Available nutrients and some soil properties of El-Qasr soils, El-Dakhla Oasis, Egypt

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*Abstract— Ten surface soil samples (0-30 cm) were collected from El-Qasr village, El-Dakhla Oasis, New Valley, Egypt to investigate some soil properties and nutrients availability. The results revealed that most of the soil texture varied clay loam to sandy clay loam. The mean values of bulk density (BD), soil pH, electric conductivity (EC), saturation percentage (SP), calcium carbonate (CaCO₃), cation exchangeable capacity (CEC), organic matter (OM), and sodium adsorption ratio (SAR) were 1.42 gcm³, 7.89, 3.34 dSm-1, 52.10%, 7.46 %, 28.08 cmol (+) kg⁻¹, and 3.65, respectively. The mean values of N, P, and K were 99.37, 31.32, 121.93, mg/kg, respectively. Meanwhile, the mean values of Fe, Mn, Cu and Zn were 27.39, 18.38, 0.48, and 3.48 mgkg⁻¹, respectively. The correlations coefficient of NPK was strongly positively significant relationship with clay, OM, CEC, and SAR, but they negatively correlated with pH, EC, CaCO₃. Meanwhile, Fe, Mn, and Cu were positively correlated with EC, CaCO₃, while they negatively correlated with clay, pH, OM, CEC, and SAR. Also, Zn was negatively **correlated** with clay, pH, EC, OM, and CaCO₃, and it positively correlated with CEC and SAR.*

Keywords—Available nutrients, soil physico-chemical properties, El-Qasr area, El-Dakhla Oasis.

I.   INTRODUCTION

El-Dakhla Oasis is belongs to the New Valley governorate that is located at the middle of the Western Desert of Egypt between longitudes 28° 22 00″ - 29◦ 30 00″ E and latitudes 25◦ 25 00″ – 25° 55 00″ N (Fig. 1). This area of El-Dakhla oasis has not conducted any studies to investigate the content of the available nutrients in their soils. El-Dakhla Oasis is the southern one in this cluster of depressions and represents an important feature in the Western Desert [11]. The general climate of El-Dakhla oasis is lies within the extremely arid belt, with long hot summer and short warm winter, since the mean monthly minimum temperature values range from 4.30 to 9.90 C° in winter and from 28.50 to 32.30 C° in summer. The groundwater is the only water resource for all life activities ([12]. Soil fertility is one of the important factors controlling the crop yield. So, soil testing provides the information about the nutrient availability of the soil

upon which fertilizer recommendation for maximizing crop yield. Nutrients available depend on soil pH, organic matter content, and other physical-chemical properties [16]. Soil characterization in relation to the evaluation of fertility status of the soils of an area or region is an important aspect in the context of sustainable agriculture production. Soil variability is naturally caused by climate, topography, parent material, vegetation, time, and management practices [2]. Soil nutrients are essential for plant growth, development, and reproduction. So, if nutrients sunlight and water are present in sufficient amounts, plants can create all the compounds needed for typical development [13]. Macronutrients are commonly available to plants as exchangeable cations. These cations content an immediate source of nutrients for plants, but some insoluble sources may exist. Also, micronutrients are generally derived from parent materials, such as ferromagnesian minerals and basic igneous rocks [24].

The main objective of the current study is assessed to the availability of macro-micronutrients and some soil physical -chemical properties of El-Qasr area. These assessments will be helping us understanding the future scope of growth of plants in this region.

II.   MATERIALS AND METHODS

Ten surface soil samples (0-30 cm) were collected from El-Qasr area in the western part of El-Dakhla oasis that is located between longitudes 28°42" 00 - 28°58"00 E and latitudes 25° 40" 00 - 25° 44" 00 N (**Fig.1**). The main crops grown on this area are parley, alfalfa, date balm and wheat plants. The collected soil samples were air-dried, crushed and sieved through a 2-mm sieve and kept for physic-chemical analysis. Particles-size distribution and the electrical conductivity of the soil samples were performed using the method of [19]. Soil organic matter content was determined using the dichromate oxidation method [19]. Soil calcium carbonate was estimated using the calcimeter method according to [23]. Soil reaction pH was determined in saturated soil paste suspension by a gears electrode [22]. Soil salinity (EC) was measured in 1:2.5 of soil and water extract using conductivity meter [19]. Cation exchange capacity (CEC) was determined using the sodium acetate method as proposed by [19].

Sodium adsorption ratio (SAR) was according to [19]. Soluble ions were determined in the saturated soil paste extract according to [17].

