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Deanship of Scientific Research

Climate Suitability for the Cultivation of Olive Trees in Iraq

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Abstract

Objectives: This research aims to assess the suitability and availability of climatic conditions for olive cultivation in Iraq. The study identifies the most and least suitable areas, along with intermediate areas, utilizing the ArcMap program for mapping and delineating agriculturally favorable regions.

Methods: A descriptive approach was employed in this research, as an analytical approach was deemed essential for describing and analyzing data to attain scientific accuracy.

Results: The research findings indicate that certain areas, namely Mosul, Erbil, Sulaymaniyah, and Kirkuk, exhibit high suitability for olive tree cultivation. The station at Al-Rutba demonstrates moderate feasibility, while Basra, Nasiriyah, Amarah, Baghdad, Diwaniyah, and Al-Hay are deemed unsuitable due to the absence of necessary climatic conditions for olive cultivation.

Conclusions: The study concludes that climatic factors vary in their impact on olive cultivation and production. Temperature emerges as a significant contributor, while other factors such as humidity and wind play a limited role. Light is identified as a crucial factor affecting fruit size, composition, and color.

Keywords: Climatic suitability, climatic requirements, olive trees

الملائمة المناخية لزراعة أشجار الزيتون في العراق

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ملخّص

الأهداف: أظهر البحث ملاءمة الخصائص المناخية في تحديد زراعة الزيتون في العراق حسب الخصائص المناخية، بعد الدراسة تبين أن هناك توافق بين المتطلبات المناخية والإمكانيات، لكنها تختلف من محطة إلى أخرى، جرى استخدام برنامج Arc Map الذي يساعد في إنشاء الخرائط ومعرفة المناطق الصالحة لزراعة.

يهدف البحث إلى معرفة مدى ملاءمة وتوافر المتطلبات المناخية لزراعة الزيتون في العراق، مع الإشارة إلى أنسب المناطق وأقلها ملاءمة، والمناطق المتوسطة الملائمة.

المنهجية: استلزم البحث منهجًا وصفيًا، حيث أن المنهج التحليلي يصف البيانات والمعلومات ويحللها للوصول إلى الحقيقة العلمية، والمنهج الكمي الذي اعتمد النمذجة الآلية للبيانات وتصنيفها باستخدام برامج التقنيات الجغرافية الحديثة.

النتائج: خلصت نتائج البحث إلى وجود مناطق تصلح على نحو مشترك لزراعة أشجار الزيتون وهي(الموصل، أربيل، السليمانية، كركوك)، بينما محطة (الرطبة) ذات متوسطة الملاءمة، بينما (البصرة، الناصرية، العمارة، بغداد، الديوانية، الحي) لا تصلح لزراعة الزيتون؛ لأنها غير صالحة لزراعة الزيتون، بسبب عدم توفر الظروف المناخية اللازمة.

الخلاصة: خلص البحث إلى أن العوامل المناخية تختلف في تأثيرها في زراعة الزيتون وإنتاجه، فبعضها يساهم على نحو كبير، مثل درجة الحرارة، وبعضها له دور محدود، مثل الرطوبة والرياح، وللضوء تأثير في حجم الفاكهة وتكوينها ولونها.

الكلمات الدالة: الملائمة المناخية، المتطلبات المناخية، أشجار الزيتون.

Introduction

The relationship between climate and agriculture has an important influence on each other, as agriculture is considered one of the activities that most affect the climatic elements. The success of growing a crop with a greater economic return and better quality. Accordingly, the research aims to find out the suitability of the climatic elements in Iraq with the climatic requirements of the olive crop and to identify the most climatically suitable areas for its cultivation. Therefore, the study of the agricultural climate is important, as the results contribute to the detection on the factors affecting agricultural production.

The olive tree is one of the perennial and evergreen trees, and the olive tree belongs to the olive family (Oleaceae), the genus (Olea), and the species (Europae), whose scientific name is (Olea europaea). Which is the original habitat for it, as it is grown in Iraq and is suitable for its cultivation and growth in areas with a moderate climate that is rainy in winter and hot and dry in summer, and environmental conditions are the main factor when starting to cultivate it (Food and Agriculture Organization of the United Nations, 2021).

Olive trees are characterized by a slow rate of growth despite their long life, and there are many perennial trees all over the world, especially in the Mediterranean countries.

The olive tree is considered one of the blessed trees and the first to spread its cultivation by the Romans in the Iberian Peninsula, which has been of great importance to man since then. The olive is of interest to many countries in the world, as it is an economic and perennial tree that extends for more than five thousand years (Abdul Qader et al., 2011).

As for the Holy Qur'an, olives were mentioned in about seven verses:

"Allah is the Light of the heavens and the earth. The parable of His light is that of a niche, in which is a lamp. The lamp is within a crystal. The crystal is like a brilliant planet, fueled by a blessed tree, an olive tree, neither eastern nor western. Its oil would almost illuminate, even if no fire has touched it. Light upon Light. Allah guides to His light whom He wills. And Allah presents the parables to the people. And Allah knows everything" Surat Al-Nur, Verse 35).

He mentioned that light is of essential importance in the process of photosynthesis and the conversion of chemical energy in the form of starchy substances in plants, which are transformed through complex processes into fatty acids and glycerol, which combine with each other to form oil.

The olive tree, like any living plant organism, is exposed to many diseases, such as insects and fungi that damage fruits and flowers. Among the insect pests that affect the olive tree are the olive thrips and the olive flea (Abu Arqoub, 1998, p. 546).

Olives in Iraq are divided into several varieties, including the local ones, which include Al-Khastawi, Al-Ashrasi, and Al-Dahkan. The olive tree is one of the strong and active trees that endure hardships because it grows in the hills or even in desert areas with low humidity and gives production. Which you need in order to be cultivated and grow naturally, and Table (1) shows the climatic requirements for olive cultivation in Iraq:

Table (1) Climatic requirements for olive cultivation in Iraq

average wind speed	relative humidity	The number of light hours	soil temperature	optimum temperature	minimum temp	upper temp
(m/s)	(%)	(hours/day)	M	M	M	**M**
9-7	60	14-12	32	37-15	15	**37**

Source: Nisreen Awad Abdoun Abdullah, Climatic Limits for the Cultivation of Palm and Olive Trees in Iraq, PhD thesis (unpublished), College of Arts, University of Baghdad, 2006, p. 101.

Research problem

(Is it possible to identify climatically suitable areas for olive cultivation in Iraq?), and this question raises a number of secondary questions that contribute to solving the main problem. The secondary problems are as follows:

1. what effect for climatic conditions have an effect on olive cultivation in Iraq?

2. How suitable is the climate of Iraq with the climatic requirements for olive cultivation in Iraq?

Research hypothesis

It is intended to suggest a solution to the research problem, formulated by the researcher clearly, and the main research hypothesis is that climatically suitable areas for olive cultivation can be identified in Iraq. As for secondary hypotheses 1. The climatic conditions have a clear impact on the cultivation of olives in Iraq.

