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Biothermal zones for wheat cultivation and production in Iraq

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Abstract---The relationship between climate and agriculture is very close; perhaps agriculture is the most significant activity regarding climate conditions. The climate factor is one of the most influential natural factors in determining the types of crops, as it determines the areas that can be cultivated with certain crops, including the wheat crop, which is the subject of the study. This study aims to study (the biothermal areas suitable for wheat cultivation and production in Iraq) that determine the geography of the applied climate. To clarify the biothermal areas suitable for wheat cultivation and production in Iraq, including the use of statistical equations in order to reach accurate and precise statistical results. The study also dealt with statistical analysis, the most crucial step that follows scientific research. Two methods were used to measure the statistical relationship: correlation and regression. Our study relied on the correlation coefficient, regression coefficient and coefficient of determination in measuring and estimating the relationship, its nature, and the level of influence between the selected study variables, which are the average productivity and salinity ratio according to units. The administrative department of the study area and the chapter analysed the statistical relationship between temperature rates, maximum temperature rates, minimum temperature rates, accumulated thermal unit rates and agricultural variables (yield, area, total production). It also determined the appropriate areas for wheat cultivation according to the deviation of their introductory thermal rates from the study area's maximum, minimum and average temperatures.

Keywords---biothermal zones, cultivation, production.

Introduction

The wheat crop is one of the primary grain crops, as this crop is consumed in most countries of the world, and about (21%) of the world's population depends on it for food, and they combine about (41%) of the world's population between wheat and other food grains for their food. As for Iraq, the wheat crop is one of the most important crops, as it represents the largest share in terms of the cultivated area, quantity and value of production and ranks first among the four essential grain crops. The role of price policy in achieving optimal production goals is still weak for the crop. The cultivation of the crop is highly dependent on the thermal characteristics of the area in which it is grown. Even the quality of the crop and its suitability for making bread depends on the percentage of gluten it contains. One of the reasons for the difference in the presence of this substance in one variety is mainly the effect of the average air temperature During the period of grain formation. Heat is one of the most specific climatic factors for the cultivation and production of crops through its direct impact on the crop and indirect, among other climate elements.

Research problem

The problem can be formulated in the form of the main question representing the main focus of the study and secondary questions representing other aspects of the study, and the following question can formulate the main problem here:

What is the geographical distribution of biothermal areas suitable for wheat cultivation and production in Iraq?

Research hypothesis

The answer to the above question requires reliance on geographical research data that considers the general geographical sense that characterises the science of geography. The hypothesis is a temporary guess that the researcher adheres to as one of the correct procedures on which the correct geographical approach is based. The thermal characteristics of Iraq's climate affect the variation of the biothermal areas suitable for cultivation and production of wheat in Iraq spatially and temporally in the study area that includes Iraq (the study area has biothermal regions that can contribute to the cultivation and production of the wheat crop).

The study's objective

The study aims to determine the biothermal regions or regions suitable for the growth of the wheat crop, which is characterised by the availability of appropriate thermal rates for the growth of the wheat crop in all stages of its growth. the importance of studying

- Iraq is one of the countries that own large agricultural areas and is famous for cultivating the wheat crop.
- Determining the regions most suitable for the cultivation of wheat varieties in order to achieve quality production and quality.

Boundaries of the study area

The study area is located astronomically between two latitudes (0-29-37) north and longitudes (48-39) 0 east.), bordered on the north by the Republic of Turkey and the east. The Islamic Republic of Iran is separated from these two countries by natural borders that form part of the eastern and northern borders of the Arab homeland, either from the west, bordered by the Syrian Arab Republic, the Hashemite Kingdom of Jordan and the Kingdom of Saudi Arabia, or from the south, bordered by the State of Kuwait, the Arabian Gulf, and the Kingdom of Saudi Arabia, as shown in Map No. (1).

Map 1. the study area

The first topic
Thermal requirements (fundamental thermal limits)
For the growth and production of wheat in Iraq

Temperature is one of the climatic factors affecting the growth of plants. It affects almost every function. All chemical processes needed for food transformation depend on temperature. Although heat is plants' primary source of energy, its relationship is still ambiguous and unresolved. It is clearly defined because plants generally grow within certain temperature limits that differ from one plant to another and from one place to another. In general, the thermal properties (fundamental thermal limits) necessary for the growth of the wheat crop are as follows:

First - the appropriate upper thermal limits for wheat growth and production in Iraq

It means the upper thermal limits after which the activity of vital processes in the plant stops. If the temperature rates exceed this limit, the plant suffers relative damage. The seriousness of damages depends on the amount of increase and the stage the plant is in, meaning at the growth stage. The higher thermal

requirements of the wheat crop during its growth stages in the growing season can be reviewed as follows:

- Germination stage: During this stage, the crop needs a temperature of (24-30) °C, and if the temperature is higher than this limit, it leads to the spread of diseases on the crop.1
- The vegetative growth stage: The temperature of (20-21) °C is the appropriate limit for growing wheat in the vegetative growth stage (seedlings).
- Flowering stage: The thermal limits appropriate for the flowering stage are in March and reach (25-31 °C); this stage stops all vital processes, and if it exceeds the required limit, the plant suffers special damages in the flowering stage.
- Maturity stage: The upper-temperature limits appropriate to the maturity stage are in April for all winter crops and the temperature reaches (31-40) °C.

