AMORPHOUS INORGANIC MATERIALS IN RELATION TO LONGTERM IRRIGATION WITH SEWAGE EFFLUENT AND SOIL PROPERTIES IN SOME SOILS OF EL-GABAL EL-ASFAR FARM, EGYPT.

Journal

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ABSTRACT

Thirteen soil profiles were selected to study amorphous inorganic materials in some soils of El-Gabal El-Asfar region. Eleven soil profiles were irrigated with sludge effluents three different periods, one profile irrigated with Nile water and one of non-irrigated virgin soils.

Data reveal that the values of amorphous silica in the soil samples irrigated with sewage effluents for 23, 37 and 75 years vary from 1.11 - 1.58, 1.11 -1.80 and 1.11 to 2.58 % respectively. The results also indicate that the highest values of amorphous silica are concentrated in the surface layers. Regarding amorphous alumina data show that the contents of amorphous alumina vary from 0.03 to 1.09,0.04 to 1.20 and 0.088 to 1.98 % in the studied profiles irrigated with sewage ettluent for periods of 23,37 and 75 years respectively. The values of amorphous iron oxide vary from 1.13 to 4.80 % in the studied profiles. Statistical analysis indicates a significant negative correlation between amorphous silica and alumina with each of clay, O.M and EC and a positive correlation with each of silt, sand and CaCO3. Some results of statistical analysis for amorphous iron oxides were obtained except that amorphous iron oxides have no significant with O.M.

INTRODUCTION

Sewage effluent has been used for crop irrigation for many years and its use is increasing particularly in water short areas. Sewage effluent can be a useable water resource if suitable precaution are taken and before the use of elements in the sewage effluent ,it should at least be subjected to the primary treatment , of separation of solids from liquid and usually secondary treatments of aeration and digestion and discharged as clear stable liquid . The use of sewage effluent , however , requires a higher level of management than the use of ordinary water supplies that are primarily related to public health and public acceptance. There are certain health precaution required by local health agencies but these are normally not sufficiently restrictive to prevent the irrigation of crops (Abdel Sabour et al., 1996; Mohamed, 2001).

Amorphous inorganic materials are usually present in soils as a result of inheritance of inheritance from the parent materials, from which the soil was derived; or as a result of chemical degradation of minerals (Fieldes and Swindale, 1954 and Rich and Tomas 1960).Follett et al. (1965) reported that the principal forms of amorphous minerals are oxides, or hydrous oxides of iron, aluminum, Silicon and manganese. They may also present as coating on the crystalline particles and play an important role in the cementation and aggregation of soil particles .Thus, the presence of completely cemented layers of haredpans and frangipanes, can be caused by these materials. This widespread and such an irreversible flocculation may occur during soil forming conditions.

Fitzpaatrick (1980) pointed out the initial stage of hydrolysis would form amorphous materials, which may crystallize gradually to produce a number of new substances, and translocate within the soil profile. The type, amount and distribution of amorphous materials can be used as criteria for measuring the degree and type of soil formations.

Hassane (1989), Abd El-Aziz (2000) and El-Shaboury (2008) reported that amorphous in organic materials in the soils of Sinai peninsula are dominance with silica followed by iron oxides and alumina oxides.

The current work has been carried out to give further information about physical, chemical and amorphous inorganic materials in soil profile were chosen to represent El-Gabal El-Asfar region. Meanwhile, that correlation between some soil variables and amorphous inorganic materials was discussed.

MATERIALS AND METHODS

Thirteen soil profiles were chosen to represent El-Gabal El-Asfar region. Eleven were irrigated with sludge effluents three different periods; one profile was irrigated with Nile water and one profile of a non - irrigated virgin soil. The two later profiles were taken for comparison.

Soil samples were air dried, crushed and finely ground, then sieved through a 2 mm sieve and analyzed for their properties (Pag et al., 1982). Chemical and physical properties of soils are shown in Table (1) according to Mohamed (2001).

Amorphous inorganic materials contents (Silica, alumina and iron oxids) were determined as follows:

1- Silica and alumina were extracted by boiling 1.0 gm of oven dry soil sample with NaoH 0.5 N for 2.5 minutes. The contents of Si and Al were measured spectrophotometrically using the ammonium molybdate method for the measuring of silica and the aluminom method for the measuring of alumina (Page et al., 1982).

2- Free iron oxides were extracted by citrate - bicarbnate - dithionite method (Mehra and Jackson, 1960). Fe oxides were determined using atomic absorption (Page et al., 1982).