2. The climate of Iraq is compatible with the climatic requirements for olive cultivation in some regions of Iraq.

Search target

The research aims to find out the suitability of the climatic requirements and their availability for olive cultivation in Iraq, with an indication of the most suitable and least suitable regions, as well as the suitable medium regions, as the study of the relationship of climate and its impact on olive cultivation is one of the important topics, so the results that we reach during this study are prepared It is important and serves agricultural plans and projects in the future, by knowing the importance of the relationship between climate, its elements, and olive cultivation.

Study area

Iraq is located in the southwestern part of the continent of Asia, as it is bordered to the north and northwest by Turkey and Syria, to the south and southwest by the Kingdom of Saudi Arabia and Kuwait, to the west by Jordan and to the east and northeast by Iran.

The study area is located between latitudes (29 3 15) -(40 2 37 N, and longitude (38 47 55) - 33 50 (48) E, map (1).

Eleven climatic stations covering the regions of Iraq were clearly selected, represented by the climatic stations (Mosul, Erbil, Sulaymaniyah, Kirkuk, Al-Hay, Baghdad, Diwaniyah, Nasiriyah, Basra, Al-Rutba, Amara). As for the time limits for the research, they were set for a period of time extending from (1980-2019).

Map (1) Study area

Source: - The arc map 10.5 program was used to explore, measure and understand geographic data to explore maps pertaining to the study area.

Research Methodology

The necessity of the research necessitated following the descriptive and quantitative approach as two basic approaches to the research method, as the analytical approach describes and analyzes data and information in order to reach the scientific truth, and the use of the quantitative approach for the purpose of reaching numerical results through which the behavior of that phenomenon can be explained, because the method of quantitative analysis of any phenomenon gives the researcher In order to visualize its reality and determine its trends and its relationship to other phenomena, it was also relied on the Lang coefficient equation to calculate the effective amount of rain, as well as using the program (CROPWAT8.0) to calculate the amount of evaporation, and using the Arc map program to find out the suitability of the climate of the study area for planting olive trees.

First: Characteristics of the study area

The study of the agricultural climate depends on the climatic characteristics of any region, because

the climate affects the agricultural activity directly, in addition to that it is considered one of the natural factors that have an impact on the agricultural activities, as each crop requires certain climatic conditions that suit its requirements, which increases the importance of the climate in influencing the Crops in terms of quantity and quality, which is reflected in agricultural production and its difference from one season to another, and accordingly, the climate elements that have a clear impact on agricultural operations in Iraq will be studied, as the climate of Iraq is characterized by fluctuation and difference between climatic stations, due to various reasons, including astronomical location, terrain and altitude from sea level and other influencing factors, so this difference has a great impact on crop cultivation and therefore on agricultural production, and the annual total for each theoretical solar radiation element will be studied, because of its importance in plant life and its impact on the plant in all stages of its growth, As it appears through Table (2) a slight variation in the amount of solar radiation for the annual average number of hours of theoretical brightness, as the highest annual average of the number of hours of theoretical brightness reached (11.92 hours / day) in Al-Rutba station, and the lowest rate in Mosul station was 11.79) hours / day), and all stations recorded an average of (11 hours/day). As a result, this affects temperatures in terms of their rise in summer and their decrease in winter, and this difference is throughout the year.

As for temperature, temperature is one of the most important elements of climate affecting agricultural crops, as it affects many vital processes of the crop such as transpiration, respiration, absorption, photosynthesis and growth. Basra with a degree of (34.4) C, due to its location in the far south and its proximity to the sunshine area, while the maximum temperature ranged from (32-33) C in the stations (Al-Hayy, Al-Diwaniyah, Al-Nasiriyah), while the lowest maximum temperature was recorded in the Sulaymaniyah station It reached (23.1 C) and the reason for this is due to the high topography of the region and its effect on the decrease in temperatures. As for the minimum temperature, the annual average recorded the lowest average minimum temperature in the Sulaymaniyah station with a degree of ((12.5 C), while the Basra station recorded (20 C), and it appears Table (2) indicates that there is a large and clear difference in the wind speed in general in the regions of Iraq, due to the different topography of the region, as the Mosul station recorded the lowest speed at a rate of (1.3) m / s, and the highest rate in the neighborhood station at a rate of (4.1) m / s, while Relative humidity recorded varying annual rates, as the Mosul station recorded the highest rate of (48%), due to its abundance of rain and low temperatures, and the highest annual total amount of precipitation was in Erbil station (407.7 mm) due to the increase in the number of depressions, and this amount is sufficient For the production of agricultural crops, while the Diwaniyah station recorded the lowest rates and amounted to (115.1 mm), while the total annual evaporation values in the study area were the highest total values of evaporation in the neighborhood station by (4129.1) mm, while the lowest rate was recorded in the Mosul station and reache (2006.4) mm.

Table (2)The annual sum of the characteristics of the study area grants

Station	solar radiation	Great temperature	Min temperature	Wind	relative humidity	Rains	evaporation
AL Mosul	11.79	28.5	14.2	1.3	48.0	189.2	2006.4
Erbil	11.82	28.0	15.8	1.7	47.9	407.7	2571.3
Sulaymaniyah	11.81	23.1	12.5	1.8	40.9	380.1	2503.1
Kirkuk	11.80	29.0	16.3	1.6	45.8	336.7	2630.8
ALhai	11.80	32.2	17.5	4.1	38.5	136.7	4129.1
Baghdad	11.83	30.6	16.0	3	41.1	134.8	3267.8
AL Diwaniyah	11.80	32.2	17.8	2.7	38.9	115.1	3562.4
AL Nassruh	11.80	33.0	19.6	3.9	39.0	138.1	3851.3
AL Basra	11.80	34.4	20.0	3.5	40.5	139.3	3562.1
ALratuba	11.92	26.7	15.6	2.6	43.5	123.7	3017.2
ALamarah	11.82	31.5	17.9	3.7	45.5	179.2	3282.5

Source: - Ministry of Transport, General Authority for Meteorology and Seismic Monitoring in Iraq.

