused high available–Mn in Sahl El-Tina soils. These results agree with those obtained by **El-Kholy et al. (2000)**.

Available – Zn.

Regarding the status of available – Zn of the tested soils, the sites of 5,6,7,9 and 10 had values of available – Zn of 0.03 to 0.84 mg/kg. They would be low in available – Zn (**Soltanpour 1985)**. The soils of sites 1, 2, 3, 4 and 8 had values of available- Zn of 1.03 to 1.61 mg/kg. Thus, they fall within medium to high in available Zn (**Soltanpour 1985). Shaban (1998), El-Sheikh (2000)** and **Farragallah and Essia (2005),** reported that soils irrigated with good quality Nile water recoded available–Zn 0.03 to 0.60 mg/kg. El- Salam Canal water must had increased available–Zn of Sahl El-Tina soils. These results agree with findings of **El-Kholy et al. (2000)**.

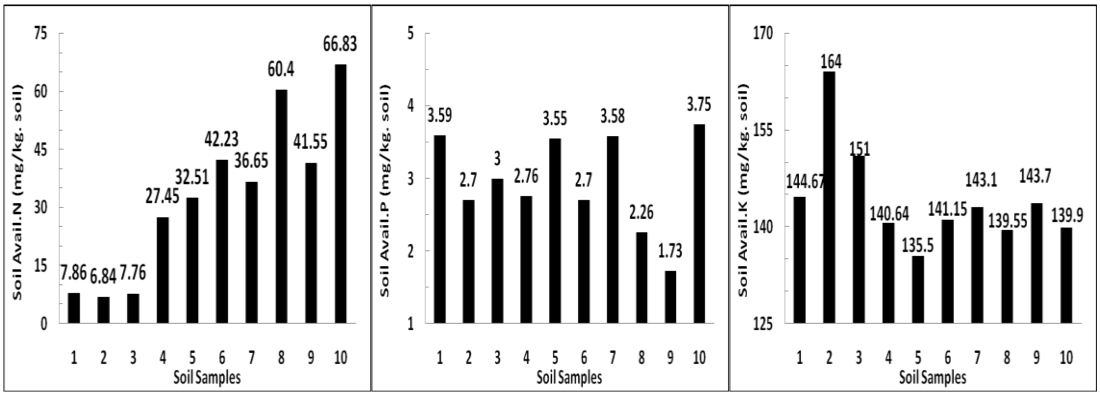

Fig (3): Avail-N, P and K of different soil sites at Sahl El-Tina area irrigated with low water quality of El-Salam Canal.

