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Evaluation of some Soils in Kurdistan for Agricultural Purposes

Albrifcany, M. S.[1*] and Hajer S. A. Askander[2]

[1] Agron, Envir, 0f Duhok Government.
[2] Dept Field Crops, Coll Agric Engin Sci, University of Duhok, Kurdistan Region of Kurdistan

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ABSTRACT

In line with the agricultural strategy aimed at reclaiming and cultivating all soils in Kurdistan, research work was carried out to assess soils of three distinct locations: Duhok, Zakho and Akri. Evaluating these soils for agricultural viability involves analyzing several critical factors such as pH levels, salinity, and the presence of contaminants, particularly heavy metals. By conducting a comprehensive assessment of these elements, agricultural practitioners and policymakers in Kurdistan can make well-informed decisions regarding soil management practices, land use planning, and the promotion of sustainable agricultural development. Continuous monitoring and research efforts are crucial for adapting to evolving environmental conditions and ensuring the long-term productivity of Kurdistan's agricultural soils. Our findings indicate that all three locations exhibit suitability for agriculture in terms of soil acidity (pH) and fertility, including available nitrogen and organic matter content. However, it's important to note that all three locations also show signs of relative contamination with heavy metals. This underscores the necessity for implementing appropriate mitigation measures to address this contamination and safeguard both soil health and agricultural productivity in these areas.

Keywords: Soil management, Soil acidity (pH), Fertility

INTRODUCTION

Agriculture stands as a cornerstone of Kurdistan economy, providing sustenance, livelihoods, and contributing significantly to national development. However, amidst the nation's ambitions for agricultural expansion and enhanced productivity, challenges emerge, demanding innovative solutions. Kurdistan's agricultural landscape is intricately linked with its soil resources, which have long served as the lifeblood of its farming endeavors. Yet, with increasing population pressures, changing climatic patterns, and the imperative of food security, the necessity for agricultural expansion looms larger than ever (Qureshi and Al-Falahi, 2015).

The quest for agricultural expansion necessitates a multifaceted approach, one that extends beyond traditional boundaries to explore new frontiers of productivity. Central to this pursuit is the identification and utilization of new soils, alongside enhancing the efficiency of existing ones. While Kurdistan boasts a rich diversity of soils across its varied terrains, unlocking their full potential requires a nuanced understanding of their characteristics, limitations, and management practices (Abu-Gullal *et al.* 2021). Moreover, as agricultural demands escalate, the imperative to optimize the utilization of existing soils becomes increasingly pressing. Enhancing the efficiency of old soils through sustainable management practices not only augments productivity but also safeguards against soil degradation, erosion, and depletion of essential nutrients. Therefore, the path to agricultural expansion in Kurdistan necessitates a strategic blend of exploration, innovation, and stewardship, with soils serving as the fundamental Substrate upon which this journey unfolds (Al-Ghrairi *et al.* 2022).

Against this backdrop, this study endeavors to evaluate the agricultural potential of soils from three distinct locations in Kurdistan: Duhok, Zakho, and Akri. By comprehensively assessing key soil properties such as pH levels, salinity, fertility, and the presence of contaminants, the study aims to provide valuable insights for agricultural practitioners and policymakers. Ultimately, the goal is twofold: first, to identify new soils conducive to agricultural development and second, to propose strategies for enhancing the efficiency and sustainability of existing soils. Through these endeavors, the study seeks to contribute to the overarching objective of fostering agricultural expansion, resilience, and food security in Kurdistan.