Second: The climatic requirements of the olive crop and its suitability in the study area

(a) Growth season:

Olive requires a frost-free growth period to complete its various stages of growth, as it needs an actual period of no less than (150) days with the availability of other climatic conditions figure (1) suitable for its cultivation. It is different between the stations of the study area and ends with different dates as well. Therefore, in the Mosul station, the appropriate period for olive growth extends to (7) months and (14) days, as it starts from the twenty-eighth of March and continues until the tenth of November by (227) days. At the Erbil station, the appropriate period for olive growth extends to (7) months, starting from the seventeenth of April and continuing until the eighteenth of November, with a rate of (215) days. In the Sulaymaniyah station, the appropriate period for olive growth extends to (7). months and (11) days, as it starts from the first of the month of April and continues until the eleventh of the month of November by (225) days, and in the Kirkuk station, the appropriate period for olive growth extends to (8) months and (14) days, as it starts from The fifteenth of the month of March and continues until the twenty-eighth of the month of November by (258) days,

As for the neighborhood station, the appropriate period for olive growth extends to (9) months and (20) days, as it starts from the seventeenth of February and continues until the ninth of December by (295) days, and at the Baghdad station, the appropriate period for olive growth extends to (8) months and (28) days, as it starts from the first of the month of March and continues until the twenty-eighth of the month of November by (273) days. It starts from the eighteenth of February and continues until the first of November with a rate of (256) days. As for the Nasiriyah station, the appropriate period for olive growth extends to (9) months and (12) days, as it starts from the sixteenth of February and continues until The thirtieth of November, with a rate of (278) days, while in the Basra station, the appropriate period for olive growth extends to (10) months and (2) days, as it starts from the thirteenth of February and continues until the fifteenth of December, with a rate of (305). days, while the Rutba station extends the appropriate period for olive growth to (7) months and (25) days, as it starts from the twenty-first of March and continues until the fifteenth of November by (239) days, and in Al-Amarah Station The period suitable for olive growth extends to (9) months and (14) days, as it starts from the twentieth of February and continues until the sixth of December by (289) days, as in Figure (3)

As for the actual duration of the olive crop, as the appropriate period for growth extends to (6) months, as it starts from the first of March and continues until the thirty-first of August with a rate of (184) days, and this means that the climatic period for the growth of olive trees exceeds the actual period, so it is Its cultivation is successful and well if its climatic requirements are met for its cultivation.

Table (3)The length of the growing season for the olive crop in the study area

Station	Beginning of the growing Season	End of the growing Season	The length of the growing season in months	The length of the growing season in days
AL Mosul	28 March	10 November	7	227
Erbil	17 april	18 November	7	215
Sulaymaniyah	1 april	11 November	7	225
Kirkuk	15 march	28 November	8	258
ALhai	17 February	9 January	9	295
Baghdad	1 march	28 November	8	273
AL Diwaniyah	18 February	1 November	8	256
AL Nassruh	16 February	30 November	9	287
AL Basra	13 February	15 January	10	305
ALratuba	21 march	15 November	7	239
ALamarah	20 February	6 January	9	289

Source: The researcher based on the data of Tables (1) and (6)and(7).

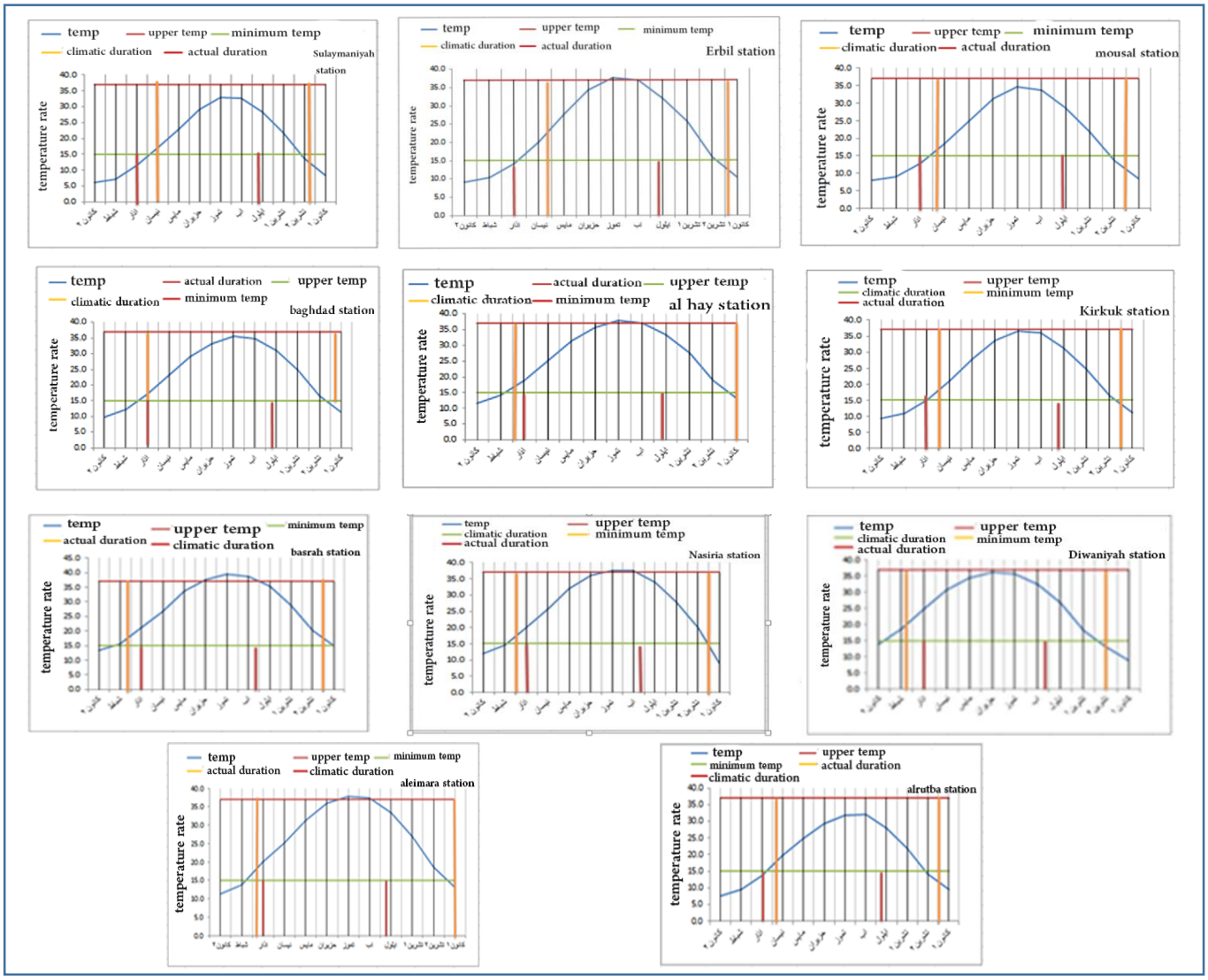


Figure (1) The length of the growing season for the olive crop in the study area.

Source: The researcher based on the data of Tables (1) and (6)and(7).

