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Exploratory Properties and Restrictions of El-Zayat Soils for Agricultural Sustainability, El-Dakhla Oasis, Egypt

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ABSTRACT

Surface (0-30 cm) and subsurface (30-60 cm) soil samples were collected from El-Zayat area, New Valley Governorate, Egypt to asses soil physical and chemical properties, and fertility as well as the relationships among these soil properties. The results revealed different soil texture classes (clay, sandy clay loam, clay loam, sandy loam and silty clay loam). The calcium carbonate and organic matter contents varied from 9.8 to 85.6 and from 0.8 to 10.2%, respectively. Cation exchange capacity (CEC) ranged from 4.8 to 71.6 cmol/ kg with an average value of 34.92 cmol/ kg. The pH values differed from neutral to moderately alkaline. Additionally, 10% of the collected samples were slightly saline, while 30.0 and 60.0% were moderately and strongly saline, respectively. Sodium adsorption ratio (SAR) for 70% of the collected samples realized values > 13 indicating sodic soils. The total nitrogen in the tested soil samples is very low. Concerning available phosphorus, about 53, 30 and 17% of tested soil samples were low, medium and high, respectively. The available potassium (K) for 98% of the tested soil samples was very high. Suitable gypsum requirements should be added to reclaim these soils which need a management program to overcome these problems. Also, organic manures have to be applied to improve the soil properties and enrich their nutrient status.
Keywords: Soil fertility, Salt affected soils, chemical and physical properties, El-Dakhla Oasis

INTRODUCTION

Soil is one of the most important natural resource that affects all aspects of the humankind life. Restore and rehabilitate of the soil system is essential strategy to recover soil services offers. Different soils have different morphological, physical, chemical, mineralogical and biological characteristics, which control the response of the soil to management practices (Kumar *et al*., 2013; Brevik *et al*., 2015; Singh *et al*., 2017). Therefore, there is a need to identify proper soil quality indicators that reflect an accurate response to deterioration and soil functioning (Elbasiouny *et al*., 2017).

However, soil quality is controlled by its physical, chemical and biological components and their interactions. The function of its physical and chemical properties on which have both qualitative and quantitative information to formulate an appropriate fertility management program and improving the productivity of problematic soil, especially salt affected soils. Physical fertility of a soil defined as the ability to allow sufficient entry, movement and retention of water and air to meet plant demand. However, chemical fertility refers to the chemical properties and processes that are important to plant growth and environment. Soil characterization in relation to its fertility status of an area or region is an important aspect in the context of sustainable agricultural production. Also, the variation in nutrient supply is a natural phenomenon which some of these nutrients may be sufficient while others are deficient. Information of Nitrogen, phosphorus and potassium fractions is important for evaluating of their status in the soil and understanding the soil chemistry that influences soil fertility (Rasool *et al*., 2007; Chaudhary *et al*., 2012; Ravikumar & Somashekar, 2013 and Patel & Lakdawala, 2014).

Moreover, soil quality is a collective term that describes the loss of productivity which results from decreases in soil salinity and/or human induced phenomena which lower the current or future capacity of the soil to support human life. It is one aspect of land degradation; others are degradation of vegetation or water resources. Among serious soil degradation processes in arid and semi-arid climates, salinization is the most common due to the evaporation/ precipitation. Salt-affected soil is a critical environmental problem in many countries around the world. This problem has deleterious impact on soil fertility and consequently reduces the soil productivity (Farifteh *et al*., 2006; Abdelfattah *et al*., 2009 and Squires & Glenn, 2010).

Estimated area of salt-affected soils varies widely and ranging from 6% to 10% of earth's land area (400 million hectares) as well as 77 million hectares (Mha) of irrigated lands. In Egypt, approximately 2.1 million feddan suffer from salinization problems in cultivated area. The majority of them in the north delta and other affected areas include wadi El-Natroun, the oases and Fayoum province. Furthermore, 25 % of the Upper Egypt regions are salt affected soil. Soil salinity problems usually resulted from dry land saline seeps, improper drainage or water management on irrigated soils and/or cultivation of naturally saline soils. It is strongly linked to water movement through the soil site. When sub-soil moisture that contains soluble salts moves upwards and evaporates, salts are precipitated at or near the soil surface that requires special remedial measures and management practice (Ghafoor *et al*., 2004; ICARDA, 2011and Arora, 2017).

Recently, some hydrological studies in the New Valley indicated that the greater storage capacity of the underground water reservoir might be about 740 milliard m3 of a good quality water that are sufficient to irrigate 143,000 feddans over 200 years. The reservoir water supply might be 2.5 million m3 daily which is sufficient to irrigate 125000 feddans (Abd El-Rahim, 2016). This abundance of water can be utilized in the exploitation of the El-Zayat area. It is flat and a promising area located on both sides of the main road of El-Dakhla Oasis and require less effort, especially with regard to reclamation managements that may occur in this region. Using the salt-tolerant crops is one of the most important strategies to solve the problem of salinity (Shrivastava and Kumar, 2015). In addition, reclamation of salt-affected land supports sustainable agriculture and contributes to the increase food and feed productivity; enhance environmental quality and increase carbon sequestration (Elbasiouny *et al*., 2017).

This work aims to assess some physical and chemical properties of El-Zayat salt-affected soils (El-Dakhla Oasis, Egypt) as well as their fertility status of N, P and K. Furthermore, the relationship among these properties to be able to develop a management program for sustainable agricultural.

MATERIALS AND METHODS

Location and Soil Samples

The study area located at El-Zayat region (latitudes form 29^{o} 42' 44'' to 29^{o} 49' 07'' E and longitudes form 25^{o}

12′ 33" to 25° 13′ 32" "N) northwest El-Dakhla oasis, New Valley Governorate, Egypt. Four transects were taken across the El-kharga - El-Dakhla main road with about 5 km distance between consecutive transects. Fifteen soil sites were designated to represent the study area (Fig. 1).