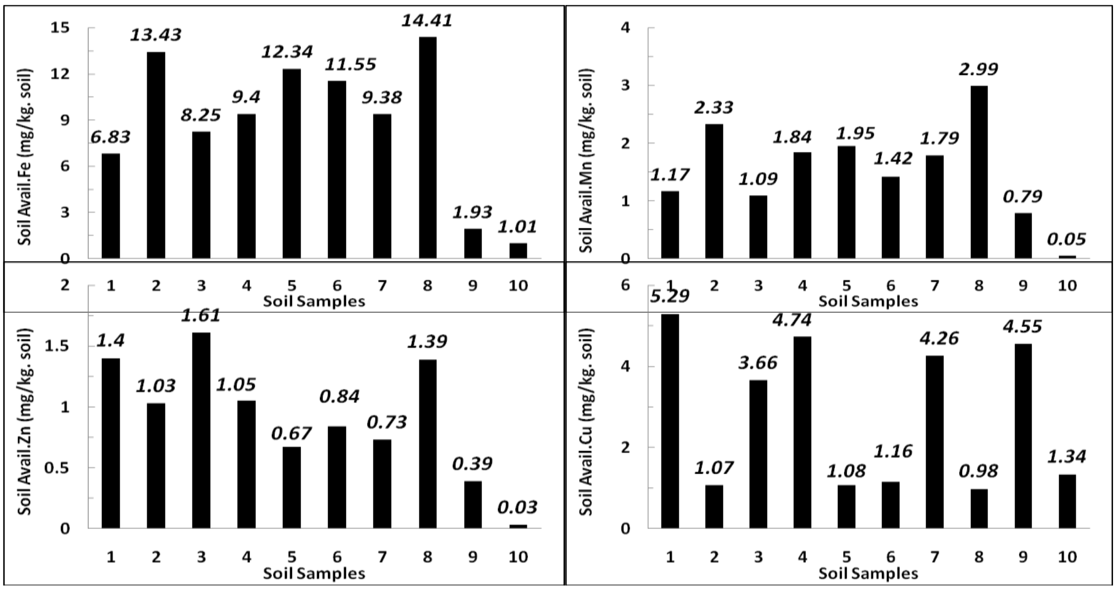

Fig (4): Avail-Fe, Mn, Zn and Cu of different soil sites at Sahl El-Tina area irrigated with low water quality of El-Salam Canal.

Table 6. Nutrient contents in leaves of some crop of sites at Sahl El-Tina (Averages).

Crops	Nutrients in dry matter						
	Macro (%)			Micro (mg./kg.dry wt.)			
	N	P	K	Fe	Mn	Zn	Cu
Alfalfa	2.79	0.39	1.87	63.96	45.30	57.79	37.72
Faba bean	2.78	0.33	2.27	37.83	50.79	43.97	38.24
Sugar Beat	4.60	0.44	4.51	59.77	36.88	53.27	36.57
Maize	2.99	0.39	3.02	57.79	27.96	37.00	39.72
Cotton	3.48	0.42	4.23	59.86	47.99	49.54	41.11
Tomato	5.11	0.55	4.92	75.24	25.14	48.65	78.25

Available – Cu.

Values of available– Cu ranged from 0.98 to 5.29 mg/kg. Therefore all the soils of the investigated sites showed high levels of available – Cu, i.e. > 0.5 mg. /kg (**Soltanpour 1985). Shaban (1998), El-Sheikh (2000) and Farragallah** and **Essia (2005),** stated that soils irrigated with good quality Nile water contained 0.02 to 0.09 mg/kg. Irrigation of Sahl El-Tina soils with El- Salam Canal water must lead increased available – Cu and may toxic levels in some sites. These trends are in agreement with the findings of **El-Kholy et al. (2000) and Selem et al. (2000)**.

Nutrients content of some cultivated crops:

Nutrient contents of leaves of some growing crops at the studied sites of Sahl El-Tina area under conditions of irrigation with low water quality of El Salam Canal are shown in Table 6 and in Figures 5 and 6.

Contents of N, P and K in crops.

Contents of N, P and K of the different tested crops, were tabulated in Table 6 and illustrated in Fig.(5). The results showed that contents of N ranged from 2.78 % to 5.11% and ranged from 0.33 % to 0.55 % P and those of K 1.87% to 4.92%.

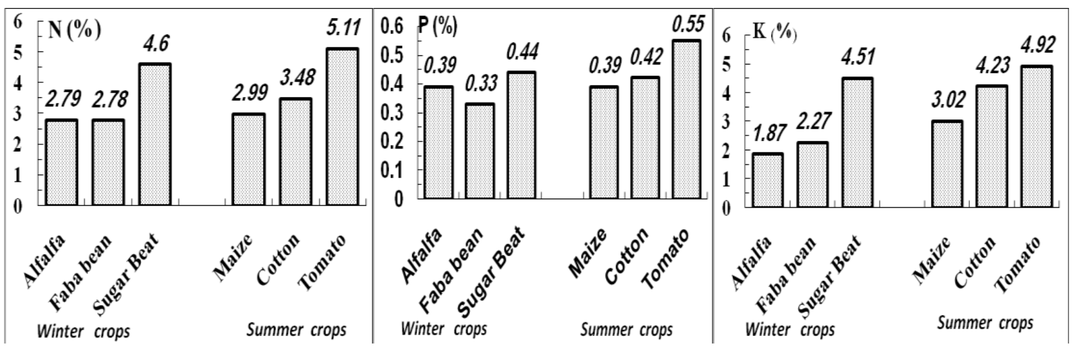

Fig (5): N, P and K (%) of some cultivated crops.