B- The accumulated temperature

The accumulating temperature required by olive trees varies from one region to another, as they need an accumulating temperature ranging from (3000-1700) C°, which is insufficient for the growth of olives, and the heat accumulated in the stations of Mosul, Erbil, Sulaymaniyah and Kirkuk reached (1634.3, 1704.9, 1827, 2079.2) C, respectively, while the stations of Al-Hayy and Baghdad reached (2478.8, 2211.8) C, respectively.Diwaniyah, Nasiriyah, Basra, Rutba, and Amarah reached (2041.6, 2297.6, 2432, 1935.9, 2307.4) m, respectively, as in Table (4), in addition to the lack of thermal units that are not sufficient for olive cultivation in Iraq, there are a number of other reasons that limit its cultivation Among them are climatic reasons that greatly affected the success of its cultivation, as olive trees are damaged by hot winds and very dry areas, and the percentage of oil decreases as we advance from the north towards the central and southern regions, and the slow growth of the tree and not giving it the commercial crop until many years have passed that exceed the period required for the fruiting of other fruit trees, which causes a reduction in the demand for agriculture a For olives

Table (4) the accumulating temperature of the olive crop during the growth period

Station	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	The total
AL Mosul		14.1	251.7	254.2	238.8	244.4	245.2	241.3	257.1	76.5		1634.3
Erbil			96.8	251.4	235.7	241.3	242	238.1	253.4	146.2		1704.9
Sulaymaniyah			253	256.2	241	246.	246.4	241.7	257.3	85.3		1827
Kirkuk		129	249	251.1	236.4	242.4	243	238.7	254.1	235.5		2079.2
ALhai	85	260.2	244.9	247.6	234.2	241.2	241.8	236.6	251.5	251.1	184.7	2478.8
Baghdad		261.9	246.8	249.9	236.9	243.4	244.1	239.1	254.2	235.5		2211.8
AL Diwaniyah	71.3	254.1	239.3	244.6	233.7	243.2	246.5	243.4	260.7	4.8		2041.6
AL Nassruh	93.3	259	244.3	246.9	234	241.4	241.4	236.1	251.2	250		2297.6
AL Basra	119.5	257.8	243.2	245.1	232.4	239.5	240.2	234.5	250	249.9	119.9	2432
ALratuba		76.4	250.4	254.2	240.8	247.3	247	242	257	120.8		1935.9
ALamarah	58.2	259	245	247.6	234	241.2	241.6	236.6	252	251.4	40.8	2307.4

Source: The researcher based on the data of Tables (3).

C- Light requirements Light

is one of the climatic requirements that have an impact on the life of the olive tree, as studies related to light have shown that its effect is on the olive tree and the fruits together, as the more the fruits receive a large amount of light, the larger the fruit is in size and more ripe compared to the fruits that receive small amounts of light. Light (Al-Jassani, 2006). It is preferable for the trees to be far apart in the areas where light is available so that the branches of the tree do not overcrowd, and thus the fruits are damaged due to the concentration of light in the upper parts of the tree, while the parts to which the light does not reach lead to falling leaves or exposure. To yellowing, which makes it unable to perform it and shade it properly and well, which results in a general weakness in the trees and thus a lack of production and fruits of not good quality (Abdel-Al, 1977).

It is estimated that olive trees need light during their growth period between (12-14) hours to complete the process of growth and maturation. Therefore, when compared with the light capabilities possessed by the study stations Table (5) and Map (2), it appears appropriate in the stations (Mosul, Erbil, Sulaymaniyah, Kirkuk), Baghdad, Al-Rutba), average fit in (Diwaniyah, Nasiriya), and little fit in (Al-Hay, Al-Amarah, and Basra) stations.

Table (5) the number of light hours suitable for the growth of olive trees during the growth period and the appropriate stations

Station	The number of light hours during the growing season	Appropriate class
AL Mosul	12.5	suitable
Erbil	12.6	suitable
Sulaymaniyah	12.6	suitable
Kirkuk	12.5	suitable
ALhai	12.0	little fit
Baghdad	12.4	suitable
AL Diwaniyah	12.1	average fit
AL Nassruh	12.2	average fit
AL Basra	11.9	little fit
ALratuba	12.4	suitable
ALamarah	11.0	little fit

Source: The researcher based on the data of Tables (3).

d- Thermal requirements

- **Higher heat requirements**

The olive tree is grown in areas associated with the Mediterranean climate, which is characterized by a rainy winter, hot, dry summer, and short spring and autumn. In tropical regions with heavy rain and high temperatures, olive trees can grow well vegetatively, but it does not bear fruit due to the absence of the important winter dormancy period for the formation of The floral parts in the buds (Abdel-Al, 1977).

Olives can withstand high temperatures during the summer without being damaged, provided that adequate water nutrition is available, as this heat works with sunlight on the accumulation of oil in large quantities in the fruits (Al-Khatib, 2008), and olives for the purpose of production require thermal requirements of up to (37) Because the rise in temperature affects the different stages of growth, in the flowering stage it leads to the killing of pollen grains and an increase in fallen flowers, while in the stage of fruit formation it leads to a decrease in the knotty fruits with a decrease in production during the ripening stage and thus works to a change in the size and shape of the fruits And the weakness of the production of oil, so the temperature is one of the most determinant climatic elements for the spread of olive cultivation, as shown by Table (6) and map (3) showing that it is suitable in all climatic stations.

Table (6)The upper temperature suitable for the growth of olive trees during the growth period and the appropriate stations therein

Station	The highest temperature during the growing season	Appropriate class
AL Mosul	**33.4**	**suitable**
Erbil	**35.2**	**suitable**
Sulaymaniyah	**29.1**	**suitable**
Kirkuk	**33.5**	**suitable**
ALhai	**33.7**	**suitable**
Baghdad	**35.7**	**suitable**
AL Diwaniyah	**35.1**	**suitable**
AL Nassruh	**35.7**	**suitable**
AL Basra	**35.6**	**suitable**
ALratuba	**30.9**	**suitable**
ALamarah	**32.8**	**suitable**

Source: The researcher based on the data of Tables (3).

- **Minimum temperature requirements**

The olive tree bears the decrease in temperature compared to other types of evergreen fruits, but the severe decrease negatively affects the life of the olive, as the leaves, branches and stump of the olive are noticeably damaged at a temperature below -12, so the temperature should not drop below -8 C, The decrease in temperature has a positive effect for the leaves to create flower buds, provided that they do not exceed the limiting degrees, as the lower the temperature, the greater the number of flower buds (Dies (1980).

The olive tree needs a low temperature of (15) C. By comparing the caloric values of the climatic stations and through Table (7) and Map (4), it appears appropriate in the climatic stations.

Table (7) the minimum temperature suitable for the growth of olive trees during the growth period and the appropriate stations therein

Station	Minimum temperature during the growing season	Appropriate class
AL Mosul	17.7	suitable
Erbil	20.5	suitable
Sulaymaniyah	15.3	suitable
Kirkuk	20.4	suitable
ALhai	18.7	suitable
Baghdad	19.4	suitable
AL Diwaniyah	20.1	suitable
AL Nassruh	20.4	Suitable
AL Basra	21.1	suitable
ALratuba	16.7	suitable
ALamarah	18.9	suitable

Source: The researcher based on the data of Tables (3).

- **optimal temperature**

The optimum temperature for olives ranges between (15-37) C. This degree has a great benefit, as it leads to an increase in the percentage of oil in the fruit, as it reaches the highest percentage in addition to its large size and an increase in the weight of the fruit, and through Table (8) and Map (5) it is clear that Olive crop requirements during the growing season are appropriate in all climatic stations.

