Kirkuk University Journal for Agricultural Sciences
ISSN:2958-6585
https://kujas.uokirkuk.edu.iq

RESEARCH ARTICLE

https://doi.org. 10.58928/ku24.15402

Combined Impact of Climate Change and Continuous cultivation on Greenhouses Soil Health in Sulaymaniyah Province, Iraq.

Akram M. Abdulrahman [1] **Nasik A. Seed [1]**
Delsuz H. Talib [1] **Hiwa Baiz Sharif [1]**
Jawhar Hamalaw Khalid [2]

[1] *Agricultural Researches Directorate, Sulaymaniyah, IRAQ.*
[2] *Sulaimaniyah Directorate of Meteorology and Seismology, Ministry of Transportation.*

*Corresponding Author: Absrh2010@gmail.com

Received: 22/06/2024 **Revised: 05/08/2024** **Accepted: 02/09/2024** **Published: 01/12/2024**

ABSTRACT

This study investigates the impact of continuous soil cultivation practices on soil health indicators in five villages located within the Bazian area of Sulaymaniyah city, Iraq. The villages, despite their geographic proximity within a single local climatic zone, exhibit consistent agricultural service approaches. Soil analyses focused on clay loam texture and were conducted annually before spring planting, bulk density, permeability, porosity, electrical conductivity (EC), organic matter content, and pH levels. Results indicate that bulk density ranged from 1.26 g cm^{-3} to 1.8 g cm^{-3} throughout the study period, showing a relative increase over time due to intensive plowing and agricultural activities. The continued use of organic fertilizers has helped maintain soil granular structure, preventing further deterioration of bulk density. Permeability showed a slight decrease from initial measurements, highlighting challenges. EC values varied significantly among villages. Organic matter content exhibited a curvilinear decline despite efforts to augment soil health through organic amendments. Analysis of cucumber crop yields revealed declining trends over the study period, underscoring soil depletion issues exacerbated by excessive agrochemical usage. The mismanagement of chemical fertilizers and pesticides has led to imbalanced soil nutrient profiles detrimental to soil biodiversity and sustainable agricultural practices. the rainfall data shows fluctuations with a notable peak in 2018 and a significant decline by 2021. The general trend indicates a decrease in annual rainfall over the study period, despite the occasional increases. a clear upward trend in average annual temperatures over the study period, with a significant increase observed from 2018 onwards. Despite protective measures like greenhouse cultivation moderating direct climatic impacts on soil properties, temperature rises have intensified plant stress and water demand, affecting agricultural productivity.

Keywords**:** Soil health indicators, Continue Cultivating, Climate, Irrigation Excessive, Greenhouse farming, change in soil parameters.

INTRODUCTION

Soil serves as an indispensable component of terrestrial ecosystems, supporting all life forms directly or indirectly by buffering environmental perturbations and facilitating essential biogeochemical processes crucial for plant growth and climate regulation. This review consolidates existing knowledge on the effects of climate change on soil health, emphasising the soil's dual role as both a source and a mitigator of greenhouse gases. It also underscores the soil's essential function in addressing global climate challenges [1].

Global climate change poses significant challenges to human populations, notably impacting food production through complex mechanisms such as climate warming, which threatens Food security, increases pest and pathogen pressures, and compromises soil health. Soil health, essential for sustainable crop and animal production and environmental resilience, encompasses chemical, physical, and biological attributes crucial for maintaining productivity and ecosystem integrity [2]. A healthy soil system sustains biological productivity, supports air and water quality, and provides habitats for diverse organisms without undergoing degradation that hinders plant growth [3]. Key parameters defining soil health include organic matter content, chemical properties like pH and electrical conductivity, and physical characteristics such as texture, bulk density, porosity, and permeability. These interdependent factors collectively influence agricultural yields and water use efficiency [4].

Historically, agricultural practices have heavily relied on chemical fertilizers and pesticides to enhance productivity and meet global food demands. While effective, these inputs persist in the environment, altering soil properties, disrupting microbial communities, and affecting nutrient cycles. Concerns over their environmental impacts have spurred interest in sustainable agriculture practices, emphasizing organic farming, biofertilizers, composting, and biocontrol agents as alternatives [5]. Moreover, excessive use of chemical fertilizers releases greenhouse gases and fosters algal blooms and

pesticide resistance, exacerbating environmental challenges. As a critical component of the climate system, soil management practices significantly influence greenhouse gas emissions, with agriculture and forestry contributing substantially to global emissions. Climate change-induced factors such as temperature increases, droughts, and floods further stress soils worldwide, necessitating a deeper understanding of these interactions [6]. A study investigated how long-term drought acclimation, short-term heat stress, and their combination affected fast chlorophyll fluorescence induction curves and grain yield in pot-grown wild barley from Northern Egypt. Drought primarily decreased biomass accumulation and grain yield, while heat stress specifically impacted floral development among agronomic traits.[7]
This review aims to contribute to the understanding of how climate change and land use practices impact soil health and associated ecosystem services, focusing on the Bazian area in Sulaymaniyah city, a significant agricultural region in Iraq. By examining these dynamics, we aim to inform sustainable soil management strategies amid ongoing environmental changes.

MATERIAL

Study sites

The study was conducted from 2014 to 2023, includes 4000 greenhouses in the Bazian plain, located southwest of Sulaymaniyah, at 35°31'12.0" N latitude and 45°13'12.0" E longitude, with an elevation ranging from 837 to 847 meters above sea level. These greenhouses shared similar ecological characteristics and were maintained under uniform

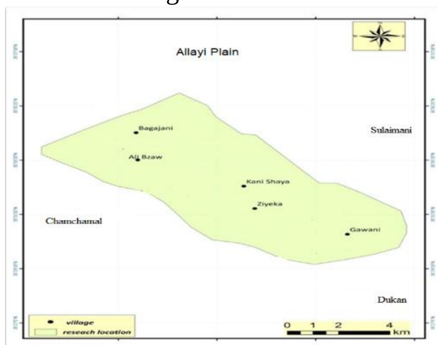

Figure 1. Location study

management practices. Data were collected from greenhouses monitored directly since 2014. to 2023 Soil samples were taken before spring planting from a depth of 0- 30 cm in five villages: Bagajani, Ali Bzaw, Kani Shaya, Ziyeka, and Gawani table 1. Production yields, along with fertilizer and pesticide usage for the study years, were obtained from project records and thoroughly documented.

