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Determination the effect of soil and irrigation water quality on total chlorophyll, carbohydrates, and proteins values in cress, parsley, celery, and basil plants.

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Abstract

The effect of soil and irrigation water quality in three sites of the Khasah Su River basin Kirkuk-Iraq was studied on the values of total chlorophyll, carbohydrates, and proteins of cress, parsley, celery, and basil plants. Samples were collected from November 2021 to May 2022. Sampling sites in the Khasah Su River located between longitudes 44° 23/ and 44° 24/ and latitudes 35° 24/ and 35° 29/. Soil quality index (SQI) values documented poor soil fertility in all sites, especially on the third site. Irrigation water quality index (IWQI) values were excellent in the first site, good in the second site, and poor in the third site. The basil plant recorded the lowest mean values of carbohydrates 0.59ppm in the first site and proteins 0.26ppm in the second site and the cress plant recorded the lowest mean value of total chlorophyll at 7.92ppm in the first site. Parsley plant recorded the highest mean values of carbohydrates 5.69ppm and total chlorophyll 21.46ppm, and cress plant highest average values of proteins 1.63ppm on the third site. Basil and cress plants were the most affected by the decrease in soil quality and irrigation water index at the study sites, while parsley and celery plants were the least affected.

Key words: Water Quality Index, Soil Quality Index, Basil, Parsley, Khasah Su river.

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Introduction

Soil, which is the main medium for the growth and development of plants, is affected by the water quality index [1]. The soil quality index is an important tool to document soil fertility and its affected by various environmental factors [2]. The water quality index has become important tool for most purposes to use water in irrigation or industry [3] drinking [4]. It affects suitability for a particular use by physical, chemical, and biological properties [5]. The quality of irrigation water has a great impact on plant growth, in addition to its effect on the physical and chemical properties of the soil, as water is the basic component of life [6]. Cress, parsley, celery, and basil plants have important nutrients and are rich in vitamins, minerals, proteins, essential oils, and antioxidants [7, 8]. The components of metabolism and their chemical composition are closely related to various external influences [9]. Primary metabolites (carbohydrates, proteins, amino acids, and chlorophyll) are directly involved in the growth, development, and reproduction of plants [10]. They usually perform a physiological function in plants and are commonly referred to as central metabolites [11].

The study aims to determine the effect of soil fertility and irrigation water quality on the values of primary metabolites in plants.

Study area

Khasah Su seasonal river divides Kirkuk city into two parts. A dam was built on it near the Kajk village after 2010 east of Kirkuk city, which reduced its water levels. The river basin is using for agriculture cress, parsley, celery, and basil to fill the need of the local markets. Three sites were selected on cultivated wetlands to measure soil and irrigation water quality index. Sites located between longitudes 44° 23′ and 44° 24′and latitudes 35° 24′and 35° 29′.

The first site was in the northern part of Khasah Su river, less affected with polluted water in the diamond area, and the second site was in the middle of the river respectively. The third site is in the south of the river basin (figure 1).

The samples were collected from November 2021 to the end of May 2022, with three replications for soil samples, irrigation water, and plants, and they were transferred to the laboratory to measure the study factors.