MATERIALS AND METHODS

Soil samples were collected at a depth of 0-30 cm from the studied areas in Kurdistan, namely Duhok, Zakho and Aqre and were transported to the laboratory to perform physical and chemical analyzes on them and determine their suitability for agricultural purposes. pH was measured by pH meter as described by Dewis and Freitas, (1970). Soil moisture content was measured according to Horn *et al.* (1994) depending on the following equation;

$$\text{Moisture content} = W_w - W_d / W_d.$$

Where, **W_w is the initial wet weight of the sample, while W_d is the weight of the dry sample after drying.**

Sodium adsorption ratio SAR involves the concentrations of sodium, calcium, and magnesium ions in a solution. It is typically expressed by the following equation;

$$SAR = \frac{Na^+}{\sqrt{\frac{(Ca^{2+} + Mg^{2+})}{2}}}$$

Electrical conductivity (EC) was assessed in a saturated soil paste extract, obtained using EC meter via the free capillary attraction method outlined by Jackson (1967).

Oxidizable organic carbon, total organic carbon, organic matter were determined using the Walkley and Black

* **Corresponding author.**
E-mail address: shikh1971@yahoo.com
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method using $H_2C_2O_4.2H_2O$, $FeSO_4$,$KMnO_4$, $K_2Cr_2O_7$ and diphenylamine indicator as reported by Hesse (1971).

Soluble and total extractable nutrients [chloride (Cl), sulfur (S), phosphorus (P), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and total nitrogen (T. Nitrogen)] were determined according to Tandon (2005). Soluble calcium and magnesium (Ca, Mg) concentrations were assessed using the versenate method, while sodium and potassium levels were determined employing flame photometry. The carbonate and bicarbonate contents were determined through titration with a standardized H_2SO_4 solution. Chloride (Cl) was titrated using silver nitrate. The sulfate concentration was calculated as the difference between the sums of cations and anions. Additionally, heavy metal analysis was carried out using inductively coupled plasma-optical emission spectrometry. Nitrogen content was determined using the Kjeldahl method.

RESULTS AND DISCUSSION

The provided Tables from 1 to 6 offer a comprehensive overview of the physical, chemical, and heavy metal properties of soils from the studied locations.

Table1 presents data on key physic-chemical properties such as pH, moisture content, sodium adsorption, electrical conductivity (E.C.), oxidizable organic carbon, total organic carbon, and organic matter. Significant variations are observed across the studied locations, with notable differences in pH, moisture content, and organic carbon levels. These variations could influence soil fertility, nutrient availability, and overall suitability for agricultural purposes.

Table 2 provides insights into the soluble and total extractable nutrients in the studied soils, including chloride (Cl), sulfur (S), phosphorus (P), calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and total nitrogen (T. Nitrogen). Significant differences in nutrient levels are observed among the studied locations, indicating variations in soil fertility and nutrient cycling processes. Understanding these nutrient dynamics is crucial for implementing targeted fertilization strategies and optimizing agricultural productivity.

Table 3 presents data on heavy metal concentrations in the studied soils, including zinc (Zn), lead (Pb), cadmium (Cd), manganese (Mn), chromium (Cr), iron (Fe), copper (Cu), nickel (Ni), aluminum (Al), and cobalt (Co). Elevated levels of certain heavy metals, such as lead, chromium, and iron, are observed across the studied locations, raising concerns about potential soil contamination and environmental risks. Effective soil management practices and remediation strategies may be necessary to mitigate these risks and ensure soil health and ecosystem integrity.

Table 1. physic- chemical properties of studied soil

Variable	Aqre		Duhok		Zakho		Pr > F
	Mean	S.E.	Mean	S.E.	Mean	S.E.	
PH	8.06	0.023	7.83	0.011	7.99	0.012	0.0002**
Moisture	3.14	0.70	0.96	0.101	1.49	0.249	0.0275*
Na adsorption	0.077	0.020	0.035	0.006	0.062	0.008	0.1619
E.C.	0.024	0	0.020	0	0.022	0.001	0.2194
OxidOrgCarbon	159.73	45.38	0.86	0.057	22.84	11.65	0.0119*
TotalOrgCarbon	5.10	1.37	1.136	0.060	1.73	0.185	0.0262*
OrgMatr	1.97	0.63	1.98	0.130	5.03	2.33	0.2803