Climate:

Bazian local climate has warm, semi-arid condition with an average annual sunshine of 2550 hours an average annual temperature of 19.42 °C and an annual precipitation of 678 mm. In total, Wind speed is fastest in September and October with monthly rates of 1.5 and 1.6 m. s^{-1} respectively, the lowest relative humidity rates are in the months of July and August at values of 9 and 10% respectively.

Table 1. Soil health indicators include soil physical indicators, soil chemical, crop yield and Irrigation's water production.

Soil Health Indicators (Drivers of climate change)				
Soil Physical Indictor	Soil Chemical Indictor	Organic Mater	Crop Yield	Irrigation's water production
Soil Stricture Soil Texture Soil bulk density porosity	Soil E.C. Soil PH	% organic Matter	Yield of the Crops in one donum	IWP. equals to the total crop yield divide by the total irrigation water use for crop.

Table 2. location study and villages name and the year of founded these projects.

Locations	Village name	Latitude	Longitude	No. of Greenhouses	Year Founded
L1	Bagajani	35°34'12.0"N	45°10'12.0"E	10	2013
L2	Ali Bzaw	35°33'00.0"N	45°10'48.0"E	18	2012
L3	Kani Shaya	35°31'12.0"N	45°13'12.0"E	20	2012
L4	Ziyeka	35°30'53.0"N	45°12'19.0"E	10	2013

L5	Gawani	35°31'48.0"N	45°12'36.0"E	14	2014

Results & Discussion

Based on data from the five villages, the results appear to be consistent. This may be due to their similar approaches to agricultural service programs from the beginning. The distance between the two furthest villages in our study area (Bagajani and Gawani) is only 5.8 km. Therefore, we will treat the five regions as one study site when discussing the results of soil analyses and agricultural operations, especially since they are located within a single local climatic zone.

Tables (3, 4, 5, 6 and 7) indicate to effect of continuous soil cultivation on soil health indicators. The soil texture in the study area is clay loam. Samples were taken before spring planting, immediately after tillage. There were no changes in soil texture across the five study areas [8, 9].

The bulk density ranged from 1.26 g.cm^{-3} to 1.8 g.cm^{-3} and did not change uniformly across the five study areas. However, there was a relative increase over the years of soil use especially after 2019, likely due to excessive plowing and intensive agriculture when soil particles are eroded and deposited into the pore space between soil aggregates the overall porosity of the soil is diminished, this reduction in porosity leads to an increase in bulk density as the soil become more compacted and less permeable. [10]. The continuous annual use of organic fertilizers has significantly helped maintain the granular structure of the soil, thus contributing to the relatively maintains bulk density values (as shown in tables 3, 4, 5, 6 and 7). This has also helped maintain soil permeability, preventing a decline beyond the documented values [11].

A comparison of permeability values over the study years in tables (3, 4, 5, 6 and 7) shows slight changes. Initially, permeability was around 0.55-0.9 cm/hour, gradually decreasing to 0.48-0.83 cm/hour. Regarding porosity, both permeability and porosity values were higher at the beginning of cultivation in 2014 compared to recent years (2022 and 2023). Despite operations to add fertilizers and soil amendments, continued ploughing and increased soil pressure have led to a decrease in these values over the years [12].

The lowest EC value recorded was 0.45 dS.m^{-1} in Bagajani village in 2014, compared to 1.2 and 1.5 dS.m^{-1} in Ali Bzaw and Ziaka, respectively, in the same year. The highest EC values were 2.6 and 3.2 dS.m^{-1} in Mahmudiya and Kani Shaya. The relative increase in soil salinity is due to the excessive use of quick-dissolving chemical fertilizers and the practice of drip irrigation by all farmers. These factors have contributed to an increased concentration of salts in the soil solution and decreased aeration rates [13].

Soil organic matter has decreased curvilinearly over the study years. Despite the excessive use of soil, organic matter values decreased slightly due to continuous additions of organic matter and soil amendments. However, some villages, such as Ali Bzaw, experienced more significant decreases, from 3.6 in 2014 to 2.4 in 2023, and Kani Shaya saw a decrease from 4.0 to 2.8 [14]. The decline in organic matter due to excessive soil use has impacted soil health by compacting soil particles, reducing air volume, and increasing bulk density, as shown in tables (3, 4, 5, 6 and 7) [15].

There were minimal changes in soil pH across all locations during the study years. This is attributed to the presence of high amount of calcium carbonates in study soils as well as continuous use of amino acids with added fertilizers which helped maintain the availability of essential elements and reduced soil degradation. Additionally, the excessive use of irrigation water by farmers influenced soil acidity [16][17].

Tables (3, 4, 5, 6 and 7) show that the relative increase in bulk density over the years, along with the decrease in organic matter values, has weakened the soil structure. Consequently, this has negatively impacted soil permeability, decreasing water infiltration into the ground and causing water to accumulate on the soil surface. This has reduced the efficiency of irrigation water [18]. Due to excess water and a lack of air, roots do not penetrate deeply and remain near the surface. Consequently, plants cannot absorb sufficient nutrients, and the shallow roots, weakened, cannot develop properly or withstand strong winds, causing the plants to fall [19]. In waterlogged soil, the absence of oxygen initiates the process of denitrification. Microorganisms use the available oxygen in nitrates, converting them into nitrous oxide, nitric oxide, and nitrogen gases, which are useless for plants. Balanced irrigation can prevent such problems [20].