Table (8) The optimal temperature suitable for the growth of olive trees during the growth period and the appropriate stations

Station	optimum temperature during the growing season	Appropriate class
AL Mosul	**24.4**	Suitabel
Erbil	**28.8**	Suitabel
Sulaymaniyah	**24.8**	Suitabel
Kirkuk	**27.0**	Suitabel
ALhai	**26.7**	Suitabel
Baghdad	**27.2**	Suitabel
AL Diwaniyah	**27.1**	Suitabel
AL Nassruh	**28.4**	Suitabel
AL Basra	**28.5**	Suitabel
ALratuba	**23.9**	Suitabel
ALamarah	**26.9**	Suitabel

Source: The researcher based on the data of Tables (3).

- **Soil temperature requirements**

The olive tree is known as a tree that is tolerant of poor soils, as it can grow in different types of soils, as well as its water needs are less than other fruit trees because the water lost in the process of transpiration is low (Al-Allaf, 2017).

Soil is one of the renewable natural resources that represent the basis of life on earth, as its exposure to damage leads to damage to the quantity and quality of agricultural production, as its maintenance is extremely important to preserve it, because its low fertility leads to negative changes in its properties, which causes soil deterioration and thus becomes Not suitable for cultivation (Al-Obaidi, Al-Hamdani, 2023, p. 390).

The soil temperature suitable for olive trees is within (32) C. When comparing the data of the thermal values of the soil in the stations of the study area during the growing season, it appears through Table (9) and Map (6) that it is suitable in all climatic stations.

Table (9) Soil temperature suitable for the growth of olive trees during the growth period and the appropriate stations

Station	Soil temperature during the growing season	Appropriate class
AL Mosul	29.0	Suitabel
Kirkuk	27.2	Suitabel
ALhai	31.1	Suitabel
Baghdad	29.3	Suitabel
AL Diwaniyah	29.6	Suitabel
AL Nassruh	28.7	Suitabel
AL Basra	29.5	Suitabel
ALamarah	27.6	Suitabel

Source: The researcher based on the data of Tables (3).

e-Wind requirements

Olive trees are characterized by their ability to withstand strong, dry winds compared to other fruit trees, but it is preferable not to plant them in areas that are exposed to strong winds and storms, because they greatly harm the growth of trees as a result of the negative impact of strong winds on the setting process, falling leaves, flowers and newly set fruits (forage)., previous source, p. 22), and the effect of the wind is stronger and worse if it is associated with high temperatures and drought, as it leads to a small size of the fruits formed and a decrease in the level of oil in them, and thus its marketing value decreases. To treat this problem and reduce the harmful effect of strong winds, trees are planted. closely in order to protect each other if the areas are plain, but in the mountainous areas, as olive trees grow in the valleys that are protected from the influence of the wind because they are surrounded by mountains, which form natural buffers against the influence of bad winds blowing in winter and hot in summer (Yassin, 1970, p. 24), as well as Its effect is bad, but it has an important role in the pollination process if it has a light and moderate speed, and olive trees require a wind speed ranging between (7-9) m / s) (Al-Khafaji, 1990), and it appears through Table (10) and Map (7). The wind speed required by the olive trees during the growing season is appropriate in all climatic stations.

Table (10) appropriate wind speed for the growth of olive trees during the growth period and the appropriate stations

station	Wind speed during the growing season	Appropriate class
AL Mosul	**1.4**	Suitabel
Erbil	**1.9**	Suitabel
Sulaymaniyah	**1.9**	Suitabel
Kirkuk	**1.7**	Suitabel
ALhai	**4.1**	Suitabel
Baghdad	**3.2**	Suitabel
AL Diwaniyah	**2.8**	Suitabel
AL Nassruh	**4.1**	Suitabel
AL Basra	**3.6**	Suitabel
ALratuba	**2.6**	Suitabel
ALamarah	**3.7**	Suitabel

Source: The researcher based on the data of Tables (3).

F- Moisture requirements:

Olive trees are among the trees that bear thirst and drought compared to other fruit trees, and their tolerance varies according to their varieties, as there are varieties that tolerate drought conditions, such as the Nibali and Al-Rasa'i olives, and other varieties that are suitable for highlands with high rainfall, such as the Shami olives. As for the Turkish varieties, they are suitable for the desert climate and can be irrigated with water salty.

High humidity negatively affects the growth of olive trees through the fertilization process during the pollination and flowering period, which leads to the failure of the pollination process and thus reduces the percentage of fruit setting. It also helps the spread of diseases such as twig weevil, stem borer and peacock eye, which leaves a clear impact on the quantity and quality of the product. Therefore, in areas with high humidity, flowering is delayed by 10-12 days compared to warm regions, which leads to a lack of fruits, while low humidity is good for olive cultivation and growth and works to increase the process of knotting and increase the amount of crop (Al-Sheikh, 1995). It is required by olive trees by (60)%, and when comparing the capabilities of the stations of the study area with what they possess of moisture rates, it appears through Table (11) and Map (8) that it is not suitable in all climatic stations.

Table (11) the average humidity suitable for the growth of olive trees during the growth period and the appropriate stations

Station	Appropriate humidity rate during the growing season	Appropriate class
AL Mosul	**40.4**	little fit
Erbil	**38.0**	little fit
Sulaymaniyah	**28.8**	little fit
Kirkuk	**37.9**	little fit
ALhai	**35.8**	little fit
Baghdad	**33.5**	little fit
AL Diwaniyah	**34.7**	little fit
AL Nassruh	**34.2**	little fit
AL Basra	**38.1**	little fit
ALratuba	**37.2**	little fit
ALamarah	**43.0**	little fit

Source: The researcher based on the data of Tables (3).

g- Water requirements

Olive cultivation is widespread in areas where the average annual rainfall ranges from (400-600) mm, because abundant production requires from (600-800) mm (Mahdi, 2004). The amount of rain required for growth depends on the depth and type of soil and its ability to retain moisture. Olive varieties differ in their tolerance to drought, as studies have shown that small-fruited varieties are more resistant to drought than large-fruited varieties, and that the reason for the ability of olives to withstand drought is the presence of a thick waxy layer on the leaves that reduces the rate of transpiration, and their roots can go deep to great distances In the depths of the soil to reach the ground water.

The study of the crop's need for water was relied upon on the actual value of rain, as its study is of great importance because of its distinctive place in giving a clear picture of the best methods used, as well as identifying ways to classify agricultural areas and the possibility of their productive specialization, and the actual value of rain is determined through the relationship between The amount of precipitation and the amount of evaporation / transpiration, as knowing the amount of precipitation helps in determining the actual value of it, the amount of precipitation may be equal in two different regions, but the effect it leaves is different from each other, as a result of its subordination after precipitation on the surface of the earth to several factors, including factors Natural factors related to the amount of rain, its distribution, seasonality, quantity, and intensity, as well as other factors related to temperature, solar radiation, relative humidity, and wind speed, as well as topographic factors and human factors that affect the determination of the actual value of rain, which is represented by the

land reclamation process, the type of tillage, soil preparation for cultivation, and the nature of the crop.