All soil sites were localized using the global positioning system (GPS) and their land uses are present in Table (1). At each site, two soil samples from surface (0-30 cm) and subsurface (30-60 cm) layers were collected (total of 30 soil samples). Stones and gravels were manually removed from each soil sample and then the samples were air-dried, crushed gently and sieved using 2mm sieve and kept for analysis.

Soil analyses

The particles-size distribution of the soil samples was performed using the pipette method (Piper, 1950). The soil organic matter and calcium carbonate contents were determined according to Jackson (1973). Soil reaction (pH) was determined in a 1:2.5 suspension of soil to water using a glass electrode as described by Jackson (1973). Soil salinity expressed as the electrical conductivity (EC) and soluble ions of the saturated soil-paste extract were determined according to Jackson (1973). Sodium adsorption ratio (SAR) was calculated according to the formula of Richards (1954). Cation exchange capacity (CEC) was determined using the method outlined by Baruah and Barthakur (1997). The available phosphorus (P) was extracted using the method described by Olsen *et al.* (1954) and determined using spectrophotometer. The available potassium (K) was extracted using 1 N NH_4OAc at pH 7 then determined by flame photometer (Carson, 1980). Total soil P and K contents were measured according to the method outlined by Shuman (1979). Total nitrogen (N) was determined using a micro Kjeldahl's method according to Jackson (1973).

Table 1. Location and land use of the studied soil sites

Transect	Site	Soil depth	Location Latitude (E)	Location Longitude (N)	Land Use
1	1	0 -30 30 -60	29° 49' 07"	25° 12′ 33"	Uncultivated
	2	0 -30 30 -60	29° 49′ 12"	25° 12' 55"	Uncultivated
	3	0 -30 30 -60	29° 49' 03"	25° 12′ 13"	Uncultivated
	4	0 -30 30 -60	29° 49′ 11"	25° 11' 52"	Uncultivated
2	5	0 -30 30 -60	29° 47' 32"	25° 12′ 27"	Wheat
	6	0 -30 30 -60	29° 47′ 33"	25° 12' 48"	Wheat
	7	0 -30 30 -60	29° 47′ 34"	25° 12′ 09"	Uncultivated
	8	0 -30 30 -60	29° 47′ 31"	25° 11' 54"	Clover
3	9	0 -30 30 -60	29° 45′ 49"	25° 12′ 58"	Wheat
	10	0 -30 30 -60	29° 45' 41"	25° 13' 18"	Wheat
	11	0 -30 30 -60	29° 45' 29"	25° 12′ 35"	Under Reclamation
	12	0 -30 30 -40	29° 45′ 29"	25° 12' 11"	Under Reclamation
4	13	0 -30 30 -40	29° 45' 57"	25° 13′ 53"	Uncultivated
	14	0 -30 30 -40	29° 43′ 03"	25° 14' 11"	Uncultivated
	15	0 -30 30 -40	29° 42' 44"	25° 13′ 32"	Uncultivated

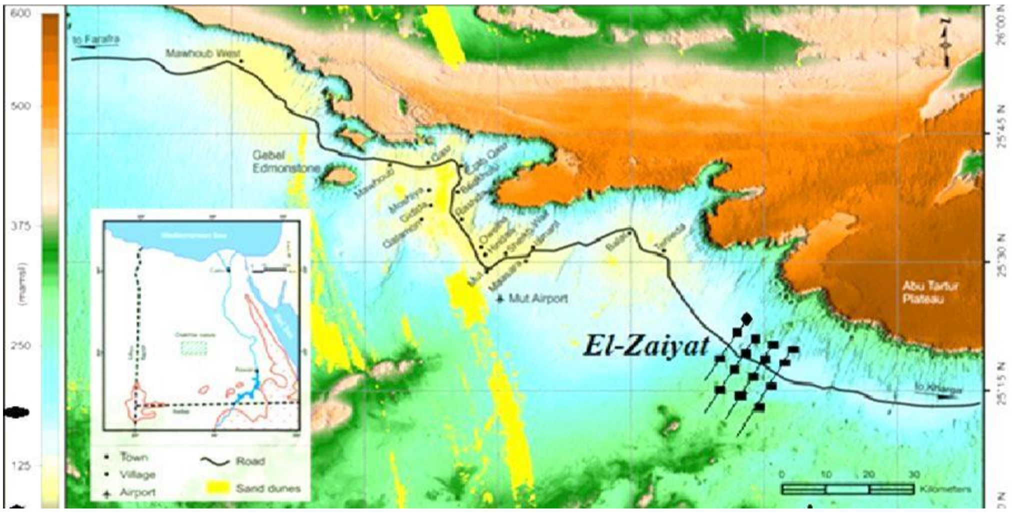

Fig. 1. The location map representing sites and transects of studied area.

RESULTS AND DISCUSSION

Soil properties

The particle size distribution of the studied soils shows a wide variation in the soil texture (Table 2). Five soil texture classes were recognized and they are clay (50%), sandy clay loam (20%), clay loam (17%), sandy loam (10%) and silty clay loam (3%). The soil texture does not change with depth which it may be attributed to the phenomena of sediment nature of the parent material. On average basis, the major soil size fraction of the study area is the clay (41.0 %) that prevails over the other fractions followed by sand (38 %) then silt (21%). The clay, sand and silt fractions ranges from 12 to 66%, 11 to 82% and from 6 to 28% in the surface layers (0-30 cm), respectively. The subsurface layers (30-60) shows that clay, silt and sand contents varied from 14 to 71%, 6 to 30% and from 12 to 80%, respectively. The variation in the particle-size distribution and soil texture might be attributed to the differences in the natural geological sedimentation pattern and the nature of the parent material of these soils. These results are in an agreement with those obtained by Selmy (2005), Abd El-Rahim *et al*. (2016) and El-Sayed *et al*. (2016).

Table 2. Some physical properties of the studied soils.