In excessively irrigated areas, H^+ ions replace positively charged Ca^{2+}, Mg^{2+}, K^+, and Na^+ ions, which adhere to soil colloids. These positively charged particles flow to lower levels, decreasing the concentration of essential cations and increasing colloidal granules. This leads to an excess of H^+ ions in the soil water, causing the soil to become acidic [21]."Deformation of soil structure can occur, along with the proliferation of diseases and harmful insects, due to excess water in the soil. When voids are filled with water or water accumulates on the soil surface, the balance of air and solution in the pores is disrupted. In the absence of air, plants are unable to respire effectively.[22]

Table 3. Soil analysis sowed with cucumber in Bagajani village during the study period

Years	Soil Texture	Soil bulk density g.cm^{-3}	Permeability cm. hour^{-1}	Porosity cm^3.cm^{-3}	Soil EC dS.m^{-1}	Organic Matter %	Soil PH	* IWP Kg. /m^3
2014	Clay Loam	1.3	0.8	0.46	0.45	3.8	_	64.86
201	Clay	1.32	0.76	0.45	0.40	3.66	7.2	63.29

5	Loam							
2016	Clay Loam	_	0.74	0.46	0.35	3.72	7.2	59.52
2017	Clay Loam	1.28	0.8	0.46	0.48	3.6	7.4	51.28
2018	Clay Loam	1.33	0..82	0.45	0.66	3.5	7.5	43.18
2019	Clay Loam	1.4	0.78	_	0.80	3.4	7.4	44.44
2021	Clay Loam	1.45	0.76	0.45	0.90	3.2	7.6	35.55
2022	Clay Loam	1.44	0.78	0.40	1.34	3.6	7.4	35.95
2023	Clay Loam	1.45	0.68	0.42	1.44	3.4	7.7	28.57

* Irrigation's water production equals to the total crop yield divide by the total irrigation water use for crop.

Table 4. Soil analysis sowed with cucumber in Ali Bzaw village during the study period

Years	Soil Texture	Soil bulk density $g.cm^{-3}$	Permeability $cm. hour^{-1}$	Porosity $cm^3.cm^{-3}$	Soil E.C. $dS.m^{-1}$	Organic Matter %	Soil PH	* IWP $Kg. /m^3$
2014	Clay Loam	1.38	0.88	0.48	1.2	3.6	7.4	45.71
2015	Clay Loam	1.34	0.76	0.47	1.1	3.4	7.2	45.45
2016	Clay Loam	1.38	0.9	0.48	1.22	3.0	7.0	38.88
2017	Clay Loam	1.36	0.8	0.44	1.0	2.6	7.33	35.13
2018	Clay Loam	1.4	0.76	0.4	1.3	2.4	7.5	40
2019	Clay Loam	1.42	0.8	0.42	1.26	2.6	7.1	36.36
2021	Clay Loam	1.4	0.7	0.4	1.32	2.4	7.0	30.55
2022	Clay Loam	1.42	0.68	0.4	1.34	2.8	7.2	28.20
2023	Clay Loam	1.51	0.6	0.42	1.46	2.2	7.5	25.64

* Irrigation's water production equals to the total crop yield divide by the total irrigation water use for crop.

Table 5. Soil analysis sowed with cucumber in Ziaka village during the study period

Years	Soil Texture	Soil bulk density $g.cm^{-3}$	Permeability $cm. hour^{-1}$	Porosity $cm^3.cm^{-3}$	Soil E.C. $dS.m^{-1}$	Organic Matter %	Soil PH	* IWP $Kg. /m^3$
2014	Clay Loam	1.4	0.78	0.66	1.5	3.6	7.4	71.79
2015	Clay Loam	1.42	0.84	0.61	1.8	3.8	7.2	78.94
2016	Clay Loam	1.41	0.9	0.58	1.6	3.4	7.5	69.23
2017	Clay Loam	1.38	0.88	0.62	1.7	3.5	7.3	67.5
2018	Clay Loam	1.36	0.82	0.68	1.8	3.6	7.4	48.78
2019	Clay Loam	1.43	0.76	0.64	1.6	3	7.7	50

2021	Clay Loam	1.46	0.74	0.63	1.7	3.3	7.6	40
2022	Clay Loam	1.46	7.2	0.62	1.6	3.1	7.6	36.95
2023	Clay Loam	1.42	7.3	0.6	1.9	3.0	7.7	34.04

* Irrigation's water production equals to the total crop yield divide by the total irrigation water use for crop

Table 6. Soil analysis sowed with cucumber in Mahmudiya village during the study period

Years	Soil Texture	Soil bulk density $g.cm^{-3}$	Permeability $cm. hour^{-1}$	Porosity $cm^3.cm^{-3}$	Soil E.C. $dS.m^{-1}$	Organic Matter %	Soil PH	* IWP $Kg. /m^3$
2014	Clay Loam	1.34	0.9	0.84	1.7	3.2	7.3	51.61
2015	Clay Loam	1.3	0.88	0.8	2.2	3.4	7.5	56.66
2016	Clay Loam	1.32	0.87	0.66	2.0	3.2	7.6	46.87
2017	Clay Loam	1.6	0.9	0.68	2.5	3.0	7.5	41.17
2018	Clay Loam	1.3	0.86	0.78	2.3	3.0	7.4	39.39
2019	Clay Loam	1.36	0.84	0.74	2.6	3.3	7.7	28.57
2021	Clay Loam	1.34	0.85	0.76	2.5	2.8	7.5	32.43
2022	Clay Loam	1.36	0.82	0.72	2.4	2.6	7.6	25
2023	Clay Loam	1.8	0.83	0.7	2.6	3.0	7.7	25.64

* Irrigation's water production equals to the total crop yield divide by the total irrigation water use for crop.