Table (1): Physical and chemical properties of soils of El-gabal El-Asfar which had been under irrigation with sewage effectents for various periods.

Irrigation period years	Profile No.	Depth cm	pH	EC dsm^{-1}	Particle size distribution %			$CaCO_3$	OM%
					Clay	Silt	Sand		
23	1	0-10	7.7	3.8	12.4	2.2	85.4	0.64	1.84
		10-20	7.8	1.31	9.6	1.8	88.6	1.46	0.51
		20-40	8.2	0.79	12.8	1.2	86	2.64	0.12
		40-80	8.3	0.82	13.8	2.6	83.6	2.43	0.20
37	2	0-10	7.4	1.16	14.6	2.4	83	0.85	0.63
		10-20	8.3	0.62	11.6	3.8	84.6	1.64	0.03
		20-40	8.4	0.63	21.6	4.4	62.28	1.64	0.20
	3	0-10	5.7	2.58	19.0	3.6	77.4	0.34	2.75
		10-20	6.8	0.89	12.0	1.4	86.6	0.64	0.97
		20-40	7.1	0.34	14.0	4.0	82	0.01	0.24
		40-80	7.1	0.76	6.85	3.03	90.13	0.01	0.18
	4	0-10	5.6	2.52	14.8	2.3	82.9	0.43	3.89
		10-20	7.1	1.18	10.6	4.4	84.89	4.43	0.33
		20-40	7.7	0.53	12.2	1.8	85.9	2.96	0.30
		40-80	7.5	0.73	12.0	1.4	86.5	3.14	0.54
		80-150	7.1	0.92	10.0	4.0	88.2	3.21	0.09
75	5	0-10	6.7	2.09	20.5	23.6	55.9	1.4	3.4
		10-20	7.4	0.40	20.4	13.8	65.8	4.2	2.66
		20-40	7.3	1.11	17.7	14.5	67.8	6.3	2.28
		40-80	7.9	0.49	7.60	1.8	90.6	4.2	0.2
	6	0-10	6.14	1.85	21.6	24.8	53.69	0.13	5.56
		10-20	7.26	0.89	15.8	7.8	76.4	.63	1.65
		20-40	7.70	0.68	17.0	8.1	74.9	3.36	0.56
		40-80	7.70	0.77	14.0	4.6	81.0	4.26	0.31
		80-150	7.80	0.60	7.2	4.8	88.0	2.47	0.2
	7	0-10	6.67	1.74	21.7	16.3	62.0	0.7	3.16
		10-20	7.75	0.76	13.3	9.4	77.3	2.04	0.2
		20-40	7.70	0.70	12.2	3.1	84.7	4.17	0.31
		40-80	7.80	0.68	9.2	8.2	82.6	4.89	0.2
		80-150	8.20	0.44	15.5	7.3	77.2	7.4	0.2
	8	0-10	5.8	2.84	25.8	17.3	56.9	0.06	4.4
		10-20	7.3	1.06	13.8	8.3	78.0	0.07	0.61
		20-40	7.62	0.72	10.2	3.2	86.6	5.64	0.52
		40-80	7.01	0.55	3.5	2	94.5	4.49	0.2
		80-150	6.90	0.52	3.3	3.1	93.6	4.64	0.1
	9	0-10	5.7	3.25	24.3	15.8	59.9	0.7	4.0
		10-20	6.4	0.99	12.2	6.3	81.5	3.28	2.67
		20-40	6.5	0.82	12.8	2.2	85.0	2.21	0.33
		40-80	6.70	0.70	11.8	3.2	85.0	4.43	0.31
		80-150	6.80	0.71	6.6	5.6	87.8	3.46	0.03
	10	0-10	6.3	1.05	10.4	9.8	79.8	0.06	4.86
		10-20	6.4	1.12	12.6	5.4	82.0	0.43	3.12
		20-40	6.70	0.71	12.8	5.4	81.8	6.3	2.15
		40-80	6.90	0.67	12.0	4.0	84.0	5.2	0.6
		80-150	6.90	0.76	12.2	4.0	83.8	4.8	0.03
	11	0-10	7.2	2	26.6	17.4	65.0	0.6	3.36
		10-20	7.3	1.96	17.8	2.6	79.6	0.85	0.78
		20-40	7.8	1.33	10.4	6.6	83.0	5.11	0.6
		40-80	7.9	1.18	12.1	2.0	85.9	3.91	0.18
		80-150	7.9	0.97	13.4	4.2	82.4	2.64	0.33
Nile water	12	0-40	8.5	0.3	13.0	2.0	85.0	0.64	0.36
		40-75	8.1	1.08	18.8	1.8	79.4	6.38	0.21
		75-150	8.2	0.80	19.8	3.6	76.6	13.19	0.09
Virgin soil	13	0-15	8.2	0.54	9.4	1.2	89.4	1.28	0.2
		15-150	8.5	0.60	10.0	3.8	86.2	0.21	0.24