III. RESULT AND DISSECTION

3. 1 Some soil physical and chemical properties

Some soil physical and chemical properties investigated are shown in **Table 1** and fig. *2*.The texture class of soil samples under study was varied from loamy sand to clay texture. Sand, silt, and clay content ranged from 28 to 89, from 4 to 37 and from 7 to 47%, respectively. The bulk density and saturation percentage were ranged from 1.22 to 1.73 g/cm^3 and 16 to 76% with mean1.42 g/cm^3 to 52.10%, respectively. Soil pH values ranged from 7.56 to 8.83 with mean 7.89. The highest value of pH was found in sample No.8. The high value of pH may be attributed to the reaction of applied fertilizer material with soil colloids and increased the soluble salts and content of calcium. Also, soil tillage systems lead to an increase of soil pH, base saturation, and extractable phosphorus [25]. [14] he found that the levels of soil pH in some soils of Upper Egypt ranged from 7.73 to 9.45. Also, [5] found that a pH range of 6.5 to 7.5 is optimal for plant nutrient availability.
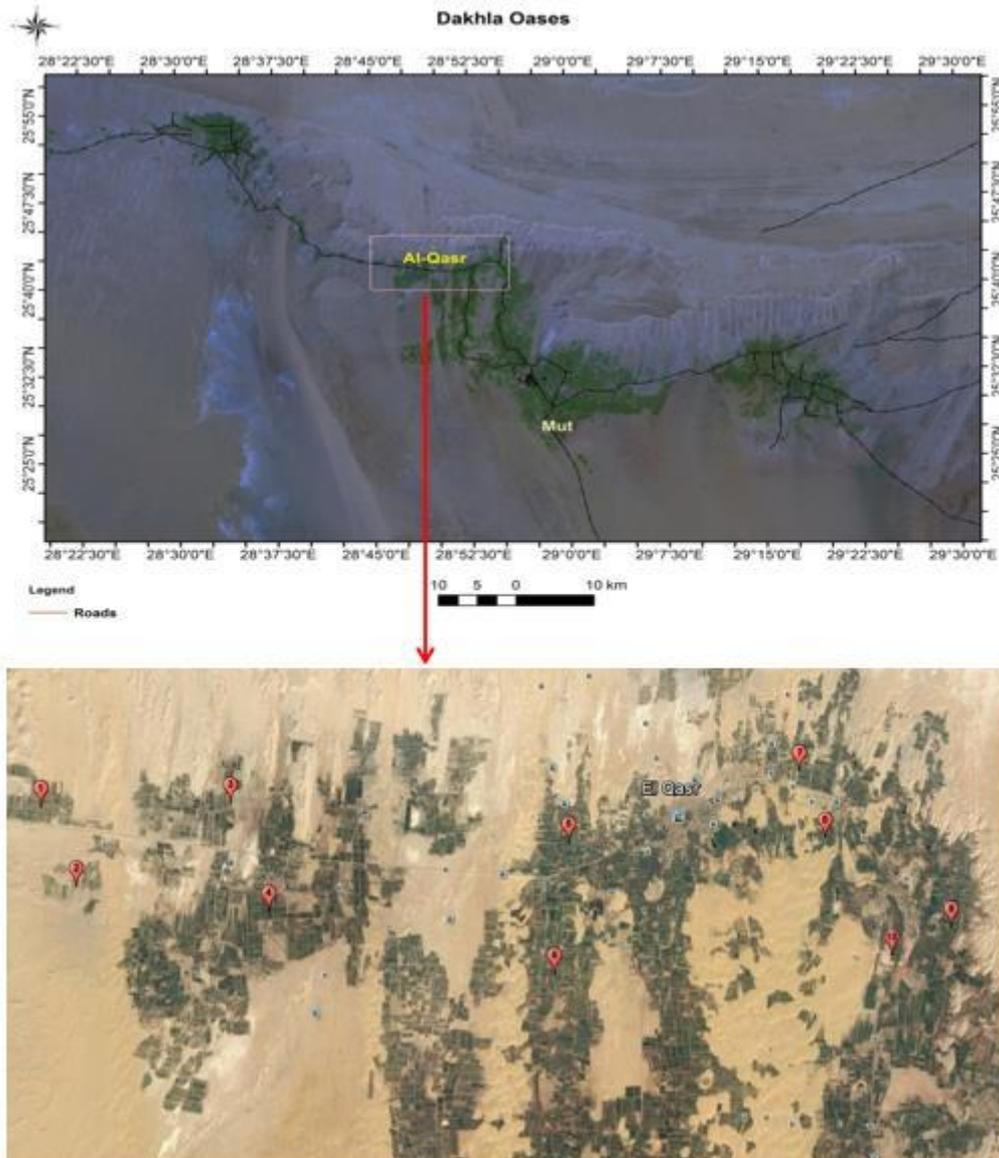

Fig.1: El-Dakhla Oasis map and location of soil sampling points in El-Qasr area.