Table 7. Soil analysis sowed with cucumber in Kani Shaya village during the study period

Years	Soil Texture	Soil bulk density $g.cm^{-3}$	Permeability $cm. hour^{-1}$	Porosity $cm^3.cm^{-3}$	Soil E.C. $dS.m^{-1}$	Organic Mater %	Soil PH	* IWP $Kg. /m^3$
2014	Clay Loam	1.28	0.55	0.9	2.8	4.0	7.3	60
2015	Clay Loam	1.26	0.53	0.86	2.7	3.8	7.4	52.63
2016	Clay Loam	1.28	0.54	0.88	2.8	3.7	7.5	59.45
2017	Clay Loam	1.3	0.52	0.85	2.5	4.1	7.4	51.28
2018	Clay Loam	1.32	0.5	0.84	2.8	3.8	7.8	45.23
2019	Clay Loam	1.34	0.52	0.83	2.9	3.6	7.6	37.77
2021	Clay Loam	1.28	0.48	0.82	2.8	3.4	7.5	37.5
2022	Clay Loam	1.32	0.46	0.8	3.0	3.0	7.7	31.81
2023	Clay Loam	1.34	0.48	0.78	3.2	2.8	7.8	26.08

* Irrigation's water production equals to the total crop yield divide by the total irrigation water use for crop.

Table 8. Cucumber Yields for Bagajani village and some cultivating operations results.

Years	Yields ton.	Using	Pesticides	irrigation	Increasing in	% Using

	donum-1	fertilizer* Kg. Donum-1	used. kg. Donum-1	water use. m^3 donum-1	Services over the years of study	Soil Enhancements
2014	48	300	2.4	740	100%	100%
2015	50	300	2.2	790	100%	100%
2016	50	350	2.8	840	100%	100%
2017	40	350	2.8	780	100%	100%
2018	38	400	3.2	880	100%	120%
2019	40	500	3.6	900	100%	140%
2021	32	600	4.8	900	120%	180%
2022	32	550	4.4	890	130%	160%
2023	28	500	4.8	980	160%	180%

*Fertilizer, contain all kind used (Essential, Micro, Macro, Foliar but not that added before transplanting.

The data in Tables 8, 9, 10, 11, and 12 indicate a decline in cucumber crop productivity over the years in the study area. Our investigations documented that productivity was high in the initial years of cultivation (2014 and 2015) but gradually decreased, with a sharp decline observed in certain villages. For instance, in Kani Shaya, productivity decreased from 42 to 24 tons per donum, and in Ziaka, it decreased from 56 to 32 tons per donum. Efforts to maintain high cucumber production, as seen in the early years, have exhausted the soil, particularly due to the disproportionate use of fertilizers. This excessive use of synthetic chemical fertilizers can cause chemical burns to crops and lead to the imperfect synthesis of proteins in leaves, resulting in poor crop yields [23].

Tables 8, 9, 10, 11, and 12 illustrate how the excessive use of agrochemicals has led to severe nutrient depletion in the soil. Farmers often apply imbalanced chemical fertilizers to individual crops without considering an integrated nutrient management approach. Consequently, soil productivity and biodiversity have been adversely affected. Recent studies, such as [24]. indicate that the growth and yield of mung beans have suffered due to poor management practices and low soil fertility. The chemical compounds in fertilizers and pesticides lower the soil pH, making it acidic and eliminating beneficial microorganisms. Sensitive microbes die immediately upon applying long-lasting and persistent pesticides [25]. These microorganisms are considered an integral part of healthy soil because they maintain the soil structure and facilitate the conversion and mineralization of organic materials as researchers have indicated Achieving soil continuity in giving depends on creating an equation between the amounts of added chemicals such as fertilizers and pesticides and what the plant consumes and what is washed away due to irrigation operations [26].

The excessive use of chemical fertilizers and pesticides has various impacts on soil health in the study area, most of these fertilizers are rich in nitrogen, phosphorus, and potassium, and their high solubility in water effects on several soil properties such as pH, electrical conductivity, and soil permeability as shown in Tables (3, 4, 5, 6, and 7) [27]. The alteration in the physicochemical properties of the soil increases nutrient availability but decreases the organic and nitrogen content. this change negatively impacts the characteristics of various soil organisms. Additionally, fertilizers and pesticides can leach into deeper soil layers and through surface runoff or filtration may reach and contaminate nearby water bodies [28]. Pesticides are known to persist in the soil forming toxic conversion products that remain harmful over time with their retention directly proportional to the soil's organic matter content. Moreover, fertilizers and pesticides contribute to soil acidification by lowering its pH, this acidification stabilizes the dissolution of soil aggregates rich in minerals essential for drainage leading to highly compacted soil with poor drainage and limited air circulation [29]

Table 9. Cucumber Yields for Ali Bzaw village and some cultivating operations results.

Years	Yields ton. donum-1	Using fertilizer* kg. Donum-1	Pesticides used. kg. Donum-1	irrigation water use. m^3. donum-1	Increasing in Services over the years of study	% Using Soil Enhancements
2014	32	260	2.8	700	100%	100%
2015	30	300	2.8	660	100%	100%
2016	28	340	2.6	720	100%	100%
2017	26	360	3.0	740	100%	100%
2018	28	400	3.2	700	100%	100%
2019	24	420	3.4	660	100%	100%
2021	22	400	4.0	720	100%	120%
2022	22	450	3.8	780	100%	120%
2023	20	400	4.4	780	120%	140%

*Fertilizer, contain all kind used (Essential, Micro, Macro, Foliar but not that added before transplanting.

Table 10. Cucumber Yields for Ziaka village and some cultivating operations results.

Years	Yields ton. donum-1	Using fertilizer* kg. Donum-1	Pesticides used. kg. Donum-1	irrigation water use. m^3. donum-1	Increasing in Services over the years of study	% Using Soil Enhancements

2014	56	340	2.8	780	100%	100%
2015	60	300	2.0	760	100%	100%
2016	54	360	2.4	780	120%	100%
2017	54	380	3.2	800	120%	120%
2018	40	340	2.6	820	140%	120%
2019	42	400	3.0	840	140%	140%
2021	36	440	3.8	900	160%	149%
2022	34	420	3.8	920	140%	160%
2023	32	460	4.4	940	160%	180%

*Fertilizer, contain all kind used (Essential, Micro, Macro, Foliar but not that added before transplanting.