Table 2. Soluble and Total an extractable nutrients properties of studied soil

Variable	Aqre		Duhok		Zakho		Pr > F
	Mean	S.E.	Mean	S.E.	Mean	S.E.	
Cl	32.89	1.183	45.23	25.16	36.98	3.70	0.8374
S	174.06	4.88	395.56	42.40	210.10	36.73	0.0062**
P	15.70	1.75	12.45	2.196	25.88	11.09	0.3849
Ca	0.183	0.047	19.20	1.058	0.11	0.019	<.0001**
Mg	1.190	0.22	188.46	42.94	0.57	0.042	0.0025**
Na	1.59	0.299	2.36	0.240	0.77	0.054	0.0070**
K	2.73	0.519	2.67	0.223	1.32	0.093	0.0395*
T.Nitrogen	24.40	0.90	0.15	0.028	26.80	1.101	<.0001**
Ext.Ca	20782.67	2730.72	24079.33	927.16	26707.33	613.03	0.1224
Ext.Mg	1283.20	548.79	1087.20	480.49	1265.60	467.28	0.9544
Ext.Na	52.50	18.99	30.00	1.802	40.00	0	0.4072
Ext.K	138.33	25.87	208.33	27.284	201.66	61.93	0.4721

Table 3. Heavy metal properties of studied soil

Variable	Aqre		Duhok		Zakho		Pr > F
	Mean	S.E.	Mean	S.E.	Mean	S.E.	
Zn	50.69	3.77	38.83	1.25	33.72	0.85	0.0058**
Pb	94.83	9.70	91.58	3.36	106.52	15.24	0.6046
Cd	0.285	0.057	0.17	0.01	0.09	0.025	0.0350*
Mn	1231.20	54.86	1067.73	29.46	1231.20	24.76	0.0377*
Cr	76.83	3.60	48.97	4.86	147.66	7.56	<.0001**
Fe	20700.00	1011.53	16607.33	406.70	17392.67	664.41	0.0169*
Cu	5.64	2.14	78.17	71.37	2.04	1.98	0.3963
Ni	119.13	7.04	94.46	3.03	104.17	12.51	0.1978
Al	36029.00	5509.22	17932.00	1051.92	24015.33	3663.46	0.0414*
Co	0.01	0	0.01	0	0.01	0	-

Tables 4, 5 and 6 present correlation coefficients between various soil properties, providing insights into the relationships and interactions among different variables. For example, correlations between pH, moisture content, and organic carbon levels highlight the interconnectedness of soil physico-chemical properties. Similarly, correlations between nutrient levels and heavy metal concentrations shed light on potential nutrient-metal interactions and their implications for soil fertility and environmental quality.

Table 4. Correlation between physic- chemical properties of studied soil

Variable	PH	Moisture	Na adsorption	E.C.	OxidOrg Carbon	TotalOrg Carbon	OrgMatr
PH	1						
Moisture	0.8	1					
Na adsorption	0.63	0.42	1				
E.C.	0.59	0.46	0.43	1			
OxidOrgCarbon	0.59	0.47	0.54	0.57	1		
TotalOrgCarbon	0.59	0.44	0.75	0.53	0.45	1	
OrgMatr	0.17	-0.16	-0.15	0.51	-	-	1

Table 5. Correlation between Soluble and Total an extractable nutrients properties of studied soil

Variable	Cl	S	P	Ca	Mg	Na	K	T.Nitrogen	Ext.C a	Ext. Mg	Ext.N a	Ext.K
Cl	1											
S	0.457	1										
P	0.21	-0.01	1									
Ca	0.13	0.86	-0.37	1								
Mg	-0.13	0.76	-0.39	0.96	1							
Na	0.14	0.69	-0.39	0.77	0.73	1						
K	-0.17	0.18	-0.33	0.40	0.43	0.79	1					
T.Nitrog en	-0.21	-0.86	0.43	-0.98	-0.92	-0.80	-0.44	1				
Ext.Ca	-	-	-	-	-	-	-	-	1			
Ext.Mg	-	-	-	-	-	-	-	-	-	1		
Ext.Na	-	-	-	-	-	-	-	-	-	-	1	
Ext.K	-	-	-	-	-	-	-	-	-	-	-	1