Table.1: Some physico- chemical properties of collected soil samples in El-Qasr area.

Soil No	Particle-size distribution			Texture	BD	pH (1-2.5)	EC (1-2.5)	SP	CaCO$_3$	OM	CEC	SAR
	Sand	Silt	Clay									
	%				gcm^{-3}		dSm^{-1}		(%)		cmol (+) kg^{-1}	
1	32.7	25	42.3	Clay	1.22	7.56	3.55	76	4.63	1.53	37.97	4.71
2	36.4	30	33.6	C L	1.27	7.55	2.64	65	2.96	1.25	29.76	1.99
3	49.8	24	26.2	S C L	1.39	7.82	1.03	50	7.65	1.07	24.32	3.66
4	36	35.9	28.1	Loam	1.43	7.75	6.58	61	2.85	1.16	32.34	5.56
5	31	35.7	33.3	C L	1.45	7.76	2.17	64	3.74	1.43	28.68	3.54
6	29.9	36.1	34	C L	1.38	8.22	1.90	70	4.12	1.11	30.10	2.87
7	28	36.8	35.2	C L	1.37	7.76	1.87	55	5.65	1.46	33.11	4.11
8	88.5	4.5	7	Sand	1.73	8.83	9.14	16	26.82	0.07	10.23	0.78
9	65.9	16	18.1	S L	1.65	8.04	2.03	23	9.30	0.12	28.21	4.96
10	50.6	23.4	26	S C L	1.33	7.63	2.44	41	6.92	1.06	26.11	4.36
Mean	44.88	26.74	28.38	------	1.42	7.89	3.34	52.10	7.46	1.03	28.08	3.65

CL= clay loam, SCL= sand clay loam, SL= sandy loam

In the present investigation study the CaCO$_3$ content of the investigated soil samples ranged between 2.85 and 26.82%. Soil No 8 has the high amount of CaCO$_3$ (26.82%). These high amounts of CaCO$_3$ probably due to the high soil salinity or even soil texture [6]. In general, the accumulation of calcium carbonate in the soils depends on the position of the area, evaporation rates and the depth of percolating rainwater [12]. [15] they found that the values of CaCO$_3$ in some soils in Upper Egypt ranged from 0.15 to 49.00%. Also, the results in Table 2 indicate that the content of OM of the studied soil samples ranged from 0.07 to 1.53% with a mean value of 1.03%. The lower OM content is related to the coarse soil texture, while the higher one is attached to the fine and medium soil texture. This result is an agreement with those obtained by [12] whom found that soil organic matter content in El-Dakhla Oasis (GarbEl-Mawhob area) was very low and ranged from 0.05 to 1.41%. The cation