RESULTS AND DISCUSSION

Amorphous Materials

Amorphous inorganic materials in soils are intimately associated to affect the physical, chemical and biological properties of soils. The fate of any of these components, will be either trans located or deposited, depending on their content, distribution and relative stability of the combination they form

1- Amorphous Silica

Data in Table (2) indicated that the accumulation of amorphous silica in the soils is affected by the application of sewage effluent. The result of amorphous materials varies in soils with period of using sewage effluents in irrigation and in soils using Nile water in irrigation. The values of amorphous silica in the soil samples irrigated with sewage effluents for 23 vary from 1.11 to 1.58 %, while soil samples irrigated with sewage effluents for 37 years range from 1.11 to 1.80 %, the highest value is present in the surface layer of profile No.2 while the lowest one is located in all the studied profiles. Regarding the values of amorphous silica in the profiles irrigated with sewage effluent for 75 year the present data indicate that those values vary widely from 1.11 to 2.58 %, the highest value is located in the surface layer of profile No. 10, while the ;lowest one is present in all the studies profiles. With respect soil profiles irrigated with Nile water, the values of amorphous silica vary from 0.5 to 2.18 %. The highest value is located in profile No. 2 (depth 0-40 cm). The two samples of profile No. 13 of virgin soils characterized by amorphous silica of 1.22 %. Data in Table (2) indicate that the highest values of amorphous silica are concentrated at the surface layer in all of the studied profiles.

Statistical analysis (Table 3) shows a highly significant positive correlation between amorphous silica and each of pH, silt, sand and $CaCO_3$ ($r = 935^{**}$), ($r = 0.656^{**}$), ($r = 0.524^{**}$) and ($r = 0.56^{**)}$ respectively and a highly significant negative correlation between amorphous silica and each of clay and OM ($r = 615^{**)}$ and r = (-$0.679^{**)}$ respectively. Result also indicate a negative correlation between amorphous silica and EC ($r = - 0.336^{*}$)

Table (2): Amorphous inorganic materials of the studied soil profiles.

Irrigation period years	Profile No.	Depth cm	Amorphous materials %		
			SiO_2	Al_2O_3	Fe_2O_3
23	1	0-10	1.58	1.09	1.70
		10-20	1.11	1.07	1.35
		20-40	1.11	0.03	1.66
		40-80	1.16	0.33	1.49
37	2	0-10	1.80	1.20	1.53
		10-20	1.11	1.05	1.36
		20-40	1.11	1.07	1.22
	3	0-10	1.17	1.07	3.25
		10-20	1.11	0.105	1.73
		20-40	1.12	0.104	1.65
		40-80	1.11	0.118	1.43
	4	0-10	1.19	0.118	4.43
		10-20	1.13	0.105	1.36
		20-40	1.16	0.105	1.32
		40-80	1.11	0.107	1.28
		80-150	1.18	0.107	1.25
75	5	0-10	2.16	1.98	4.00
		10-20	1.13	1.15	3.58
		20-40	1.16	0.99	2.52
		40-80	1.18	0.089	1.2
	6	0-10	1.17	1.18	4.80
		10-20	1.15	0.78	2.33
		20-40	1.11	1.15	1.76
		40-80	1.17	0.88	1.2
		80-150	1.11	0.104	1.14
	7	0-10	2.18	1.29	1.33
		10-20	1.18	1.62	1.37
		20-40	1.15	0.182	1.58
		40-80	1.11	0.152	1.27
		80-150	1.13	0.132	1.27
	8	0-10	2.17	1.82	4.60
		10-20	1.16	0.115	1.68
		20-40	1.21	0.19	1.62
		40-80	1.11	0.107	1.75
		80-150	1.12	0.108	1.39
	9	0-10	1.14	1.05	4.50
		10-20	1.11	1.03	3.21
		20-40	1.11	1.06	1.57
		40-80	1.11	0.188	1.50
		80-150	1.12	0.19	1.13
	10	0-10	2.58	0.182	4.70
		10-20	1.11	0.152	3.90
		20-40	1.11	0.104	2.95
		40-80	1.11	0.118	1.19
		80-150	2.16	1.08	1.14
	11	0-10	2.18	1.15	3.95
		10-20	1.15	0.114	1.53
		20-40	1.11	0.118	1.83
		40-80	1.11	0.099	1.69
		80-150	1.11	0.033	1.32
Nile water	12	0-40	2.18	0.033	1.3
		40-75	2.18	0.033	1.37
		75-150	0.50	0.03	1.62
Virgin soil	13	0-15	1.22	0.025	1.75
		15-150	1.22	0.025	1.65