Rain is one of the most important elements that make up the climate after temperature, which helps in determining the region that can be exploited for agriculture, and the importance of the actual impact of rain and its relationship to natural vegetation and its spatial distribution, so many geographers were interested in studying and knowing the value of effective rain and how to calculate it, as some called it Evidence of drought, including De Matron, Thorn Thwaite, Lang and other geographers, due to its association with vegetation. To calculate the effective amount of rain for the climatic stations included in the study, the Lang coefficient was relied on to find the rain effectiveness because it gives accurate results through the use of the instantaneous equation:

$$f = N/T$$ **Whereas**

F = rain coefficient

N = total annual precipitation (mm)

T = mean annual temperature (°C)

Lang has set up a table for his equation in which he determines the characteristics of the climate according to the application of the equation, as in Table (12).

Table (12) Rain coefficient divisions according to Lange equation

Area Adjective	Rain Coefficient
Very Dry	10-0
Dry	40-10
Semi Wet	160-40
Wet	More than160

Source: - Adel Saeed Al-Rawi, Qusay Abdul-Majid Al-Samarrai, Applied Climate, 1st Edition, Baghdad University Press, Baghdad, 1990, pg. 115.

After applying the equation to the studied stations of Iraq, Table (13) shows that the results are less than (40), and this means that all stations are located in the dry region, and this indicates that all stations are less suitable, This is because the climate of Iraq is distinguished by its continental character, as it overlooks a narrow water body from the Arabian Gulf, and is a common distance away from the rest of the seas, which made the climate of Iraq characterized by continental and extremes in temperatures (high and low), the length of the summer season, the short winter season, and the moderation of the two transitional seasons (spring and autumn). Likewise, the lack of rain (Naji, Al-Ani, 2023, p. 523).

Table (13) Characteristics of the area according to the Lange equation for the stations of the study area for the period (1980-2019)

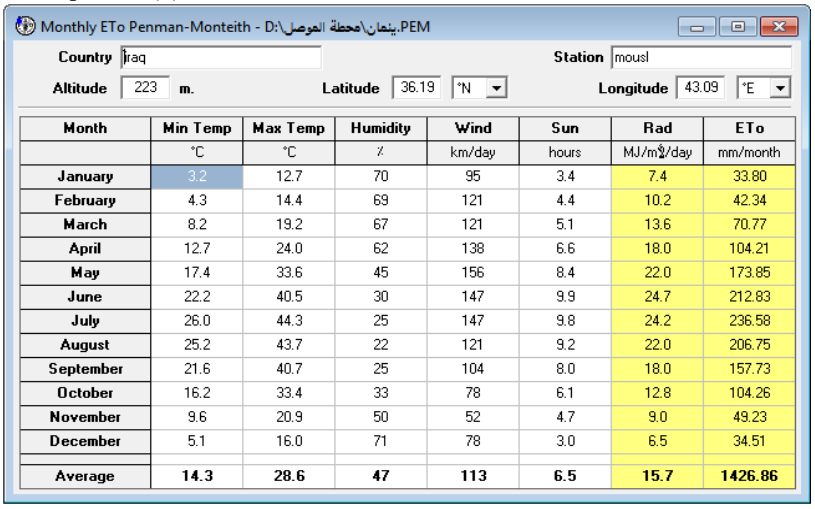
station	Tot Rain(MM)	Aver Annual temp(m°)	Tot Final	Appropriate class
AL Mosul	189.2	20.4	9.3	little fit
Erbil	407.7	22.3	18.3	little fit
Sulaymaniyah	380.1	19.3	19.7	little fit
Kirkuk	336.7	22.8	14.8	little fit
ALhai	136.7	25.4	5.4	little fit
Baghdad	134.8	23.2	5.8	little fit
AL Diwaniyah	115.1	24.7	4.7	little fit
AL Nassruh	138.1	26.3	5.3	little fit
AL Basra	139.3	27.2	5.1	little fit
ALratuba	123.7	20.8	5.9	little fit
ALamarah	179.2	25.6	7.0	little fit

Source: - The researcher based on Table (12).

h- Evaporation/transpiration

Evaporation/transpiration represents the first step to know the water consumption, which is the main determinant of weather conditions, as the process of evaporation/transpiration is clearly related to the air temperature, meaning that if the air temperature increases, evaporation increases and vice versa, many mathematical methods have been used to calculate evaporation Transpiration, which depends directly on the main climatic elements that affect the activity of the evaporation / transpiration process (Al-Rawi, Al-Dulaimi, 2016, p. 193).

The calculation of the amount of evaporation / transpiration was based on the equation or model of Banjan Monthet, FAO 1998, affiliated with the Food and Agriculture Organization of the United Nations F.A.O. for its accuracy, and after being studied by the organization, it was modified for ease of use and application, because the basic equation is not available in many regions of the world. Therefore, it became called the modified Penman equation, then it developed to be easier to use in the form of a computer program running on the **Windows** system, through which climatic data with all its elements can be entered into the program in order to obtain the amount of evaporation / transpiration (Al-Waeli, 2004), through the (**CROPWAT 8.0)** program (8.0) through which water needs and irrigation requirements can be calculated based on irrigation and soil data, as the program requires entering data for each of the minimum and maximum temperature rates, the average number of hours of solar brightness, wind speed and relative humidity, as well as specifying the name of the country and the name of the climatic station and its height About sea level, latitude and longitude of the site (Al-Jubouri, (Al-Jubouri, 2014). As in the picture (1).



Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/month
January	3.2	12.7	70	95	3.4	7.4	33.80
February	4.3	14.4	69	121	4.4	10.2	42.34
March	8.2	19.2	67	121	5.1	13.6	70.77
April	12.7	24.0	62	138	6.6	18.0	104.21
May	17.4	33.6	45	156	8.4	22.0	173.85
June	22.2	40.5	30	147	9.9	24.7	212.83
July	26.0	44.3	25	147	9.8	24.2	236.58
August	25.2	43.7	22	121	9.2	22.0	206.75
September	21.6	40.7	25	104	8.0	18.0	157.73
October	16.2	33.4	33	78	6.1	12.8	104.26
November	9.6	20.9	50	52	4.7	9.0	49.23
December	5.1	16.0	71	78	3.0	6.5	34.51
Average	**14.3**	**28.6**	**47**	**113**	**6.5**	**15.7**	**1426.86**

photo(1) Using CROPWAT8.0 software to measure evapotranspiration at Mosul station

After applying the program to the stations of the study area included in the study, the rates of evaporation / transpiration were obtained, as in Table (14).