exchange capacity (CEC) was varied from 10.23 to 37.97 cmol (+) kg^{-1}. The high value (37.97 cmol (+) kg^{-1}) of CEC may be due to the high of organic matter and clay content. This result agrees with those obtained by [26], [21]) and [7] they reported that both clay content and organic matter considered as a source of nutrients by attracting cations and provide more exchange sites to get the cations adsorbed on it; so, soils that have a large amount of clay or organic matter have higher exchange capacities than sandy soils, which are usually low in clay content and organic matter. Also, the low values of CEC may be attributed to the effect of soil tillage that led to the reduction of soil organic matter [25]. The values of SAR ranged from 0.78 to 5.56 (Table 2. and figure 3), SAR values can be indicating that the majority of soils have less than 8, the non-sodic soils cover about 77% of the soils.
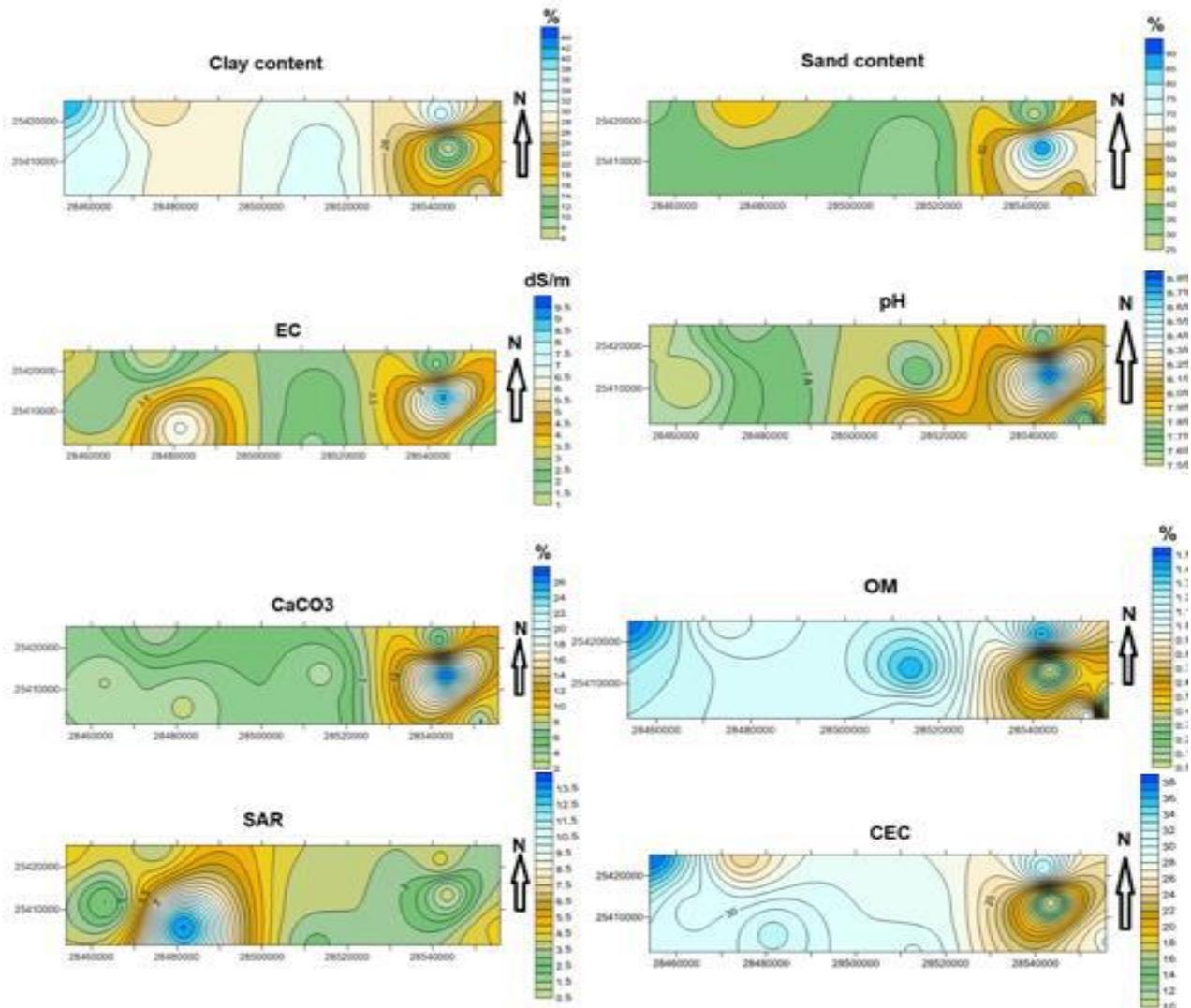
Fig.2: The distribution maps of some physical and chemical properties in El-Qasr area soils.

3. 2 Availability of macro-micronutrients

The results of the available NPK in the studied soils are shown in Table 3 and Figure 3. The values of macro elements were ranged from 70.31 to 170.22 mg/kg for N with a mean value of 99.37 mg/kg, from14.33 to 52.71mg/kg for P with a mean value of 31.32 mg/kg, and from 82.36 to 240.04 mg/kg for K with a mean value of 121.93 mg/kg. The highest level of available N, P, and K was recorded in soil sample No. 5. This may be attributed to the addition of plants residual and organic fertilizers that provide substrate for microbial growth, and subsequent microbial activity [28]. In sandy calcareous soils, the content of extractable soil P was 4.50 mgkg[-1] reported by [10]. On the other hand, [1] demonstrated that the extractable soil P ranged from 0.10-0.35 mgkg[-1]in some different soils of Egypt. The mean levels of the extractable P in the loamy soils were always higher than those of sandy or clay soils. The value of available potassium ranged from 0.1 to 2.34 mg kg^{-1}.