2- Amorphous Alumina

Alumina are present in soils in various forms, i.e. soluble, amorphous coating on negatively charged colloids (Field and Williason, 1955) and in the interlayer spacing of 2:1 layer silicates forming the intergradient minerals (Sawhney, 1960).

Table (2) shows that the contents of amorphous alumina vary from 0.03 to 1.09, 0.104 to 1.20 and 0.088 to 1.98 %in the soil profiles irrigated with sewage effluent for periods of 23, 37 and 75 year, respectively. The highest value was detected in the surface layer (depth 0-10 cm) of profile No. 5, while the lowest one was detected in profile No.1 (depth 40-80 cm). Data in Table (2) indicated that the surface layer of the studied soil profiles irrigated for 25, 37 and 75 years with sewage characterized by the highest contents of amorphous alumina. Regarding the soil profile No. 12 that irrigated with Nile water and virgin soils (Profiles No. 13), the values of amorphous alumina are very low and range from 0.025 to 0.033 %.

Statistical analysis (Table 3) indicate a highly significant positive correlation between amorphous alumina and each of pH, silt, sand and $CaCO_3$ (r = 0.472^{**})'(r = 0.633^{**}), r = 0.588^{**}) and (r = 0.461^{**}) respectively and a highly significant negative correlation with clay r = 0.684^{**}, while amorphous alumina shows a significant negative correlation with each of EC (r = 0.289^{*}) and O.M (r = 0.297^{*})

3- Amorphous iron oxides

Amorphous iron oxides exist as discrete particles, coating on soil mineral particles and as cementing agent between them. Data in Table (2) indicate that the values of amorphous iron oxides for soil profile No. 1 irrigated with sewage effluent for 23 years are narrow rang from 1.35 to 1.70 %. The highest value is located at the surface layer (depth 0-10 cm). Regarding the soil profiles Nos. 2,3 and 4 irrigated with sewage effluent for 37 year, data in Table (2) show that the values of amorphous Fe – oxides vary widely from 1.22 to 4.43 ppm, the highest value is detected in the surface layer of profile No.4 this soil sample characterized by high content of organic matter (Table1). On contrast the lowest value of amorphous Fe oxides characterized by low content of organic matter.

With respect to the soil profile Nos. 5,6,7,8,9,10 and 11 irrigated with sewage effluent for 75 years, results presented in Table (2) show that, the values of amorphous Fe. Oxides vary widely from 1.13 to 4.80 %, the lowest value is detected in profile No. 9 (depth 80-150 cm), this soil sample exhibit very low content of organic matter (Table 1). The highest value was detected in profile No. 6 (depth 0-10 cm), this sample contains the highest value of amorphous Fe-oxides in all the studied profiles and this is may be due the highest content of organic matter measured in this sample.

With respect to soil profiles No. 12 and 13 that irrigated with Nile water and virgin soils, data in Table (2) indicated that the values of iron oxides vary in a narrow rang from 1.3 to 1.75 %. The lowest one is located in profile No. 12 (soils irrigated with Nile water), while the highest one is present in surface layer (depth 0-15 cm) in profile No. 13. These two profiles characterized by low contents of organic matter.

Statistical analysis (Table 3) shows a highly significant positive correlation between amorphous iron oxides and both of pH (r = 0.405**) and silt (r = 0.361**) and significant positive correlation with each of sand (r = 0.316 *) and CaCO3 (r = 0.290 *). Data also indicate a significant negative correlation between amorphous Fe oxides and both of EC (r = -0.333 *) and clay (r = -0.329 *).

Table (3) Simple correlation cofficients among soil properties and each of amorphous silica, alumina and iron oxidex.