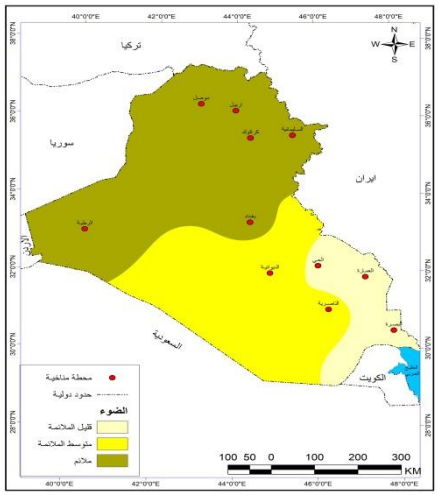
Table (14) Evaporation / transpiration rates (mm) for climatic stations in Iraq for the perio (1980-2019)

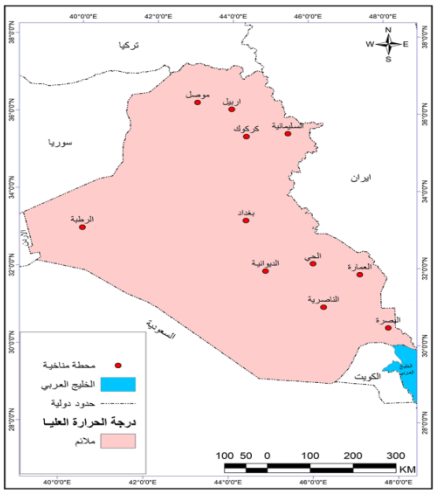
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
AL Mosul	33.8	42.3	70.7	104.1	173.9	212.7	236.5	206.8	157.8	104.2	49.2	34.4	1426.3
Erbil	39.1	43.7	81.5	118.8	184.8	231.9	283.7	268.2	204.9	139.8	69.9	38.1	1704.3
Sulaymaniyah	33.5	40.6	71.9	81.3	142.9	211.5	240.9	210.2	151.2	117.2	67.2	36.9	1405.2
Kirkuk	38.8	51.8	90.5	132.6	201.5	239.1	255.8	240.6	173.4	128.0	65.7	41.5	1659.3
ALhai	68.8	90.7	136.7	189.0	291.1	398.4	430.3	404.2	309.9	216.4	135.3	79.4	2750.2
Baghdad	58.9	71.7	125.9	175.5	260.7	332.4	357.1	291.4	245.1	177.6	107.7	56.7	2260.7
AL Diwaniyah	62.0	82.9	132.1	181.5	260.4	280.5	334.5	296.1	227.4	166.5	106.2	67.3	2197.2
AL Nassruh	79.7	97.7	169.9	221.1	322.7	408.0	421.9	404.2	315.6	204.6	118.5	81.5	2845.5
AL Basra	80.6	114.0	163.4	223.2	266.6	418.2	393.4	409.8	301.8	208.0	122.4	77.5	2778.9
ALratuba	56.4	66.1	106.3	146.1	209.3	252.0	286.4	251.4	183.3	137.3	81.9	52.7	1829.3
ALamarah	61.1	82.9	137.6	185.4	264.7	389.1	395.9	381.3	289.5	164.3	125.1	66.0	2542.9

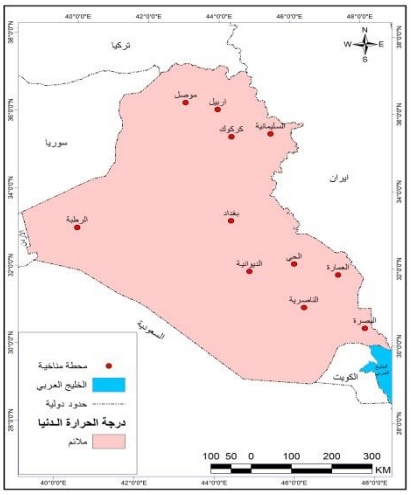
Source: - the researcher based on the program (CROPWAT8.0).

The process of evaporation / transpiration is one of the important processes in agricultural production due to its connection with the vital processes carried out by the plant, as plant growth is determined to a large extent by the internal balance of water because all physiological processes depend on it, and it appears through the analysis of Table (14) that the values of evaporation / transpiration vary Among the stations of the study area during the period of olive growth, as it is low during the month of February in all stations and then increases from month to month, due to changes in the climatic elements such as high temperatures, low precipitation and lack of humidity, and evaporation rates are increasing starting from the month of March all the way to the summer months, which witness a severe rise in temperatures with a lack of precipitation and a lack of humidity in exchange for high rates of evaporation, then the evaporation rates decrease during the month of September to decrease significantly during the month of December in all stations due to the drop in temperatures with An increase in precipitation, and it appears on the map (9) that it is suitable in stations (Erbil, Mosul, Sulaymaniyah, Kirkuk, Al-Rutba) and moderately appropriate in stations (Baghdad, Al-Hay, Diwaniyah, Nasiriyah, Amarah, Basra).

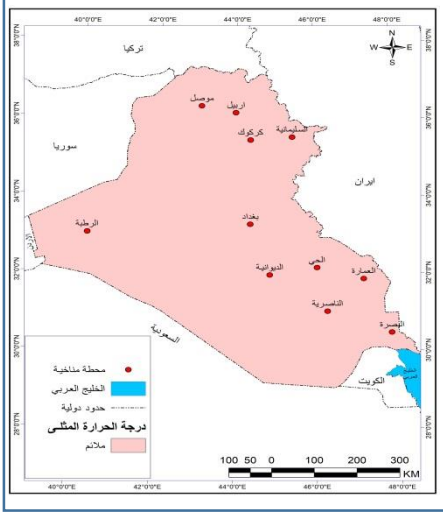
Map (2) Map (3) Map (4)