Table 11. Cucumber Yields for Mahmudiya village and some cultivating operations results.

Years	Yields ton. donum^{-1}	Using fertilizer* kg. Donum^{-1}	Pesticides used. kg. Donum^{-1}	irrigation water use. m^3. donum^{-1}	Increasing in Services over the years of study	% Using Soil Enhancements
2014	32	200	1.6	620	100%	100%
2015	34	240	2.0	600	100%	100%
2016	30	220	1.6	640	100%	100%
2017	28	260	1.8	680	100%	100%
2018	26	300	2.4	660	100%	100%
2019	20	320	2.2	700	100%	100%
2021	24	340	2.8	740	100%	120%
2022	18	380	3.0	720	120%	120%
2023	20	300	3.6	780	140%	140%

*Fertilizer, contain all kind used (Essential, Micro, Macro, Foliar but not that added before transplanting.

Table 12. Cucumber Yields for Kani Shaya village and some cultivating operations results.

Years	Yields ton. donum^{-1}	Using fertilizer* kg. Donum^{-1}	Pesticides used. kg. Donum^{-1}	irrigation water uses m^3. donum^{-1}	Increasing in Services over the years of study	% Using Soil Enhancements
2014	42	280	2.0	700	100%	100%
2015	40	300	2.6	760	100%	100%
2016	44	300	2.8	740	100%	100%
2017	40	280	3.2	780	100%	100%
2018	38	340	3.8	840	140%	120%
2019	34	360	4.0	900	160%	120%
2021	30	400	4.4	800	160%	140%
2022	28	420	4.2	880	160%	160%
2023	24	440	4.2	920	160%	160%

*Fertilizer, contain all kind used (Essential, Micro, Macro, Foliar but not that added before transplanting.

It is noted from Figures 2 documented in the weather stations, that the state of climate elements, in general, was not stable. With regard to the rain curve, it is noted that there is a relative disparity in the amounts of rain during the years of the study, ranging from low to moderate and then high, except for the year 2018 when the rainfall amounts reached 1330 mm, a value not previously measured. Additionally, in two other years (1970 and 1992), rainfall amounts exceeded the threshold of 1250 mm since 1941. These fluctuations in rainfall amounts indicate variability in precipitation patterns [30]. The rainfall curve in Figure 2 shows a pattern of fluctuations, suggesting an urgent need to monitor rainfall events in the coming years, as our region may experience what is now termed a "rain shock," characterized by significant variability in rainfall [31].

Figure 3, it is noted that temperatures have been rising over the years of the study, consistent with findings by [32]. This temperature increase directly affects soil properties by raising evaporation and transpiration rates, necessitating larger quantities of irrigation water. Growing crops under plastic houses protected plants from the direct effects of climate changes, particularly those studied elements. For example, climate changes did not affect soil porosity, permeability, or bulk density as physical characteristics, nor did they affect chemical characteristics such as soil acidity and electrical conductivity [33]. However, the temperature rise directly impacted plants. It indirectly affected soil health by increasing plant activity, thus requiring more frequent irrigation and better ventilation due to higher evaporation and transpiration rates. The impact of climate change on soil organic matter is somewhat sensitive, as increased plant activity inside greenhouses affects water storage, microbial activity, and, consequently, soil resilience [34].

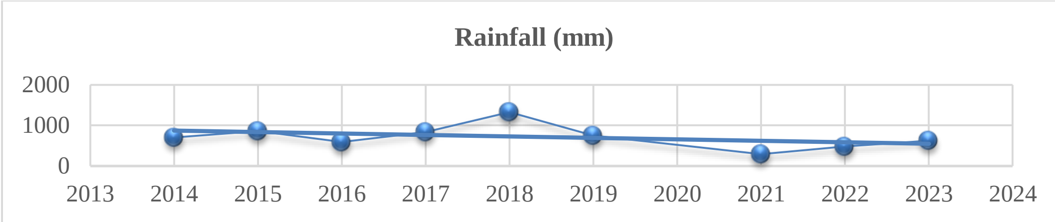

Figure 2. indicate the changing in rainfall amount during the study period 2014- 2023

Rise in temperatures, in addition to the excessive use of soil, negatively impacted cucumber crop production during the years of the study across all locations to varying degrees. For example, in the villages of Kani Shaya and Ziaka, productivity decreased by 57% in 2023, a significant reduction attributed to stress. The plants redirected their energy towards adapting to high temperatures and absorbing water and nutrients to compensate for the extreme climatic events in the study area [35].

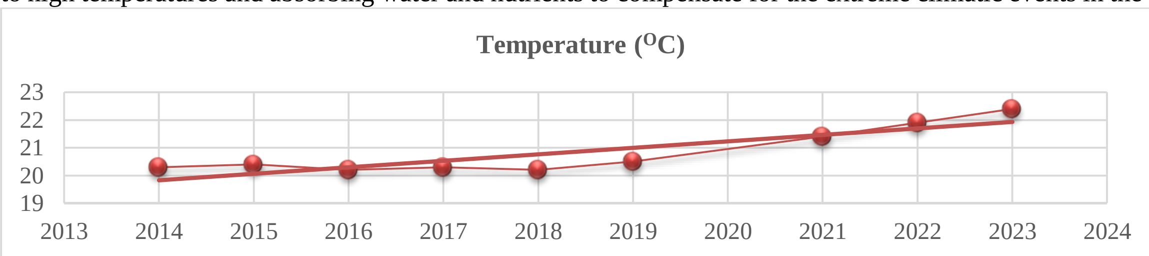

Figure 3. indicate the changing in heat degree amount during the study period 2014- 2023.