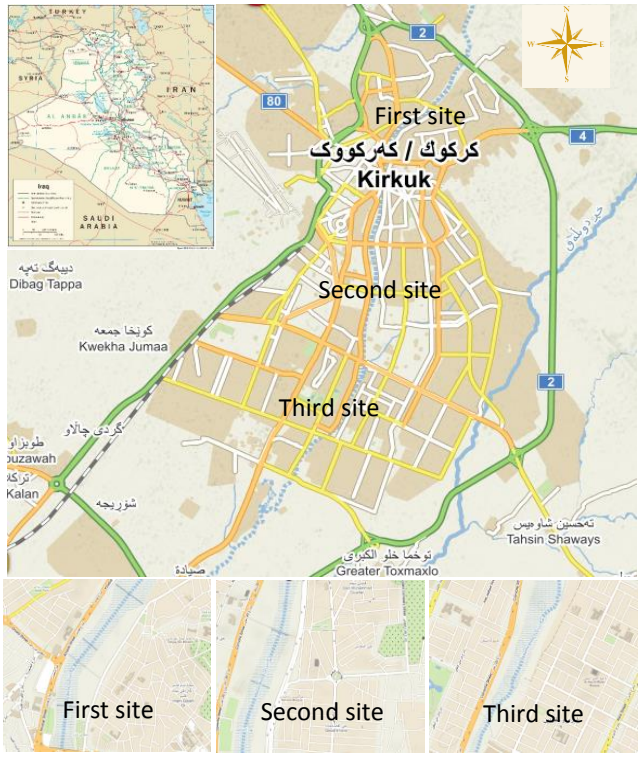

Figure 1: Study area

Materials and methods

The physical factors (Total dissolved solids and Electrical conductivity) and chemical factors (pH, chloride ions, sulphate ions, sodium ions, potassium ions, total nitrogen, and total phosphate) in water samples were measured according to [12]. Soil texture, pH, potassium ions, total nitrogen, and total phosphate were measured according to [13]. Carbohydrates according to [14], proteins according to[15], and total chlorophyll according to [16].

The irrigation water quality index was estimated using the Sub-index WQI [17, 18] and soil quality index estimates according to [19]. The analysis of variance test (ANOVA) was calculated used the SPSS program (version 26) and Duncan's test($p \leq 0.05$).

Results and discussion

Factors mean values was estimated in the irrigation water and soil (table 1).

Table 1: means values of environmental factors in irrigation water and soil on selected sites.

Environmental factors		First site	Second site	Third site
TDS ppm	Water	565.71a	632.85a	187.14b
	Soil	674.28a	661.42a	262.85b
EC ms/cm	Water	1.08a	1.14a	0.31b
	Soil	0.74a	1.16b	0.55a
pH	Water	7.32a	7.5a	7.35a
	Soil	7.15a	7.32a	7.01a
OM ppm	Water	80.02a	91.66a	86.53a
	Soil	2.48a	2.44a	1.56b
Cl ppm	Water	53.44a	89.7b	20.87c
	Soil	58.43a	152.62b	67.47a
SO_4 ppm	Water	1454.82a	1674.39a	587.58b
	Soil	451.88a	561.55a	462.4a
K ppm	Water	9.83a	15.14b	5.66c
	Soil	242.72a	263.98a	143.51b
Na ppm	Water	49.14a	85.11b	11.01c
	Soil	784.64a	1387.89b	523.51a
TN ppm	Water	0.97a	1.78b	1.4b
	Soil	2912.36a	1881.34b	1256.89c
TP ppm	Water	1.13a	0.93a	0.51b
	Soil	82.18a	129.43b	77.39a

The Soil quality index were low-fertile on all sites, but the Irrigation water quality index varied. It was excellent on the third site, good on the first site, and poor on one-second site (table 2).

Table 2: Soil and Irrigation water quality index on selected sites.

Sites	SQI		IWQI	
First	0.56	Low fertile	27.20	Excellent
Second	0.56	Low fertile	100.29	Good
Third	0.44	Low fertile	117.00	Poor

Soil quality index was inferred based on [19] and the irrigation water quality index [20].

The variation in the values of environmental factors is mostly the reason for the variation in the irrigation water quality index, which mostly results from the use of the Khasah Su River basin as a canal to transfer the domestic sewage from residential neighborhoods in Kirkuk city (table 3).