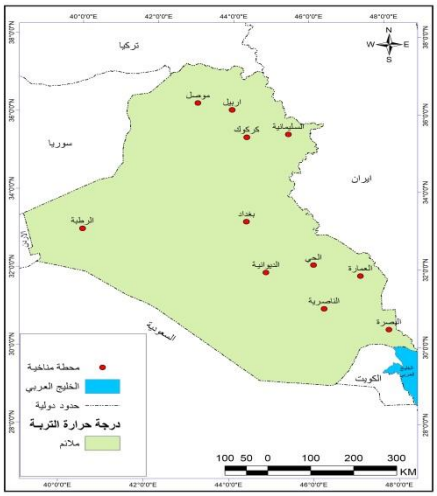


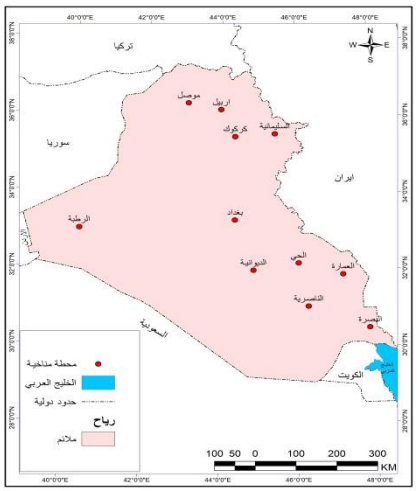




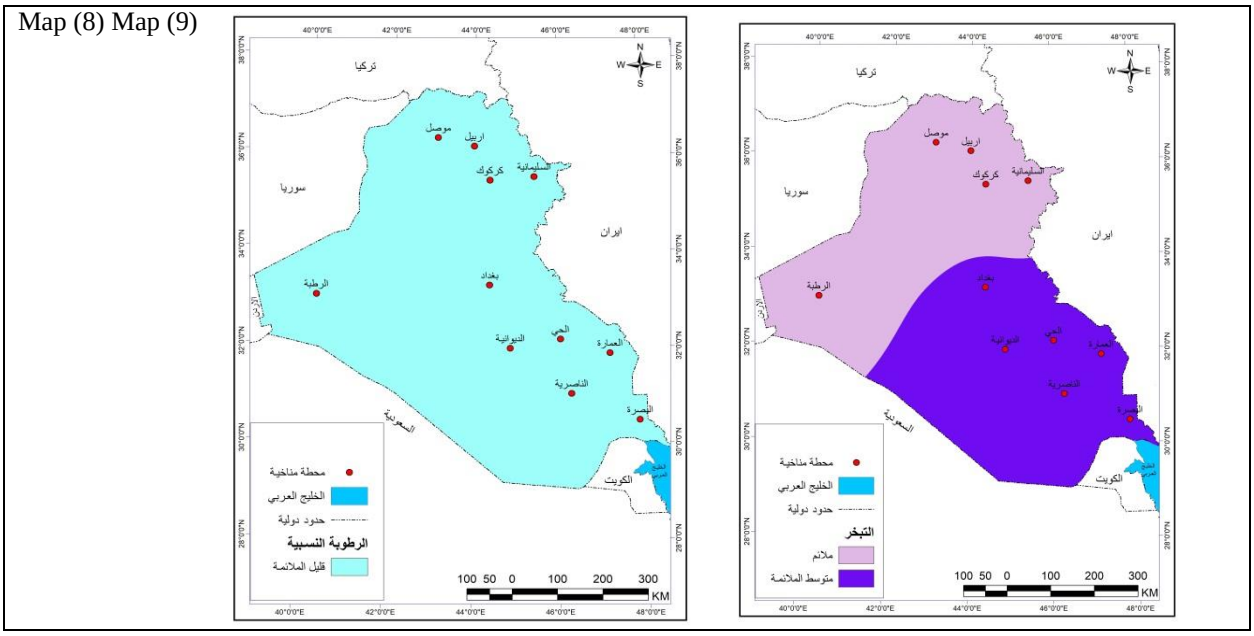
Map (5) Map (6) Map (7)







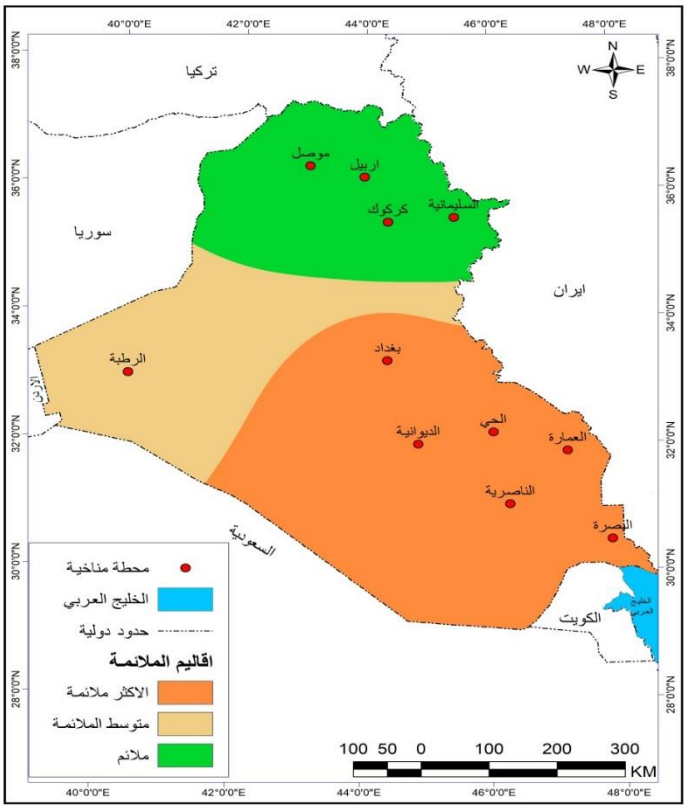
Map (8) Map (9)



Maps suitable for climate elements for the cultivation of olive trees in Iraq

Source: - From the researcher's work, based on the Arc map 10.8.

As for the final suitability map for the suitability of the cultivation of olive trees in Iraq, it appears through a map (10) that the stations of the study area participated in their suitability for the cultivation of olive trees in the station (Mosul, Erbil, Sulaymaniyah, Kirkuk), which was characterized by the availability of appropriate climatic requirements for the cultivation of olive trees, while (Al-Rutba) station was one of the appropriate medium stations, due to its variation in the availability of climatic requirements required by olives, while (Basra, Nasiriyah, Amarah, Baghdad, Diwaniyah, Al-Hay) stations were among the stations that participated in their lack of suitability for olive cultivation due to the lack of climatic requirements. needed by olives, which are not within the ideal degree for it, as shown in Map (10).



map (10) Climate suitability regions for olive trees

Source: - From the researcher's work, based on the Arc map 10.8

Conclusions

1. The study shows that the climatic factors vary in the strength of their impact on the cultivation and production of olives.
2. Light affects the size, composition and color of the fruit.
3. Olives grow in a wide range of temperatures, but the ideal limits in which they grow range between (15-37)
4. Increasing or decreasing humidity from the limits required for the growth of olive trees has an adverse and negative effect, as its increase leads to the spread of diseases and its lack causes cracks and drying of fruits.
5. The growing season of olive trees varies from one region to another within the stations of the study area, depending on the different temperatures suitable for the crop.
6. The research showed that there are areas suitable for the cultivation of olive trees, and other areas that are moderately suitable and less suitable.
7. The study showed that the stations of the study area participated in their suitability for the cultivation of olive trees, namely (Erbil, Sulaymaniyah, Kirkuk, and Mosul).

Recommendations

To facilitate researchers in obtaining climate data from government departments that contribute to reaching accuracy in the results.

1- It is preferable not to rely on the cultivation of agricultural crops that have a number of light hours that are more or less than the crop's need for light, which requires determining the optimal light requirement that provides ideal growth and production.

2- Paying attention to areas that are well suited when planting olive trees to obtain economic production and ensure its abundance, as it is involved in multiple industries.

Working on knowing and determining the cultivation of the crop that is compatible with the climatic requirements available in the study area.

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