The excess in potassium may lead to plants will exhibit typical Mg, and possibly Ca deficiency symptom due to a cation imbalance [24]. DTPA-extractable of micronutrients in the studied soils was shown in Table 3 and Fig. 3. The values of these elements ranged from 21.54 to 33.54, 14.76 to 24.87, 2.12 to 4.23, and 0.31 to 0.72 mgkg[-1]with a mean value of 27.39,18.38,0.48 and 3.48 mg/kg for Fe, Mn, Cu, and Zn, respectively.

Generally, the highest levels of micronutrients were showed in soil samples No.8, respectively. In El-Dakhla oasis soils, [4] found the available Fe, Mn, Cu and Zn content range from 250 to 396, 0.21to 7.4, 0.15 to 0.43-0.77, and from 0.15 to 0.43-0.77mgkg[-1], respectively. [20] found that the Fe extracted by DTPA ranged between 1.20 to 28.60 mgkg[-1] in some soils of middle and Upper Egypt. Also, they found that the DTPA-extractable Mn ranged from 1.10 to 57.40 mgkg[-1]. [18] reported that the levels of DTPA-extractable Cu varied from 0.17 to 4.88 mgkg[-1] in Sohag soils, Egypt. Generally, the availability

of all nutrients in soil remarkably improved by the application of gypsum, which creates a more favorable environment in soil and maintain elements in a more available form due to reclamation effect [9] and [27].

Table.2: Available macro and micronutrients (mgkg⁻¹) of the collected soil samples in El-qasr area.

| Soil No	Available macronutrients			DTPA-extractable micronutrients			
	N	P	K	Fe	Mn	Cu	Zn
1	140.36	44.42	133.12	29.65	14.78	3.22	0.44
2	110.32	36.31	127.11	29.87	13.43	3.22	0.48
3	70.31	28.41	116.52	13.32	14.76	2.12	0.31
4	80.16	38.35	97.34	17.43	18.32	3.65	0.52
5	170.22	52.71	243.04	31.55	12.43	4.20	0.63
6	104.21	26.34	112.54	33.54	22.54	3.97	0.39
7	99.12	24.65	105.67	29.67	21.64	3.78	0.44
8	55.71	14.33	82.36	36.75	24.42	4.23	0.72
9	55.61	21.78	92.13	21.54	20.65	4.12	0.41
10	107.64	25.91	109.44	30.54	20.87	2.23	0.43
Mean	**99.37**	**31.32**	**121.93**	**27.39**	**18.37**	**3.48**	**0.48**
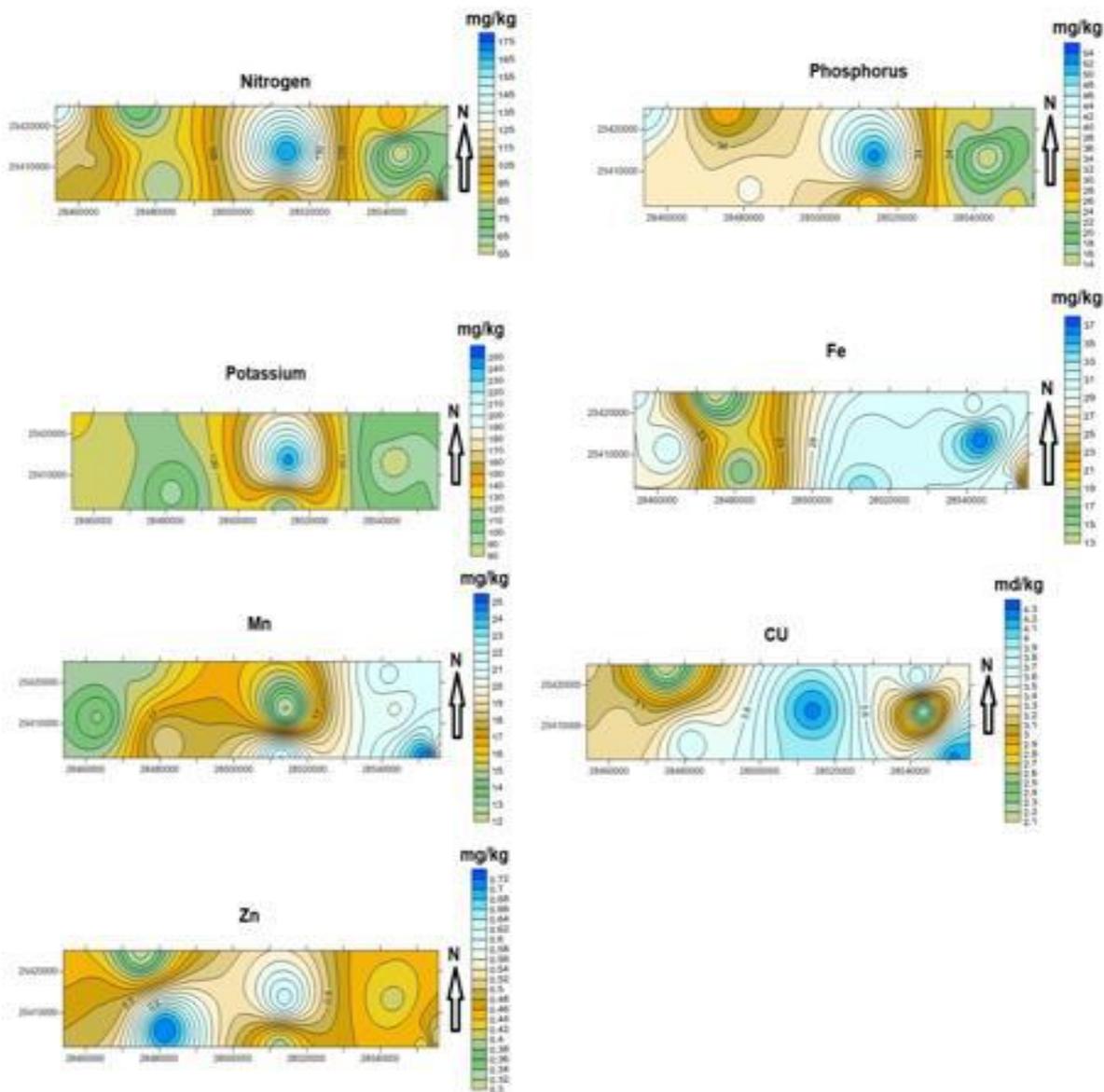
Fig.3: The distribution maps of macro and micronutrients in El-Qasr area soils.