Transect	Site	Depth (cm)	Particle Size Distribution (%)			Texture	Saturation Percentage (SP) (%)
1	1	0 -30	50	21	29	Sandy Clay Loam	68
		30 -60	44	22	34	Clay Loam	69
	2	0 -30	60	18	22	Sandy Clay Loam	52
		30 -60	61	16	23	Sandy Clay Loam	52
	3	0 -30	41	28	31	Clay Loam	68
		30 -60	43	26	31	Clay Loam	63
	4	0 -30	32	28	40	Clay	61
		30 -60	39	30	31	Clay Loam	52
2	5	0 -30	16	26	58	Silty Clay Loam	89
		30 -60	40	15	45	Clay	99
	6	0 -30	11	23	66	Clay	102
		30 -60	15	23	62	Clay	110
	7	0 -30	11	27	62	Clay	54
		30 -60	41	30	29	Clay Loam	52
	8	0 -30	48	24	28	Sandy Clay Loam	37
		30 -60	80	6	14	Sandy Loam	37
3	9	0 -30	82	6	12	Sandy Loam	60
		30 -60	18	17	65	Clay	103
	10	0 -30	12	23	65	Clay	95
		30 -60	39	16	45	Clay	94
	11	0 -30	22	16	62	Clay	80
		30 -60	12	16	71	Clay	97
	12	0 -30	31	22	47	Clay	83
		30 -60	30	23	47	Clay	82
4	13	0 -30	50	18	32	Sandy Clay Loam	65
		30 -60	37	19	44	Clay	76
	14	0 -30	66	16	18	Sandy Loam	41
		30 -60	63	15	22	Sandy Clay Loam	41
	15	0 -30	28	26	46	Clay	64
		30 -60	18	24	58	Clay	64

The soil saturation percentage (SP) differed from site to another and from surface to subsurface layers of each soil site depending on soil texture class. The SP of the tested samples increased as the clay content increases. Generally, the highest SP value (110%) was recorded in site 6 which has a clay texture that might have high content of expanded clay minerals. These findings coincide with those of Abd El-Rahim (2016), El-Sayed *et al*. (2016) and Tantawy *et al*. (2017). On the mean basis, the subsurface layers exhibited a higher saturation percentage value (72.7%) than the surface one (67.91%) due to increases in the clay (41.4%) and silt content (38.67%) in the subsurface layers.

The calcium carbonate ($CaCO_3$) content of the study area varies from 9.8 to 85.6 g/kg, with an average of 50.4 g/kg (Table 3). The highest value of $CaCO_3$ content (85.6 g/kg) was recorded in the subsurface layer of site 14, while the lowest one (9.8 g/kg) was found in the subsurface layer of site 12. In general, the $CaCO_3$ content was higher in the loamy sand and sandy clay loam soils than in the clay and clay loam ones. The mean value of $CaCO_3$ content was 49.2 g/kg in the surface layer and 51.6 g/kg in the subsurface one. These results coincide with those of Selmy (2005). However, cultivating the soils may cause a decrease in the $CaCO_3$ content of the surface layer due to the dissolution of $CaCO_3$ as a result of CO_2 evolution and organic acids production during organic matter decomposition. El-Dakhla shale derived soils also contain high levels of carbonates which are ascribed to the high carbonate production and reduction of the delirious influx during the period of sea level high stand. In addition, the limestone nature that dominates in the plateau surrounding the study area can lead these soils to have a high $CaCO_3$ level (Selmy, 2005; Abd El-Rhman, 2016; Abd El-Rahim *et al*., 2016 and El-Sayed *et al*., 2016).

Table 3. Some chemical properties of the studied soil.

Transect	Site	Depth (cm)	CaCO3 (g/kg)	O.M (g/kg)	pH	CEC (cmol/kg)
1	1	0 -30	68.2	8.6	7.53	42.5
		30 -60	56.8	10.2	7.39	32.1
	2	0 -30	80.3	6.5	7.28	32.8
		30 -60	72.0	5.9	7.35	36.5
	3	0 -30	72.0	6.5	7.36	32.8
		30 -60	85.6	2.8	7.70	33.6
	4	0 -30	49.2	6.5	7.63	30.6
		30 -60	62.9	2.8	7.91	25.4
2	5	0 -30	40.2	8.9	7.71	36.3
		30 -60	43.9	7.2	7.73	38.4
	6	0 -30	45.5	10.2	7.76	43.1
		30 -60	41.7	9.2	7.58	41.7
	7	0 -30	30.3	4.2	7.65	41.3
		30 -60	36.4	0.8	8.21	20.3
	8	0 -30	40.9	4.8	8.21	4.8
		30 -60	58.3	2.1	7.75	24.8
3	9	0 -30	34.1	5.9	7.42	32.6
		30 -60	33.3	3.2	7.66	39.8
	10	0 -30	68.2	7.5	7.90	29.4
		30 -60	49.2	7.2	7.57	71.6
	11	0 -30	15.9	6.2	7.63	63.2
		30 -60	13.6	3.2	8.07	33.0
	12	0 -30	12.1	2.8	7.94	35.0
		30 -60	9.8	3.5	7.78	18.4
4	13	0 -30	64.4	9.2	7.83	47.0
		30 -60	56.1	7.9	7.55	48.2
	14	0 -30	74.2	8.6	7.68	19.8
		30 -60	85.6	9.6	7.46	20.8
	15	0 -30	42.4	7.5	7.39	37.0
		30 -60	68.2	6.5	7.61	35.0

The organic matter content (OMC) in the studied soil samples is low since it varied from 0.8 g/kg in the subsurface layer of site 7 to 10.2 g/kg in the surface layer of site 6 and in the subsurface layer of site 1 with an average value of 6.2 g/kg (Table 3). The low organic matter content in these soils may be attributed to the poor vegetation and the high rate of organic matter decomposition under the soil hyperthermic temperature regime that prevails in this area leading to extremely high oxidizing conditions. In most cases, the organic matter content decreases with soil depth. The mean value of OMC in the surface layer was 7.5 g/kg, while it was 5.5 g/kg in the subsurface one. These results are in accordance with those reported by Selmy (2005), Abd El-Rahim *et al.* (2016) and El-Sayed *et al.* (2016).