Table 3: sewage pipe GPS in Khasah Su River-Kirkuk*

ID	Diameter mm	X	Y	Region
1	600	446346.5365	3927221.34	Escan
2	600	446328.0266	3927194.765	Escan
3	600	446106.3121	3927274.355	Reheimao
4	600	446074.8493	3926940.773	Azadie
5	800	445354.7259	3926809.611	Reheimao
6	800	445131.7041	3926320.092	Emam Kasim
7	600	444960.8627	3925878.311	Emam Kasim
8	300	444944.2019	3925702.831	Emam Kasim
9	500	444809.0864	3925712.505	Sare Kahya
10	1000	444935.2279	3925596.639	Emam Kasim
11	500	444953.5569	3925132.093	Perydi
12	500	444921.5986	3924993.699	Mosala
13	400	444910.6441	3924962.112	Mosala
14	1000	444800.5119	3924947.864	Sare Kahya
15	2000	444748.6317	3923933.843	Mosala
16	1200	444642.7956	3924018.646	Sare Kahya
17	500	444663.5833	3923697.956	Mosala
18	1200	444521.9828	3923309.621	Kasab Khana
19	1000	444535.3344	3923136.905	Kasab Khana
20	1500	444439.0442	3923029.868	Grenata
21	600	444683.9732	3922537.473	Runaky
22	1200	444545.0253	3922384.027	Grenata
23	2000	444612.4033	3922191.927	Runaky
24	800	444473.0221	3922145.838	Grenata
25	1400	444667.7013	3922059.238	Runaky
26	500	444603.942	3921833.328	Runaky
27	1000	444417.8782	3921651.99	Grenata
28	800	444628.4803	3921629.332	Aluruba
29	600	444304.2629	3921209.921	Grenata
30	500	444217.9359	3920692.469	Grenata
31	600	444313.2844	3920599.015	Aluruba
32	800	444183.4399	3920237.232	Grenata
33	1100	444331.4778	3919754.556	Aluruba
34	800	444328.8249	3919726.04	Aluruba
35	3000	444252.471	3919397.995	Altadamon
36	600	444109.374	3919157.354	Altadamon
37	800	443839.0944	3918607.989	Altadamon
38	800	443650.7186	3918327.623	Almadina
39	2500	443639.1659	3918098.542	Almadina
40	800	443213.5472	3917634.769	Alzura
41	1600	443161.184	3917628.918	Alzura
42	800	442815.4825	3917688.667	Almadina
43	500	442531.7049	3917233.49	Wahed Adera
44	400	442438.4745	3917037.427	Wahed Adera
45	600	442392.8005	3916997.392	Wahed Adera
46	1400	442144.668	3916466.854	Wahed Adera
47	1000	442182.5423	3916336.736	Hsare
48	2500	442170.1158	3916270.874	Alrasheed
49	500	441809.9965	3915593	Kobany

*Kirkuk sewage directorate, 2023.

The irrigation water quality index recorded excellent quality in the first site, which was less affected by sewage water, while the second site recorded a good quality because of the mixing sewage with river water while in the third site was greatly affected by sewage water projectiles, in addition to solid pollutants from the markets surrounding the river basin therefore its values was poor.

The Soil quality index recorded poor fertility in all sites with varying values, mostly resulting from the lack of nutrients in the soil and the accumulation of pollutants on it.

Samples of cress (*Lepidium sativum*), parsley (*Petroselinum crispum)*, celery (*Apium graveolens*), and basil (*Ocimum basilicum*) plants were affected by a variation in their primary metabolites values by environmental factors at the three sites (table 4).

Table 4: mean values of total chlorophyll, carbohydrate, and proteins in plants

Plants	T. chlorophyll ppm			Carbohydrate ppm			Protein ppm		
	First site			Second site			Third site		
Cress	7.92 a	8.33 a	9.51 a	2.8 a	2.9 a	3.3 a	1.4 a	1.4 a	1.6 a
Parsley	10.6 b	18.4 b	21.4 c	4.2 a	4.6 a	5.6 a	1.0 a	1.2 a	1.3 a
Celery	14.8 c	19.3 b	16.6 b	3.7 a	3.7 a	3.5 a	1.1 a	1.1 a	1.0 a
Basil	1.4 d	8.3 a	6.5 a	0.08 b	0.7 b	1.6 c	0.1 b	0.2 b	0.8 b

The results of the statistical analysis ($p \leq 0.05$) documented the variation between the effect of soil and irrigation water quality in total chlorophyll, carbohydrates, and proteins values. The basil plant is more sensitive to environmental factors variation and less so than the cress plant, while celery and parsley plants are more tolerant to the stress of environmental factors and decreasing soil quality and irrigation water quality index values in all sites especially on the third site.