3. 3 Linear correlation coefficients amonge macro-micronutrients and some soil physico- chemical properties in El-Qasr area.

The correlation coefficient in *Table 4* shows that NPK were related positively and significantly relationship with clay, (0.687, 0.625, 0.466 and, respectively), OM (0.728, 0.676, 0.519and, respectively), and CEC (0.415, 0.516, 0.233and, respectively), while, they negatively correlated with pH, EC, $CaCO_3$. This is evident as the proportion of clay in the soil is recognized to positively increase the amount of nutrients in the soil [26]; [3]. Meanwhile, Fe, Mn, and Cu were positively correlated with EC, $CaCO_3$, but they negatively correlated with clay, pH, OM, CEC, and SAR. Also, SAR was negatively correlated with K, Fe, Mn, and Cu, while it was positively correlated with N, P and Zn. As well as Zn was negatively correlated with clay, pH, EC, OM, and $CaCO_3$, while it was positively correlated with CEC and SAR. Generally, the high positive correlations may be attributed to imply that soil properties are influenced by similar climatic and biotic factors that are likely to influence the buildup of nutrients in the soil, while the negative associations mean that the soil properties are not influenced by similar climatic and biotic factors [8].

Table.3: The correlation coefficient among macro and micronutrients and some soil physico- chemical properties in El-Qasr area.

property	N	P	K	Fe	Mn	Cu	Zn
Clay	0.687	0.625	0.466	-0.059	-0.487	-0.157	-0.055
pH	-0.489	-0.611	-0.349	-0.402	-0.655	-0.510	-0.138
EC	-0.388	-0.264	-0.344	0.239	0.408	0.371	-0.051
OM	0.728	0.676	0.519	-0.058	-0.533	-0.285	-0.226
$CaCO_3$	-0.548	-0.666	-0.389	0.343	0.556	0.237	-0.171
CEC	0.415	0.516	0.233	-0.314	-0.349	-0.051	0.275
SAR	0.006	0.260	-0.008	-0.644	-0.102	-0.182	0.394

IV.   CONCLUSION

The soil sample shows the relatively highly alkaline nature and low value of N, P, and K. The EC values were in a medium range for most soils but it's high in soil no 4 and 8. The excess amount of micro nutrient shows a medium range in most study soils. So, recommended that in location point where the soil is deficient in N, P, and K which requires addition of more fertilizer and manures to improve their physical and chemical properties and make it suitable plantation and for increasing plant growth and yield production.

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