Soil reaction (pH) affects nutrient availability, microbial activity, and root growth. The collected soil samples exhibit alkaline pH value ranged from 7.28 to 8.21(Table 3). The relative high pH of the soils might be due to the presence of high degree of base saturation. In addition, the neutral to alkaline pH values may be attributed to the reaction of applied fertilizer materials in cultivated site with soil colloids, which results in the retention of basic cations on the exchangeable complex of the soil. According to the classification of soil pH suggested by Brady and Weil (1999), 23.33% of the investigated soil samples are neutral (pH< 7.50), 53.33% are mildly alkaline (pH 7.50 to 7.80) and 23.24% are moderately alkaline (pH 7.81 to 8.40). The accumulation of exchangeable sodium and calcium carbonate may also result in higher soil pH values (Singh *et al*., 2014). Kumar *et al.* (2013) also indicated that the relative high pH of the soils might be due to the presence of high degree of base saturation.

Cation exchange capacity (CEC) of a soil is the ability of its solid phase to attract or store and exchange cations with the soil solution and render them available to plants through exchange reactions (Dohrmann, 2006). The CEC values of the studied soil samples varied from 4.8 to 71.6 $cmol_c$ / Kg with an average value of 34.92 $cmol_c$ / Kg (Table 3). Furthermore, the soil mineral and organic colloids have the ability to adsorb and hold positively charged ions. Thus, soils containing high clay and organic matter have high cation exchange capacity values (Tomašić *et al*., 2013). Regarding soil depth, the average value of CEC in surface layer (35.21 $cmol_c$/Kg) was higher than that of the subsurface one (34.64 $cmol_c$/ Kg). The decrease in CEC values in the subsurface layer is attributed to the decrease in organic matter and clay contents. El-Sayed *et al*, (2016) found that the CEC values of Gharb El-Mawhob soils ranged from 5.17 to 59.15 $cmol_c$/ kg and it was closely associated to the clay content

The soil salinity of the saturated soil paste extract (ECe) of the studied samples is shown in Table (4). Wide variation occurs in the electrical conductivity (ECe) values. It ranged from 2.2 dS/m in the surface layer of site 8 to 131.4 dS/m in the subsurface layer of site 13 which may due to the fact that some of these sites are cultivated while the other not. About 93.33% of the soil samples show an ECe value > 4.0 dS/m, while only 6.66 % < 4.0 dS/m. According to Abrol *et al.* (1988), 6.67% of these samples are very slightly saline (ECe 2- 4 dS/m), 3.33% are slightly saline (ECe 4 - 8 dS/m), 30.0% are moderately saline (ECe 8-16 dS/m) and 60.0% are strongly saline (ECe>16 dS/m). The normal EC values may be ascribed to leaching the soluble salts with irrigation water in cultivated soil and the high EC values may be related to the salt accumulation in the top soil of medium and heavy textures due to the capillary rise of soil water in uncultivated one. Abd El-Rahim *et al*. (2016) indicated that 32.35 % of Gharb El-Mawhob soils had strongly saline. In addition, El-Sayed *et al*. (2016) found that the majority of these soils are salt-affected.

Table 4. Electrical conductivity (EC_e), cations and anions and sodium adsorption ratio (SAR_e) in the soil paste extract of the studied soil samples.

Transect	Site	Depth (cm)	ECe (dS/m)	Soluble cations (mmol/L)				Soluble anions (mmol/L)			SAR_e
				Ca^{2+}	Mg^{2+}	K^+	Na^+	SO_4^-	Cl^-	HCO_3^-	
1	1	0 -30	85.1	293.6	130.4	5.3	234.8	7.2	889.6	6.0	16.13
		30 -60	115.2	304.0	164.0	5.5	421.1	7.2	1235.2	9.6	27.52
	2	0 -30	90.6	309.6	122.4	5.2	289.4	6.8	903.9	4.8	19.69
		30 -60	40	211.2	106.4	4.2	156.0	7.0	589.8	6.0	12.41
	3	0 -30	24	36.8	12.8	1.8	246.6	12.0	161.4	7.2	50.32
		30 -60	55.7	93.6	22.4	4.0	325.2	18.5	432.7	7.2	42.73
	4	0 -30	10.4	20.8	4.0	2.4	35.9	13.6	48.6	6.0	10.19
		30 -60	24.5	24.8	4.0	3.1	143.7	19.4	147.1	6.0	37.91
2	5	0 -30	56.8	52.0	11.2	7.5	542.3	20.1	471.2	6.0	96.49
		30 -60	24.3	25.6	8.0	3.3	206.0	15.0	159.9	6.0	50.23
	6	0 -30	7.4	19.2	7.2	3.6	11.2	13.1	31.4	8.4	3.1
		30 -60	9.7	16.8	8.0	3.2	69.6	15.4	45.7	7.2	19.76
	7	0 -30	19.5	14.4	6.4	2.1	310.8	27.6	57.1	14.4	96.53
		30 -60	26	21.6	0.8	4.1	172.9	27.9	87.1	15.6	51.77
	8	0 -30	2.2	9.6	4.8	2.3	5.7	4.5	11.4	7.2	2.13
		30 -60	3.1	17.6	4.8	2.0	2.1	9.3	8.6	7.2	0.62
3	9	0 -30	8.7	17.6	2.4	2.4	69.6	17.6	31.4	10.8	22.01
		30 -60	9.8	12.0	3.2	1.8	160.4	23.6	20.0	12.0	58.32
	10	0 -30	9.4	20.0	11.2	5.4	85.5	17.3	62.8	8.4	21.64
		30 -60	10.6	16.0	8.8	3.9	113.8	17.3	64.0	8.4	32.34
	11	0 -30	17.9	17.6	8.1	6.4	187.8	23.7	62.8	10.8	63.23
		30 -60	12.3	12.8	4.8	2.0	138.0	20.2	28.6	6.0	46.48
	12	0 -30	10.7	16.0	16.0	7.2	102.9	16.5	50.0	4.8	25.73
		30 -60	9.7	16.0	6.4	6.5	98.7	16.3	40.0	7.2	29.46
4	13	0 -30	131.4	145.6	43.2	8.3	1184.7	12.3	1346.6	8.4	122.01
		30 -60	52	57.6	15.2	4.1	279.7	13.6	435.5	6.0	46.38
	14	0 -30	104.5	250.4	54.4	5.1	325.6	7.1	791.1	7.2	26.39
		30 -60	111.5	368.0	102.4	6.4	188.4	7.8	942.5	6.0	12.28
	15	0 -30	70.4	184.0	43.2	6.8	141.3	6.5	578.3	6.0	13.25
		30 -60	41.1	76.0	130.4	5.6	207.5	14.4	50.0	6.0	20.43