Affected basil is mostly caused by a lack of nutrients that the plant uses in its primary metabolism[21]. Their sensitivity to the lack of environmental conditions suitable for their growth in most of the study seasons [22]. The mixing of Khasah Su river water with domestic sewage water is the main source for irrigating crops. It is a good source for irrigation crops, but it needs continuous monitoring to determine its validity and the extent of its impact on the soil quality index [23]. Variance soil content of macronutrients, especially total nitrogen and micronutrients, effect in the growth and development of plants and their productivity [24]. The use of Khasah Su river basin as a final outlet for sewage water increases pollutants in its waters in addition to its accumulation in the soil [25]. The pollution of the river water and the accumulation of pollutants in the soil of its wetlands is evident in the decrease in the values of total chlorophyll, carbohydrates and protein in sensitive plants more than resistant to pollutants.

Exploiting the wetlands in Khasah Su river basin, for plant cultivation is useful in providing plants to cover the local market, but at the same time, it needs to determine the appropriate conditions for its growth to provide it with a higher content of primary metabolites, which is one of its most important nutrients.

Conclusion

Cultivating wetlands in Khasah Su river basin is a useful way to cover the local market's need for agricultural products, but it needs to determine the success factors for its cultivation by determining the soil quality and irrigation water index, as they are a useful tools in providing basic information for the success of

its growth and providing it in a successful economic manner.

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تقدير تأثير جودة التربة ومياه السقي في قيم الكلوروفيل الكلي، الكربوهيدرات، والبروتينات في نباتات المعدنوس، الكرفس، الرشاد والريحان*

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- البحث مستل من رسالة ماجستير للباحث الاول .

المستخلص

قدرت تأثير معامل جودة التربة ومياه السقي في قيم الكلوروفيل الكلي، الكربوهيدرات، والبروتينات في نباتات المعدنوس، الكرفس، الرشاد، والريحان المزروعة في ثلاثة مواقع في حوض نهر خاصة صو–كركوك بين خطي الطول 44° 23/ و44° 24/ وخطي العرض 35° و 24/ و 35° 29/. العينات جمعت من تشرين الثاني 2021 إلى أيار 2022. معامل جودة التربة وثقت فقر خصوبة تربة المواقع كلها وبالأخص في الموقع الثالث. معامل جودة مياه السقي سجلت نوعية ممتازة في الموقع الأول، جيدة في الموقع الثاني وغير مناسبة في الموقع الثالث. سجل نبات الريحان أدنى قيم متوسط الكربوهيدرات 0.59 جزء بالمليون في الموقع الأول والبروتينات 0.26 جزء بالمليون في الموقع الثاني وسجل نبات الرشاد أدنى متوسط لقيم الكلوروفيل الكلي عند 7.92 جزء بالمليون في الموقع الأول. نبات البقدونس سجل أعلى متوسط قيم للكربوهيدرات 5.69 جزء بالمليون و الكلوروفيل الكلي 21.46 جزء بالمليون كما سجل نبات الرشاد أعلى متوسط قيم للبروتين 1.63 جزء بالمليون في الموقع الثالث. نباتا الريحان والرشاد هي الأكثر تضررا بانخفاض مؤشر جودة التربة و مؤشر جودة مياه الري في مواقع الدراسة، بينما كانت نباتا المعدنوس والكرافس هي الأقل تأثرا.

الكلمات المفتاحية: معامل جودة المياه، معامل جودة التربة، الريحان، المعدنوس.