Figures 4 and 5 illustrate changes in the rates of evaporation, transpiration, and solar radiation. These changes contribute to increased photosynthesis, heightened plant metabolic activity, and greater energy expenditure, necessitating more water and nutrient uptake from the root zone. This increased demand comes at the expense of fruit production. It was also noted that higher air temperatures and environmental heat caused intense rates of transpiration and evaporation, even on non-sunny days and under lower radiation levels, where stomatal resistance is reduced. Consequently, there was increased germination activity due to climate change and elevated temperatures, as reported by [36].

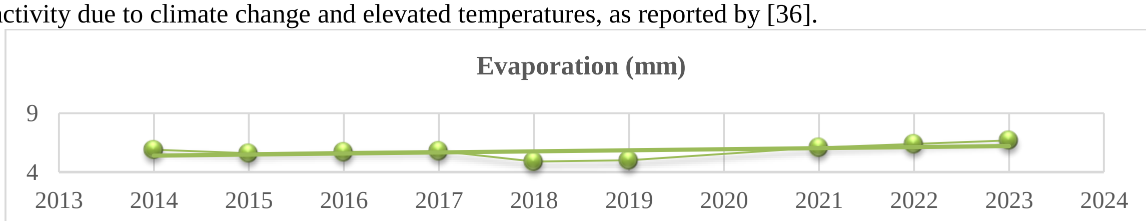

Figure 4. indicate the changing in Evaporation amount during the study period 2014- 2023.

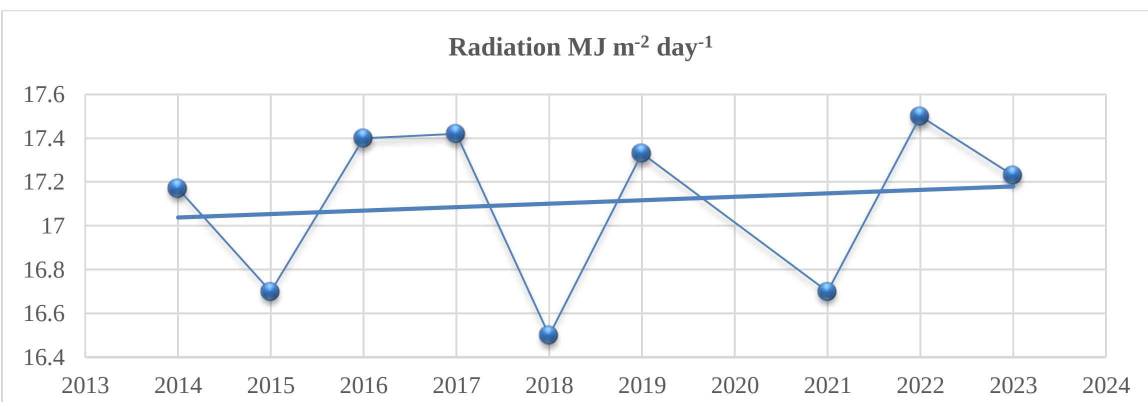

Figure 5. indicate the changing in radiation amount during the study period 2014- 2023.

Conclusion

Despite consistent soil texture, bulk density values ranged from 1.26 $g.cm^{-3}$ to 1.8 $g.cm^{-3}$, with a relative increase over time attributed to excessive plowing and intensive agriculture.

Porosity and permeability were higher at the beginning of the study but declined due to continuous plowing and increased soil pressure.

There was a notable increase in soil salinity (3.2 $dS.m^{-1}$), with EC values rising significantly due to the excessive use of chemical fertilizers and drip irrigation, which concentrated salts in the soil.

Organic matter content decreased over the years, with notable declines in villages like Ali Bzaw and Kani Shaya. This

decline impacted soil health by compacting soil particles, reducing air volume, and increasing bulk density.
Soil pH remained relatively stable, likely due to the continuous use of amino acids with fertilizers and the influence of excessive irrigation water Due to high buffering capacity of the soil.
The productivity of cucumber crops has declined over the years. Initial high productivity in 2014 and 2015 gradually decreased, with sharp declines observed in certain villages. For example, productivity in Kani Shaya dropped from 42 to 24 tons per donum, and in Ziaka, 56 to 32 tons per donum. This decline is linked to soil exhaustion and the disproportionate use of synthetic fertilizers, which cause chemical burns and imperfect protein synthesis in crops.
Climatic Influences
Rainfall Variability: The rainfall data show significant fluctuations, with some years like 2018 experiencing unprecedented rainfall amounts. This variability, termed "rain shock," suggests the need to closely monitor future rainfall patterns to mitigate potential adverse impacts.
Temperature Increases: Rising temperatures have increased rates of evaporation and transpiration, leading to higher water and nutrient demands by plants. While growing crops under plastic houses provided some protection from direct climate impacts, the overall rise in temperature indirectly affected soil health by increasing the need for irrigation and ventilation.
Overall Implications
The combined effects of intensive agricultural practices excessive use of chemical fertilizers, and climate variability have adversely affected soil health and crop productivity in the study area. Strategies for sustainable agriculture should include balanced nutrient management reduced reliance on synthetic fertilizers and adaptive measures to cope with climatic.
changes. Monitoring and managing soil health indicators are crucial for maintaining soil fertility and ensuring long-term agricultural productivity.

References

[1.]Allen, D. E., Singh, B. P., & Dalal, R. C. (2011). Soil Health Indicators Under Climate Change: A Review of Current Knowledge. Soil Biology. 25–45. doi:10.1007/978-3-642-20256-8_2

[2.]Çullu, M. A. (2002). Estimation of the Effect of Soil Salinity on Crop Yield Using Remote Sensing and Geographic Information System. Journal of Agricultural and Food Chemistry. (27). 23_28.