The tested soil samples are highly enriched in the major cations (Table 4). The results showed that sodium (Na^+) was the dominant cation but all cations decrease in the subsurface layer except magnesium (Mg^{+2}). The highest value of Na^+ (251.6 mmol/L) is recorded in the surface layer while the lowest one (178.9 mmol/L) is in the subsurface one. The cations in these studied soil sample could be ranked in the decreasing concentration of Na > Ca >Mg >K. Abd El-Rahim *et al*. (2016) and Tantawey *et al.* (2017) showed similar results concerning the soluble cations in Gharb El-Mawhob soils. Also, Ageep (1999) indicated that the dominant soluble salts in shale-derived soils of El-Dakhla deposits were mostly in the descending order of Na_2SO_4 > $MgSO_4$ > $CaCl_2$. Higher concentrations of exchangeable cations in the soil surface layer than those of the subsurface one are associated with the insufficient annual rainfall (evapotranspiration exceeding rainfall) to leach them down wards (Abd El-Rahim *et al*., 2016 and Tantawey *et al*., 2017). The dry climate of this region induces the basic cations to be accumulated at the soil surface. Concerning the soluble anions, Soluble CO_3 was not detected, which could be a result of its reaction with water to form HCO_3; Cl anions were dominant followed by SO_4 ions while the HCO_3 ions were the lowest ones. These anions had a variable trend with soil depth. So, the mean soluble anions could be ranked in the decreasing order of $Cl^- > SO_4^{-2} > HCO_3^-$. From the previous discussion it can be concluded that most of the salts that may prevail in this region are sodium chloride and sodium sulfate salts, which are often dissolved and easy to wash with the addition of water. El-Desoky *et al*. (2015) found that the halite mineral was present by 47% in the red clays of Quseir (Mut) formation. Similar findings were indicated by Selmy (2005).

The sodium adsorption ratio (SAR) is normally a satisfactory index to the exchangeable sodium status of salt affected soils (Bohn *et al*., 2001). The results in Table (4) clearly reveal that the SAR value differed not only from one soil site to another but also between the surface and subsurface layers in each site. It varied from 2.13 in the surface layer of site 8 to 122.01 in the surface layer of site 13. According to Bohn *et al*. (2001), 70% of the investigated soil samples exhibit a SAR value that is more than 13% (sodic soils). However, 30% of these samples showed a SAR value that was lower than 13 (normal soils). Abd El-Rahim *et al*. (2016) indicated that 70.53% of Gahrb El-Mawhob soils, El-Dakhla oasis were normal soils and 29.42% were sodic soils.

Soil nitrogen, phosphorus and potassium status

The total Nitrogen (N) in the studied soil samples was very low compared to both the total phosphorous (P) and potassium (K) due to the vegetation scarcity in the tested area (Table 5). On the average basis, a very slight difference in the total N occurs between the sites and within each site (surface and subsurface). This result may be due to scant vegetative, high temperature and good aeration in the soil resulting in a reduction in the soil total nitrogen.

As a mean value, the available P of the surface layer was higher than that in the subsurface one (Table 5). The mean available P is 10.63mg/ kg in the surface layer while it was 5.65mg/ kg in the subsurface one. On the other hand, the total P in these soils shows an opposite trend to available P where it was lower in the surface layer. The highest total P value was 3.66g/ kg in the subsurface layer of site 1while the lowest one was 1.53g/ kg in the subsurface layer of site 8and surface layer of site 4. Although the total P in the studied soils was high but their available P is relatively low, which attributed to the high content of both Ca ions and calcium carbonate, which might precipitate the available P. According to Olsen and Sommers (1982), 53.33% of the studied soil samples are low (Olsen P< 6 mg/kg), 30% are medium (Olsen P 6-10 mg/kg) and 16.66% are high (Olsen P>10 mg/kg) in the available P content.

The available potassium (K_{av}) ranged from 348.05 mg/kg in the surface layer of site 8 to 1859.01 mg/kg in the subsurface layer of site 6 with an average value of 999.19 mg/kg (Table 5). In addition, there are wide variations in the available K content among all studied soil sites depend upon the soil texture (finer or coarser), the dominant clay mineral and the soil organic matter content (high or low). The available K level in the surface layer is lower than that of the subsurface ones. Bashour (2001) classified the available soil K into five divisions which are very low (< 85 mg/kg), low (86-150 mg/kg), moderate (151-250 mg/kg), high (251-450 mg/kg) and very high (> 450 mg/kg). According to this classification, 1.33% of these samples were considered high and 98.67% of them were very high. Also, the total K in the studied soils varied between 2.9g/kg in the subsurface layer of site 8 to 21.6g/kg in the surface layer of site 1 with an average value of 13.5g/kg, which is considered very high and sufficient for grown plants.

Table 5. Total nitrogen and the form of phosphorus and potassium in the studied soil samples.