The crops can be arranged according to their N or P in the descending order of Tomato > Sugar beet > Cotton > Maize > Alfalfa > Faba bean. As for K the order were similar to that of N and K except that bean > alfalfa. According **Leo and James (1973)** and **Reuter and Robinson (1986)**, all tested crops contained N, P and K within the adequate ranges for the mentioned crops, except N of Alfalfa and bean which showed a marginal ranges.

Contents of Fe, Mn, Zn and Cu in crops.

Contents of Fe, Mn, Zn and Cu of crops are shown in Table 6 and illustrated in Figures 6**.** Contents (mg/kg) ranged from 37.83 to 75.24 mg/kg for Fe, 25.14 to 50.79 mg/kg for Mn, 37.00 to 57.79 mg/kg for Zn and 36.57 to 78.25 mg/kg for Cu.

According to classification described by **Reuter and Robinson (1986), Iwai et al. (1972), Leo and James (973) jones (1975), Mengel** and **kirkby (1978)**, it can be concluded that micronutrients in those crops as follows:

Alfalfa adequate for all nutrients. Faba bean: low Fe and adequate Mn and Zn, but marginal Cu. For sugar beet Fe is and adequate for Mn and Zn, Maize and Cotton recorded adequate for Fe, Mn and Zn, Tomato showed low Fe and Mn and adequate for Zn.

It could be concluded what alfalfa had adequate content of Fe, Mn and Zn. Faba bean showed low Fe and adequate Mn and Zn. Sugar beat showed adequate Mn and Zn. Maize and Cotton had adequate contents from all of Fe, Mn and Zn. Tomato were low in Fe and Mn and adequate Zn. **Kobata-Pendias and Pendias (1984) and Misra** and **Mena (1991),** reported that Cu ranges from 4 to 15 mg/kg, while **Podlesakova et al. (2002)** stated that 10 mg/kg of Cu in plants is critical**.** On the other hand**, Iwai et al. (1975)** showed that of 20.0 mg/kg is toxic. Thus Cu values in alfalfa, bean, maize, cotton and tomatoes are toxic.

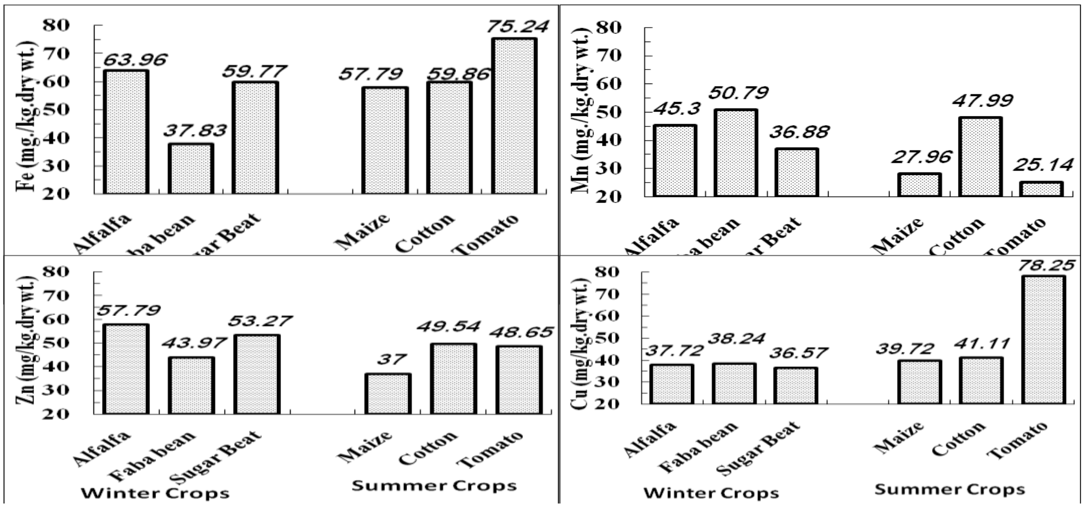

Fig (6): Fe,Mn, Zn and Cu (mg/Kg. dry wt.)