[3.]Itelima, J.U., Bang, W.J., Onyimba, I.A. (2018) A review: biofertilizer; a key player in enhancing soil fertility and crop productivity. J Microbiol Biotechnol Rep 2(1):22–28

[4.]Akram, M. Abdulrahman. (2021). Mapping a Survey for Soil Fertility in Tainal Watershed (Bazian plane) Sulaimaniyah Ecosystem Using Application of GIS. Kufa Journal For Agricultural Sciences – 2021:13(1):22-34. doi.org/10.36077/kjas/2021/130103

[5.]Prashar, P. and Shah, S. (2016) Impact of fertilizers and pesticides on soil microflora in agriculture. In: Lichtfouse E (ed) Sustainable agriculture reviews, vol (19). Springer, Cham, pp 331–361. https:// doi.org/10.1007/978-3-319-26777-7_8.

[6.]Walter, L. Filho, Gustavo, J. Nagy, Andréia, F. Freitas, Setti, A. Sharifi, Felix K. Donkor, Karina B. and Ilija D. (2023). Handling the impacts of climate change on soil biodiversity. Science of the Total Environment 869, doi: 10.1016/j.scitotenv.2023.161671.

[7.]Jedmowski C, Ashoub A. and Momtaz, O. (2015) Impact of drought, heat, and their combination on chlorophyll fluorescence and yield of wild barley (Hordeum spontaneum). J Bot 2015:1–9

[8.]Sarfaraz, I. (2019) The effects of chemical fertilizers on soil. Hunker. https://www.hunker.com/ 13427782/the-effects-of-chemical-fertilizers-on-soil

[9.]Reynolds, W.D., Drury, C.F., Tan, C.S., Fox, C.A. and Yang, X.M. (2009) Use of indicators and pore volume function characteristics to quantify soil physical quality. Geoderma (152): 252–263

[10.] Congreves, K.A., Hayes, A., Verhallen, E.A., Van and Eerd, L.L. (2015) Long-term impact of tillage and crop rotation on soil health at four temperate agroecosystems. Soil Tillage Res (152): 17–28

[11.] Ahmed, A. M., Al-Ogaidi, Mohammad, T. Mahmood, Abdulghani K. Mohammed and Haqqi I. Yasin. (2023). Effect of bulk density on water infiltration in layered soil. Tikrit Journal of Engineering Sciences. 30 (3): 174-189. Doi: http://doi.org/10.25130/tjes.30.3.16

[12.] Alsharifi S.k., Alaamer, S.A. and Nayyef, H.R. (2021) Effect of sowing methods, sowing depth and sowing distances on some characteristics of growth and wheat yield. 3rd international conference on food, Agriculture and veterinary, Izmir-TURKEY.pp.1278-1288

[13.] Al-Ansari, A.M., Imran, R.A. and Al- Hadi, S.S. (2012) Effect of Soil Moisture and depth on some soil physical properties and Growth and yield of Barley (Hordeum vulgar L.). Basra Journal of Agricultural Sciences. vol. (25)1 pp.124-138.

[14.] Qiao, Y., Miao, S., Li, Y., Zhong, X. (2018). Chemical composition of soil organic carbon changed by long-term monoculture cropping system in Chinese black soil. Plant Soil Environ. (64). 557–563.

[15.] Kumar, V. and Power, K. (2018) A review on soil health and fertility management in organic agriculture through green manuring. J Pharmacogn Phytochem SP1:3213–3217

[16.] Ayad, H.E. alalaf, ayad T. S. alalam, Sulaiman M. kako Al-Zebari. (2022). The effect of spraying amino acid