Transect	Site	Depth (cm)	Total N (g/kg)	Phosphorus Available (mg/kg)	Phosphorus Total (g/kg)	Potassium Available (mg/kg)	Potassium Total (g/kg)
1	1	0 -30	0.36	36.98	2.79	725.28	21.6
		30 -60	0.58	3.60	3.66	1365.53	14.1
	2	0 -30	0.17	10.36	2.95	1032.19	12.9
		30 -60	0.24	7.45	2.99	1105.09	7.8
	3	0 -30	0.17	32.93	2.98	871.26	14.1
		30 -60	0.24	8.24	3.42	929.92	15.0
	4	0 -30	0.17	13.60	1.53	1020.00	10.8
		30 -60	0.17	4.52	2.24	1042.20	9.0
2	5	0 -30	0.27	8.07	2.16	1442.87	17.1
		30 -60	0.27	6.32	2.25	955.95	17.1
	6	0 -30	0.44	2.69	2.66	1165.69	17.4
		30 -60	0.31	3.90	2.10	1859.01	19.2
	7	0 -30	0.30	13.60	2.01	856.11	12.0
		30 -60	0.17	9.46	2.13	632.75	9.6
	8	0 -30	0.24	1.38	1.64	348.05	3.0
		30 -60	0.85	2.41	1.53	688.26	2.9
3	9	0 -30	0.38	5.41	2.61	1453.22	21.9
		30 -60	0.10	3.97	2.30	869.87	23.7
	10	0 -30	0.50	4.00	2.95	1091.30	18.9
		30 -60	0.24	4.66	2.48	1311.94	20.1
	11	0 -30	0.17	8.45	1.62	1465.52	14.4
		30 -60	0.17	9.04	1.85	873.41	9.6
	12	0 -30	0.27	4.83	1.90	995.98	8.5
		30 -60	0.2	4.83	1.84	1127.40	18.9
4	13	0 -30	0.31	5.10	2.95	775.86	12.3
		30 -60	0.14	5.61	3.20	1041.24	8.4
	14	0 -30	0.17	4.98	2.55	759.75	8.4
		30 -60	0.14	3.57	2.86	494.64	7.8
	15	0 -30	0.17	7.06	1.74	891.45	13.8
		30 -60	0.17	7.29	2.01	783.84	14.4

Correlations among soil properties

The correlation coefficient of soil properties shows that several physical and chemical variables are correlated to each other (Table 6). The sand content showed highly significant positive correlations with $CaCO_3$ ($r = 0.448^{**}$) and significant with EC_e ($r = 0.352^{*}$). However, it has highly significant negative correlations with the silt ($r = -0.561^{**}$), clay content ($r =-0.957^{**}$), saturation percentage ($r = -0.690^{**}$) and not significant with CEC (r=-0.297). Additionally, silt content showed insignificant correlation to the clay (r=0.298), available P (r=0.267) and pH (r=0.241), the total nitrogen content (r = - 0.332) and CEC (r = -0.172).

The clay content showed highly significant positive correlations with the saturation percentage ($r=0.783^{**}$), significantly with total and available K K ($r=0.393^{*}$ and $r=0.343^{*}$). Contrary, the clay content showed highly significant negative correlations with the $CaCO_3$ content ($r=-0.518^{**}$), significantly with ECe ($r=-0.392^{*}$) and insignificant with total P (r=-0.281). CaCO3 content exhibited highly significant positive correlations with the total p ($r=0.643^{**}$), ECe (r=0.567**) and significantly with the organic matter (r=0.354*), but it has a negative correlation with the pH (r=-0.412*).

The organic matter was negatively correlated to the ECe (r = -0.532**) and positively correlated to the total P (r = 0.425*), total K (r = 0.304*), CEC (r = 0.299), and available K (r = 0.273), but it insignificant correlated to available K (r = 0.085). These results agree with those obtained by Awad *et al*. (2016) who showed that the organic matter had highly significant positive correlations with the available K (r = 0.650**). Kumar *et al*., (2009) found insignificant correlation (r = 0.085) between available P and organic carbon. Also, Kumar *et al.* (2013) observed a positive significant correlation between the organic matter and available phosphorus (r= 0.714). Abd El-Rahim *et al*. (2016) reported that a significant positive correlation between available P and soil organic matter content (r = 0.602**). Soil reaction (pH) was negatively correlated to the total P(r = -0.434*), ECe (r = -0.382*), CEC (r = - 0.355*), available k (r = - 0.345*) and total K (r = - 0.301). On the other side, the CEC showed a positive correlation with available K (r = 0.515**), total K (r = 0.458**) and SAR (r = 0.346*).

Table 6. correlation coefficient (r) among some physical and chemical soil properties and some nutrients.

property	Sand	Silt	Clay	SP	CaCO3	O.M	pH	CEC	EC	SAR	Total. N	Avail. P	Total .p	Avail. K
Sand	1													
Silt	-0.561**	1												
Clay	-0.957**	0.298	1											
S.P.	-0.690**	0.040	0.783**	1										
CaCO3	0.448**	0.007	-0.518**	-0.442*	1									
O.M	-0.030	-0.081	0.066	0.204	0.354*	1								
pH	-0.274	0.241	0.229	0.056	-0.412*	-0.499**	1							
CEC	-0.297	-0.172	0.405*	0.531**	-0.127	0.299	-0.355*	1						
EC_e	0.352	-0.040	-0.392*	-0.352*	0.567**	0.532**	-0.382*	-0.022	1					
SAR	-0.294	0.161	0.283	0.191	-0.196	-0.025	0.143	0.346*	0.203	1				
Total.N	0.240	-0.332	-0.160	-0.063	0.034	0.045	0.016	-0.075	-0.068	-0.196	1			
Avail. P	0.013	0.267	-0.110	-0.067	0.193	0.058	-0.285	0.123	0.110	0.095	-0.068	1		
Total. p	0.257	-0.042	-0.281	-0.011	0.643**	0.425*	-0.434*	0.130	0.565**	0.075	0.007	0.144	1	
Avail. K	-0.277	-0.060	0.343	0.587**	-0.276	0.304*	-0.345*	0.515**	-0.200	0.083	0.116	-0.152	0.091	1
Total. k	-0.336	-0.009	0.393*	0.676**	-0.148	0.273	-0.301	0.458**	-0.105	0.153	-0.034	0.209	0.201	0.532**

Different lower case * and ** above the number indicate significant and high significant at $p < 0.01$.