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حالة بعض الخصائص الكيميائية للتربة ومحتوى العناصر الغذائية لبعض المحاصيل المنزرعه في منطقة سهل الطينه (شمال سيناء) والخاضعة للرى بمياه ترعة السلام المنخفضة الجوده

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يهدف هذا البحث إلى حصر بعض التغييرات النوعية لبعض الخصائص الكيميائية للتربة ومحتوى العنلصر المغذية لبعض المحاصيل المنزروعة في منطقة سهل الطينه (شمال سيناء)، نتيجة خضوعها للري بمياه منخفضة الجوده من ترعة السلام0ولتحقيق الهدف من هذا البحث، تم جمع عينات مختلفة من التربة من عمق صفر – 60 سم من عشر قرى. وقد تم تحليل بعض الخصائص الكيميائية للتربة ومحتواها من المغذيات الميسرة فى عينات التربة التي تم جمعها0 ومن ناحية أخرى ومن نفس مواقع الدراسة ، تم أخذ عينات من اوراق بعض المحاصيل المختلفة عند إكتمال مرحلة النمو الخضري، ، لتحديد محتوياتها من المواد الغذائية المختلفة.

● **أما بالنسبة للخصائص الكيميائية للتربة :**

فقد تتراوحت قيم الـ pH للأراضى تحت الدراسة من 7,4 إلى 8,01 مما يعنى أن درجة حموضتها تتراوح من خفيفة إلى متوسطة القلوية ، كما تتراوحت قيم الـ EC لها من 1.39 إلى 7,28 ديسيمنز/ م وهى تزيد عن تلك ملوحة تلك النوعية من الأراضى المروية بمياه النيل جيدة النوعية .

كما أظهرت النتائج أن ايونات الصوديوم هى أكثر الكاتيونات شيوعا فى مستخلص عجينة التربة المشبعة ، يليها كاتيونات الكالسيوم ثم المغنسيوم ثم البوتاسيوم 0 بينما كان أكثر الأنيونات شيوعا هو أيونات الكلور يليها أيونات الكبريتات ثم أيونات البيكربونات.

بالنسبة لحالة تيسر عناصرالنتروجين والفوسفور والبوتاسيوم (ملليجرام / كجم تربة) فى التربة ، فقد أظهرت النتائج أن النتروجين الميسر تراوحت قيمه من 6.48 الى 66.82 والفوسفورالميسر تراوحت قيمه من 1.73 إلى 3,75 ملليجرام / كجم تربة ، والبوتاسيوم تراوحت قيمه بصفة عامة من 135 إلى 164 ملليجرام / كجم تربة 0 وبالنسبة لتيسر العناصر الغذائية الصغرى (ملليجرام / كجم تربة) بالتربه ، فقد لوحظ إختلاف كبير فى قيمها فيما بين المواقع تحت الدراسة ، وبصفة عامة تراوحت القيم الميسرة (ملليجرام / كجم تربه) لعنصر الحديد (1,01 – 14,14) والمنجنيز (0,05 – 2,99) والزنك (0,03 – 1,61) 0 وبالنسبة لعنصر النحاس وتيسره فى التربه فقد سجل قيم تجاوزت الحدود الحرجة أو المسموح بها (0.98 – 5,29).

● **وبالنسبة لمحتوى العناصر المغذية لبعض المحاصيل المنزرعة**

بالنسبة لمحتوى محاصيل من النتروجين والفوسفور فقد تزواح محتواها مابين 2.79الى 5.11 % للنتروجين و 0.33 الى 0.55 % للفوسفور و 1.87 الى 4.92 % للبوتاسيوم.

وبالنسبة للعناصر الصغرى فقد إختلف محتواها من الحديد والزنك والمنجنيز من نوع لأخر . وقد تجاوز محتوى كل المحاصيل تحت الدراسة من عنصر النحاس الحدود المسموح بها ووصلت لحدود السمية.