fertilizer on the growth characteristics and mineral content of pomelo (Citrus grandis) seedlings
[17.] Wright, A.L., Hanlon, E.A. and Rice, R.W. (2012). Managing pH in the Everglades Agricultural Soils. SL287, Soil and Water Science Department, University of Florida.
[18.] Suat, I. Rmak, Ali T. Mohammed, William K. Ranz, Yonts, C.D. and Simon V. Donk. (2020). Maize Hybrids under Different Irrigation Levels, Population Densities, and Environments. Sustainability, 12(1), 358; doi.org/10.3390/su12010358
[19.] Farooq, M., Wahid, A. and Kobayashi, N. (2009) Plant drought stress: effects, mechanisms and management. Agron Sustain Dev 29:185–212
[20.] Hayrettin, Kuscu, A., Turhan, Nese, O., Pinar, Aydinol and Ali Osman D. (2014). Optimizing Levels of Water and Nitrogen Applied through Drip Irrigation for Yield, Quality, and Water Productivity of Processing Tomato (Lycopersicon esculentum Mill.) Hort. Environ. Biotechnol. 55(2):103-114. DOI 10.1007/s13580-014-0180-9
[21.] Yu.N. Nikolskii, I.P. Aidarov, Cesáreo Landeros-Sánchez and V.V. Pchyolkin. (2019). impact of long- term freshwater irrigation on soil fertility. Irrigation and Drainage 68(10). DOI: 10.1002/ird.2381
[22.] Paula, Muukkonen, Helinä, Hartikainen and Laura, Alakukku. (2009). Effect of soil structure disturbance on erosion and phosphorus losses from Finnish clay soil. Soil and Tillage Research 103(1):84-9. DOI: 10.1016/j.still.2008.09.007
[23.] Dhakal, Y., Meena, R.S., De, N., Verma, S.K. and Singh A. (2015) Growth yield and nutrient content of mungbean (Vigna radiata L.) in response to INM in eastern Uttar Pradesh, India. Bangladesh J Bot 44(3):479–482
[24.] Meena, R.S. (2013). Effect of organic and inorganic sources of nutrients on nutrient status of crop and soil after harvest of greengram [Vigna radiata (L.) Wilczeck] in arid western Rajasthan. Ann. Bio. 29(3): 307-310.
[25.] Yadav, I.C. and Devi, N.L. (2017) Pesticides classification and its impact on human and environment. Environ Sci Eng Toxicol 6:140–158
[26.] Prashar, P. and Shah, S. (2016) Impact of fertilizers and pesticides on soil microflora in agriculture. In:Lichtfouse E (ed) Sustainable agriculture reviews, vol 19. Springer, Cham, pp 331–361. https:// doi.org/10.1007/978-3-319-26777-7_8
[27.] Zhang, Y., Wang, S., Wang, H., Wang, R., Wang, X. and Li, J. (2018) Crop yield and soil properties of dryland winter wheat-spring maize rotation in response to 10-year fertilization and conservation tillage practices on the loess plateau. Field Crop Res 225:170–179
[28.] Peralta, A.L., Sun, Y., McDaniel, Lennon, J.T. (2018) Crop rotational diversity increases disease suppressive capacity of soil microbiomes. Ecosphere 9(5): e02235. https://doi.org/10.1002/ ecs2.2235
[29.] Adesemoye, A.O. and Kloepper, J.W. (2009) Plant-microbe's interactions in enhanced fertilizer use efficiency. Appl Microbial Biotechnology 85(1):1–12
[30.] Akram M. AbdulRahman, Jawhar H. Khalid & Zana M. Majeed. (2022). A Study on Precipitation Change and its Impact on Wheat Cultivation in Sulaimaniyah Region, Iraq. B.A.E.R. 6(2): 178-19.
[31.] Mulubrhan, Amare, Nathanie, D., Jensen, Bekele Shiferaw and Jennifer Denno Cissé. (2018). Rainfall shocks and agricultural productivity: Implication for rural household consumption. Agricultural Systems. Vol;166, Pages 79-8
[32.] Akram M. AbdulRahman, Jawhar H.Khalid, Zana M. Majeed and Aso K. Taib. (2021). influence of temperatures rise over 48-years on sulaymaniyah agroecosystem structure and nematodes distribution using gis application. Zagazig J. Agric. Res., Vol. 48 No. (1)
[33.] Gil, S.V., Meriles, J., Conforto, C., Figoni, G., Basanta, M. and Lovera, E. (2009). Field assessment of soil biological and chemical quality in response to crop management practices. World J Microbiol. Biotech. 25:439-448.
[34.] Gelybó, G., Tóth, E., Farkas C., Horel A., Kása I. amnd Bakacsi Z. (2018). Potential impacts of climate change on soil properties. agrochemistry and soil science 67 (1); 121-141
[35.] Jerry, L., Hatfield and John, H., Prueger. (2015). Temperature extremes: Effect on plant growth and development. Weather and Climate Extremes. Vol (10). Pp 4-10
[36.] Akram, M., AbdulRahman, Jawhar, H., Khalid, Aso, K., Tayyib, H., sharif and Layla umer.(2024). Effect of changing in Some Sulaymaniyah Climate Elements on Rates of Evapotranspiration from the period 1979 to 2022, Iraq. Kirkuk University Journal for Agricultural Sciences, Vol. 15, No. 1, (104-117)

التأثير المشترك لتغير المناخ والزراعة المستمرة على صحة التربة في البيوت البلاستيكية في محافظة السليمانية، العراق.

أكرم محى الدين عبدالرحمن[1]   ناسك أحمد سعيد[1]
دلسوز حمه طالب[1]   هيوا بايز شريف[1]   جوهر حمةلاو خالد[2]

[1]مديرية الابحاث الزراعية في محافظة السليمانية، وزارة الزراعة و الموارد المائية.
[2]مديرية الانواء الجوية و الرصد الزلزالي في محافظة السليمانية، وزارة النقل و المواصلات.

الخلاصة

تبحث هذه الدراسة في تأثير ممارسات الزراعة المستمرة على صحة التربة في خمس قرى تقع ضمن منطقة بازيان في مدينة السليمانية، العراق. وتظهر القرى التي شملتها الدراسة بانه على الرغم من قربها الجغرافي داخل منطقة مناخية محلية واحدة فانها تسلك نهجًا متشابها في الخدمات الزراعية. تم اجراء تحليلات التربة سنويا وقبل الزراعة الربيعية. تقييم عوامل مختلفة كدلالات لصحة التربة مثل الكثافة الظاهرية، النفاذية، المسامية، التوصيل الكهربائي، محتوى المادة العضوية و مستويات الأس الهيدروجيني. تشير النتائج إلى أن الكثافة الظاهرية تراوحت من 1.26 جم/سم3 إلى 1.8 جم/سم3 خلال فترة الدراسة أظهرت النفاذية انخفاضًا طفيفًا في قيمها وانخفاض في معدلات تسرب مياه الري. تباينت قيم التوصيل الكهربائي بشكل كبير بين القرى. أظهر محتوى المادة العضوية انخفاضًا منحنيًا على الرغم من الجهود المبذولة لتعزيز صحة التربة من خلال استخدام محسنات العضوية. أظهرت قيم الانتاج لمحصول الخيار عن اتجاهات انخفاضية خلال فترة الدراسة مما يؤكد على مشاكل استنزاف للتربة التي تفاقمت بسبب الاستخدام المفرط للتربة و للكيمائيات الزراعية وقد أدى سوء إدارة الأسمدة الكيمائية والمبيدات الحشرية إلى اختلال توازن مغذيات التربة مما يضر بالتنوع البيولوجي للتربة والممارسات الزراعية المستدامة. يشيرالاتجاه العام إلى انخفاض في معدل هطول الأمطار السنوي خلال فترة الدراسة على الرغم من الزيادات العرضية. كان هناك اتجاه تصاعدي واضح في متوسط درجات الحرارة السنوية خلال فترة الدراسة مع زيادة كبيرة ملحوظة من عام 2018 فصاعدًا. على الرغم من التدابير الوقائية مثل زراعة البيوت المحمية التي تخفف من التأثيرات المناخية المباشرة على خصائص التربة إلا أن ارتفاع درجات الحرارة أدى إلى تكثيف إجهاد النبات والطلب على المياه مما أثر على الإنتاجية الزراعية

الكلمات المفتاحية: دوال خصوبة التربة، الزراعة المستمرة، التغير المناخي ، الري المفرط، الزراعة المحمية.