Parameter (Y)	**Parameters (X)**						
	Clay	Silt	Sand	$CaCO_3$	OM%	pH	EC
Silica	- 0.615**	0.656**	0.529**	0.564**	- 0.679	0.935**	- 0.336*
Alumina	- 0.684**	0.633**	0.589**	0.461**	- 0.297	0.472**	- 0.289*
Oxides	0.329	0.361**	0.316*	0.290*	- 0.203	0.405**	- 0.333*

* = Indicate significant at 5% probability level
** = Indicate significant at 1% probability level

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علاقة المواد الأمورفية بالرى بمياه المجارى وخواص التربة فى بعض أراضى مزرعة الجبل الأصفر بمصر.

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أجرى هذا البحث على مزرعة الجبل الأصفر لدراسة تأثير الرى بمياه المجارى على محتويات المواد الأمورفية غير العضوية فى بعض أراضى مزرعة الجبل الأصفر. وقد أجريت هذه الدراسة على 11 قطاع تربة فى مزرعة الجبل الأصفر تمثل مدد مختلفة رويت فيها الأراضى بمياه الصرف وهى23 سنة ، 37 سنة، 75 سنة هذا بالأضافة الى قطاع يروى بمياه النيل وقطاع تربة بكر عير منزرعة بنفس المزرعة .

وقد أظهرت الدراسة أن قيم السيلكا الأمورفية فى القطاعات المروية بمياه الصرف بمدد 23 ، 37 ، 75 سنة تتراوح ما بين 1.11 – 1.58 ، 1.11- 1.8 ، 1.11 – 2.58 % على الترتيب . وقد أوضحت الدراسة أيض أن الطبقات السطحية فى القطاعات المدروسة تحتوى على أعلى قيم للسيلكا الأمورفية . بالنسبة للألومينا الأمورفية أوضحت النتائج أنها تتراوح ما بين 0.03 – 1.09 ، 0.04- 1.2 ، 0.088 – 1.98 % فى الأراضى المروية بمدد 23 ، 37 ، 75 سنة على الترتيب.

بالنسبة لأكاسيد الحديد الأمورفية فى القطاعات المدروسة تراوحت مابين 1.13- 4.80 .

وأظهرت نتائج التحليل الأحصائى وجود علاقة معنوية وسالبة مابين السيلكا الأمورفية والألومينا الأمورفية مع كلا من المادة العضوية ومحتوى الطين والتوصيل الكهربى وأظهرت الدراسة أيضا علاقة معنوية موجبة مع كلا من السيلت والرمل وكربونات الكاسيوم . وتم الحصول على نفس نتائج التحليل الأحصائى بالنسبة لأكاسيد الجديد الأمورفية فيما عدا عدم وجود علاقة معنوية مع المادة العضوية .

أجرى هذا البحث على مزرعة الجبل الأصفر لدراسة تأثير الرى بمياه المجارى على محتويات المواد الأمورفية غير العضوية فى بعض أراضى مزرعة الجبل الأصفر. وقد أجريت هذه الدراسة على 11 قطاع تربة فى مزرعة الجبل الأصفر تمثل مدد مختلفة رويت فيها الأراضى بمياه الصرف وهى23 سنة ، 37 سنة، 75 سنة هذا بالأضافة الى قطاع يروى بمياه النيل وقطاع تربة بكر عير منزرعة بنفس المزرعة .

وقد أظهرت الدراسة أن قيم السيلكا الأمورفية فى القطاعات المروية بمياه الصرف بمدد 23 ، 37 ، 75 سنة تتراوح ما بين 1.11 – 1.58 ، 1.11- 1.8 ، 1.11 – 2.58 % على الترتيب . وقد أوضحت الدراسة أيض أن الطبقات السطحية فى القطاعات المدروسة تحتوى على أعلى قيم للسيلكا الأمورفية . بالنسبة للألومينا الأمورفية أوضحت النتائج أنها تتراوح ما بين 0.03 – 1.09 ، 0.04- 1.2 ، 0.088 – 1.98 % فى الأراضى المروية بمدد 23 ، 37 ، 75 سنة على الترتيب.

بالنسبة لأكاسيد الحديد الأمورفية فى القطاعات المدروسة تراوحت مابين 1.13 – 4.80

وأظهرت نتائج التحليل الأحصائى وجود علاقة معنوية وسالبة مابين السيلكا الأمورفية والألومينا الأمورفية مع كلا من المادة العضوية ومحتوى الطين والتوصيل الكهربى وأظهرت الدراسة أيضا علاقة معنوية موجبة مع كلا من السيلت والرمل وكربونات الكاسيوم . وتم الحصول على نفس نتائج التحليل الأحصائى بالنسبة لأكاسيد الجديد الأمورفية فيما عدا عدم وجود علاقة معنوية مع المادة العضوية .