CONCLUSION

In El-Zayat area, five soil texture classes were found, calcium carbonate ($CaCO_3$) and organic matter contents were varied from 0.98 to 8.56 %, and from 0.08 to 1.02 %, respectively. The pH differed from neural to moderately alkaline and about 10 % of studied samples were slightly saline, 30% moderately saline and 60% of them were strongly saline. The level of nitrogen and phosphorus in this area is low and not sufficient for plant growth while the potassium is sufficient. Most of the investigated area is salt affected soils. Thus, this area can be exploited in the cultivation of some salt resistance crops such as date palms, barley plants and some feed plants such as Arteplex which be able to tolerate salinity status. Therefore, suitable gypsum requirements should be added to reclaim these soils which need a management programs to overcome these problems. Also, organic manures have to be applied to improve the soil properties and enrich their nutrient status and promote the reclamation. Other mineral nitrogen and phosphate fertilizers should be considered during carrying out the reclamation program to increase the soil fertility.

REFERENCES

Abd El-Rahim, M. G. M., M. A. El-Desoky., Nadia, M. Roshdi and M. H. Hamed. 2016. Available Phosphorus Assessment of Gharb El-Mawhob Soils, El-Dakhla Oasis, Egypt. Assiut J. Agric. Res., 47(4): 186-200.

Abd El-Rhman, A.A. 2016. Physical Properties and Water Resources of Some Soils Representing the Limestone Plateau at Assiut, Egypt. M. Sc. Thesis, Faculty of Agric., Assiut Univ., Egypt.

Abdelfattah M. A., S. A. Shahid.,Y.R. Othman. 2009. Soil Salinity Mapping Model Developed Using RS and GIS – A Case Study from Abu Dhabi, United Arab Emirates. European Journal of Scientific Research, 26 (3), 342-351.

Abrol, I.P., J.S.P. Yadav and F.I. Massoud. 1988. Salt-affected soils and their management. FAO soil bulletin No. 39, FAO, Rome, Italy.

Ageeb, G.W., 1999. Comprehensive investigation of the soils formed on shale deposits in Egypt. Ph.D. Thesis, Fac. of Agric., Cairo Univ., Egypt

Arora S. 2017. Diagnostic Properties and Constraints of Salt-Affected Soils. In: Arora S., Singh A., Singh Y. (eds) Bioremediation of Salt Affected Soils: An Indian Perspective. Springer, Cham.

Awad, M. Y, M. A. El-Desoky, Nadia M. Roshdi and M. A. Tantawy. 2016. Potassium forms of EL-Dakhla Oasis soils, New valley governorate, Egypt. J. of Soil Sci. and Agric. Eng., Mansoura Univ., 7(12): 947-954.

Baruah, T.C. and H.P. Barthakur. 1997.A Textbook of soil analysis. Vikas Publishing House PVT LTD, New Delhi, India.

Bashour, I.I. 2001. Fertility and fertilizer requirements. In rural integrated development of the mountains of northern lebanon. FAO report to ministry of agriculture, Beirut, Lebanon p:116.

Bohn, H. L., B.L. McNeal and G.A. O'Connor. 2001. Soil Chemistry. 3rd ed. John Wiley & Sons, Inc. New York., USA.

Brady, N. C. and R. R. Weil. 1999. The nature and properties of soils. 11th Edition. Prentice-Hall. Upper Saddle River, NJ, USA.

Brady, N.C and R.R. Weil 2002. Nature and Properties of soils. Thirteen edition, Pearson Education, Pvt.Ltd., Delhi, India.

Brevik, E. C., A.Cerdà, J.Mataix-Solera, L.Pereg, J. N.Quinton, J.Six, and K. Van Oost 2015. The interdisciplinary nature of SOIL, SOIL, 1, 117-129.

Carson, P.L. 1980. Recommended potassium test. P.17-18 In: Dahnke, W.C. (ed.) Recommended chemical test procedures for the North central region. NCR Publ. No. 221 (revised). N. Dakota agricultural experimental stationn, North Dakota State Univ., Fargo, North Dakota, USA.

Chaudhary,P.R.; D.V.Ahire and V.D. Ahire.2012.Correlation between Physico-chemical properties and available nutrients in sandy loam soils of Haridwar, Journal of chemical, biological and physical science, 2 (3),1493-1500.

Dohrmann, R. 2006. Cation Exchange Capacity Methodology I: An Efficient Model for the Detection of Incorrect Cation Exchange Capacity and Exchangeable Cation Results. Applied Clay Science, 34, 31-37.

Elbasiouny H., F.Elbehiry,M.Abowaly 2017. Soil Quality Indices- Special Focus on Salt-Affected Soil: Review and Case Study in Northern Egypt Env. Biodiv. Soil Security Vol.1, pp.85-100.

El-Desoky, H., M. El-Rahman., S. Farouk., A. Khalil and W. Fahmy 2015. Geochemical characteristics of goethite-bearing deposits in the Dakhla - Kharga Oases, Western Desert, Egypt. Inter. J. of Scientific Engineering and App. Sci.1(8):72-85.

El-Sayed, M.A., S.H. Abd El-Aziz, A.I. El-Desoky and S.A.H Selmy. 2016. Pedomorphic Features and Soil Classification of Gharb El-Mawhob area, El-Dakhla Oasis, Western Desert, Egypt. Middel East J. Agric. Res., 5(2): 247-257.

Farifteh, J., A. Farshad and R.J. George. 2006. Assessing salt-affected soils using remote sensing, solute modeling and Geophysics. Geoderma, 30(2): 191-206.

Ghafoor, A., M. Qadir and G. Murtaza. 2004. Salt-Affected Soils: Principles of Management, Allied Book Centre, Urdu Bazar, Lahore, Pakistan.

ICARDA. 2011. Water and Agriculture in Egypt. Technical paper based on the Egypt-Australia-ICARDA Workshop on. On-farm Water-use Efficiency. Working paper, July 2011, Cairo-Egypt

Jackson, M. L. 1973. Soil chemical analysis. Prentice-Hall, Inc., Englewood Cliffs. NJ, USA.