Table 6. Correlation between Heavy metal properties of studied soil

Variable	Zn	Pb	Cd	Mn	Cr	Fe	Cu	Ni	Al	Co
Zn	1									
Pb	-	1								
Cd	-	-	1							
Mn	-	-	-	1						
Cr	-	-	-	-	1					
Fe	-	-	-	-	-	1				
Cu	-	-	-	-	-	-	1			
Ni	-	-	-	-	-	-	-	1		
Al	-	-	-	-	-	-	-	-	1	
Co	-	-	-	-	-	-	-	-	-	1

CONCLUSION

The evaluation of soils from Duhok, Zakho, and Akri in Kurdistan has provided valuable insights into their agricultural potential and challenges. The findings underscore the importance of soil management practices in enhancing agricultural productivity and sustainability. Despite the relative suitability of these locations for agriculture in terms of pH levels and fertility, the presence of heavy metal contamination presents a notable concern. Moving forward, addressing soil contamination and implementing appropriate mitigation measures will be imperative to safeguarding both soil health and agricultural productivity. Moreover, the study highlights the need for continued research and monitoring to adapt to evolving environmental conditions and ensure the long-term viability of Kurdistan's agricultural soils. Furthermore, the study emphasizes the importance of exploring new soils and optimizing the efficiency of existing ones to support agricultural expansion and food security initiatives in Kurdistan. By integrating scientific research with practical insights, policymakers and agricultural practitioners can make informed decisions to enhance soil management practices, promote sustainable land use, and achieve the overarching goals of agricultural development in Kurdistan.

In essence, this study serves as a foundation for future endeavors aimed at unlocking the full potential of Kurdistan's soil resources, fostering resilience in the face of environmental challenges, and ultimately, advancing the nation's agricultural prosperity and food security.

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تقييم بعض الاراضي في كوردستان للأغراض الزراعية

محمد طاهر صلاح الدين البريفكاني[1] و هاجر سعيد علي [2]

[1] دائرة بيئة دهوك

[2] قسم المحاصيل الحقلية- كلية علوم الهندسة الزراعية-جامعة دهوك- اقليم كوردستان العراق

الملخص

تماشياً مع الاستراتيجية الزراعية التي تهدف إلى استصلاح وزراعة جميع أنواع الاراضي في كوردستان، تم إجراء عمل بحثي يهدف الي تقييم الاراضي في ثلاثة مواقع في كوردستان وهي دهوك وزاخو وعقرة. يتضمن تقييم هذه الاراضي من حيث الجدوى الزراعية تحليل العديد من العوامل الحاسمة مثل مستويات الرقم الهيدروجيني والملوحة ووجود الملوثات، وخاصة المعادن الثقيلة. ومن خلال إجراء تقييم شامل لهذه العناصر، يمكن للممارسين الزراعيين وصانعي السياسات في كوردستان اتخاذ قرارات مستنيرة فيما يتعلق بممارسات إدارة التربة، وتخطيط استخدام الأراضي، وتعزيز التنمية الزراعية المستدامة. إن جهود الرصد والبحث المستمرة أمر بالغ الأهمية للتكيف مع الظروف البيئية المتطورة وضمان إنتاجية التربة الزراعية في كوردستان على المدى الطويل.تشير النتائج التي توصلنا إليها إلى أن جميع المواقع الثلاثة تظهر ملاءمة للزراعة من حيث حموضة التربة (pH) والخصوبة، بما في ذلك محتوى النيتروجين والمواد العضوية المتاحة. ومع ذلك، من المهم ملاحظة أن المواقع الثلاثة تظهر ً أيضا علامات التلوث النسبي بالمعادن الثقيلة. وهذا يؤكد ضرورة تنفيذ تدابير التخفيف المناسبة لمعالجة هذا التلوث والحفاظ على صحة التربة والإنتاجية الزراعية في هذه المناطق.