Kumar, P, A. Kumar, B.P. Dhyani, P. Kumar, U.P. Shahi, S.P. Singh, R. Kumar, Y. Kumar, A. Kumar and S. Raizada 2013. Soil fertility status in some soils of Muzaffarnagar district of Uttar Pradesh, India, along with Ganga canal command area. African J. of Agric. Res., 8(14):1209-1217.

Kumar, R.; A. S. Sarka; K. P. Singh; B. K. Agarwal and S. Karmakar. 2009. Appraisal of available nutrients status in Santhal Paraganas region of Jharkhand. J. Indian Soc. Soil Sci. 57(3): 366-369.

Olsen, S.R. and L.E. Sommers. 1982. Phosphorus. P. 403-430. In A.L. Page, R.H. Miller and D.R. Keeney (eds.) Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties. 2 nd ed. Am. Soc. Agron, Inc. & Soil Sci. Soc. Am., Inc., Madison, WI., USA.

Olsen, S.R.; C.V. Cole, F.S. Watanabe and L.A. Dean. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. USDA Circ. 939. U.S. Gov. Print. Office, Washington, DC.

Patel H. and M.M. Lakdawala. 2014. Study of soil's nature by pH and soluble salts through EC of Kalol-Godhra taluka territory, Der Chemical Sinica, 5(2):1-7.

Piper, C.S. 1950. Soil and Plant Analysis. Inter. Soc. Publ. Inc., New York, USA.

Rasool R., S.S. Kukaland G.S. Hira. 2007. Soil physical fertility and crop performance as affected by long term application of FYM and inorganic fertilizers in rice-wheat system. Journal of Soil and Tillage Research, 96(1-2):64-72.

Ravikumar, P. and R. K. Somashekar. 2013. Evaluation of nutrient index using organic carbon, available P and available K concentrations as a measure of soil fertility in Varahi River basin, India. Proceedings of the International Academy of Ecology and Environmental Sciences, 3(4): 330-343.

Richards, L.A. 1954. Diagnosis and Improvement of Saline and alkali Soils. United States Salinity Laboratory Staff, Department of Agriculture, Hand Book, No.60. California, USA.

Selmy, S. A. H. 2005. Studies on some shale-derived soils in the New Valley, Egypt. M.Sc. Thesis, Fac. Agric., Assiut Univ., Egypt.

Shrivastava P, R. Kumar 2015.Soil salinity: A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. Saudi Journal of Biological Sciences. 22(2):123-131.

Shuman, L. M., 1979. Zinc, manganese and copper in soil fraction. Soil Sci. 127: 10-17.

Singh ,Y. P., B.P. S.Raghubanshi, R. J.Tiwari, S. Motsara 2014. Distribution of available macro and micronutrients in soils of Morena district of Madhya Pradesh. TECHNOFAME- J Multidisciplinary Adv. Res., 3 (1): 1-8.

Singh Y., G.Singh, B.Singh, A. Cerdà 2017. Restoration of Degraded Salt Affected Lands to Productive Forest Ecosystem. Geophysical Research Abstracts Vol. 19, EGU2017-1473.

Squires, V.R., Glenn, E.P., 2010. Salinization, desertification, and soil erosion. In: Encyclopedia of Life Support Systems. The role of food, agriculture, forestry, and human nutrition, vol. III

Tantawy, M.A, M.A. El-Desoky, M.Y. Awad and Nadia M. Roshdi. 2017. Available Potassium Evaluation of Gharb El-Mawhob Soils, El-Dakhla Oasis, Egypt. Assiut J. of Agric. Sci., 48 (1): 214-228.

Tomašić , M., Ž. Zgorelec, A. Jurišić, I. Kisić, 2013. Cation exchange capacity of dominant soil types in the republic of Croatia. Central European Agriculture J. 14(3):937-951.

فحص صفات ومحددات الزراعة المستدامة لأراضى منطقة الزيات بواحة الداخلة، مصر

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تم جمع عينات تربة سطحية (0-30 سم) وتحت سطحية (30-60 سم) من منطقة الزيات، بمحافظة الوادي الجديد، مصر بهدف تحديد خواصها الفيزيائية والكيميائية ومدى خصوبتها والعلاقة بين هذه الصفات لاستغلالها زراعياً. وقد أظهرت النتائج أن قوام التربة يتغير من طينى الى طمي رملي طيني الى طمي طيني والى طمي رملي. وقد تراوح محتوى التربة من كربونات الكالسيوم بين 9.8 إلى 85.6 % ومن المادة العضوية بين 0.8 إلى 10.2٪. كما تراوحت السعة التبادلية الكاتيونية (CEC) بين 4.8 و 71.6 سم / كجم بقيمة متوسطة 34.92 سم / كجم. وتتغير قيم الأس الهيدروجيني (pH) من المتعادل إلى متوسط القلوية. وكانت 10 ٪ من العينات الكلية قليلة الملوحة، في حين أن 30% منها كانت معتدلة و 60 ٪ منها كانت عالية الملوحة. وكانت قيم نسبة الصوديوم المدمصة (SAR) في 70٪ من العينات الكلية أعلى من 13 دالة على أن التربة صودية. وكان محتوى النيتروجين الكلى في عينات التربة المدروسة منخفض جدًا. وكانت قيم الفوسفور الميسر فى حوالي 53 ، 30 ، 17 ٪ من عينات التربة المدروسة منخفضة ومتوسطة وعالية على التوالي. وكذلك كان البوتاسيوم الميسر فى حوالى 98٪ من عينات التربة المدروسة مرتفعًا جدًا. وقد أوصت الدراسة الى أنه يجب إضافة كميات مناسبة من الجبس لاستصلاح هذه التربة وإضافة السماد العضوي لتحسين صفات التربة وزيادة خصوبتها مع اتباع برنامج إدارة مزرعية مناسب للتغلب على معوقات الزراعة المستدامة.