Table 1
Maximum temperatures of the wheat crop according to growth stages

crop	germination	vegetative growth	flowering	maturity
Wheat	24-30 °C	20-21 °C	25-31 °C	31-40 °C

Source: Wassan Majid Abdullah Al-Harbi, The effect of climate on the requirements of field crops, their diseases and pests in Maysan Governorate, PhD thesis, University of Basra, College of Education for Human Sciences, 2019, p. 74

Second - the appropriate minimum thermal limits for wheat growth and production in Iraq

It is the degree that every agricultural crop needs at the beginning of its growth, but if it drops below it, the plant's growth stops, and it is also called the zero growth temperature at which the crop begins to grow. Low temperature harms crops when it recurs in short and sudden periods. The minimum thermal requirements for the wheat crop during its growth stages in the growing season can be reviewed as follows:

- **The germination stage:** the wheat crop requires a minimum temperature of (2-4.5 °C) during the germination stage. The germination stage begins at the end of November and the beginning of December.
- **The stage of vegetative growth:** the minimum thermal limits for this stage are between (8-10) °C, and the wheat crop enters the stage of vegetative growth at the end of January and the beginning of February
- **C - Flowering stage:** The flowering stage of the wheat crop begins during April, and its temperature is medium, meaning it is suitable for plant growth (12 ° C).
- **Ripening stage:** The ripening stage of the wheat crop begins during April, as this stage needs a temperature of (20°C).

Table 2
Minimum temperatures of the wheat crop according to growth stages

crop	germination	vegetative growth	flowering	maturity
Wheat	2 - 4.5 °C	8 - 10 °C	12 °C	22 °C

Source: Wassan Majid Abdullah Al-Harbi, The effect of climate on the requirements of field crops, their diseases and pests in Maysan Governorate, PhD thesis, University of Basra, College of Education for Human Sciences, 2019, p. 55

Third - the optimum thermal limits suitable for the growth and production of wheat in Iraq

The optimum temperature (the degree between the lower and upper extremes of plant growth) is the best temperature at which the highest level of germination, growth and maturity can be reached. The optimum thermal requirements for the wheat crop during its growth stages in the growing season can be reviewed as follows:

- **Germination stage:** At the optimum temperature for the germination stage, the wheat crop requires a temperature ranging (from 22-25) Cº.
- **The stage of vegetative growth:** the wheat crop suits the moderately cold climate during the period of vegetative growth, discharge and flowering; this is in the winter season, and the wheat crop at this stage requires a temperature of (10-15) °C.
- **The flowering stage:** The appropriate thermal limits for the wheat crop for the flowering stage are (22) °C, and this degree has a significant impact on the physiological processes in the plant.
- **Maturity stage:** The optimum thermal requirements for the maturity stage are (20-27) Cº if this degree is the ideal degree for the crop if it is far from the appropriateness, and in some cases, the ideal degree for the maturity stage reaches (30) Cº.

Table 3
Optimal temperatures for wheat crop according to growth phases

growth phase	germination	vegetative growth	flowering	maturity
Ideal temperatures	22°C	14°C	21°C	27°C

Source: Raja Muhyi Abu Al-Issa, Wheat, Journal of Agriculture and Grains, Volume, 26, Issue 13, 1971, p. 142

Fourth is the growing season

The growing season is the period the plant requires to complete its life cycle, from (germination) to the stage of (maturation). The growing season can be defined as the number of days with temperatures above the degree representing the

beginning of growth. Moreover, another definition defines it as the appropriate climate of the year for plant growth and development, which is the frost-free period when the temperature rates are higher than the minimum degrees of growth and below the upper limit degree 5.

Fifth: Thermal units accumulated during the growing season

The accumulated heat is the sum of the degrees or thermal units that accumulate above the minimum thermal average in which plants can grow. Without these thermal units, maturation is not completed six since the accumulated temperature varies according to the different plant types and their growth stages. It is defined as the sum of the units or temperatures required to reach maturity. Moreover, on this basis, the heat accumulated during the growth period of the crop under study can be calculated. It is done by subtracting the minimum degree of growth from the average monthly temperature multiplied by the number of days of the month, after which the accumulated heat units are collected each month. Then, the heat units accumulated for all months of the planting season are collected to obtain the heat collected during the growing crop season, according to what is evident in Equation 7.

Accumulated heat = (monthly average temperature - zero degree of growth) x number of days of the month

We find from the comparison and observation of Table (33) and Figure (27) that the total heat units accumulated during the growing season of the wheat crop at the level of Iraq. Characterised by an increase as we go from north to south and in a manner consistent with the trend of rising general thermal rates for the study area, as we find that the highest amount Of the heat accumulated within the study area, we find it in Nasiriyah station, as it reached (3671 °C), followed by Basra, which reached (3568 °C). Architecture ranked third, reaching (3461 °C), and it continues to decrease gradually within the study area to reach its lowest amount in the Mosul station, as it reached (2211 AD). The trajectory of the total heat units accumulated throughout the months of growth continues with a gradual increase starting from the month of October, when the highest total of heat units accumulated, reaching (5666 mº), and during the aforementioned month, we find that the total accumulated thermal units vary spatially between the administrative units of the study area, where it reached its peak In Basra (802 m º) and its lowest value was in Mosul (589 m º) and ranged in the rest of the study area between them. (465 m), and the heat units accumulated in November decreased to (3440 ºC) until they reached their lowest value in January, reaching (1838 ºC) and in a manner consistent with the significant drop in temperatures witnessed in January, which is considered one of the coldest months of the year in Iraq.

The second topic
The deviation of the thermal rates (average, maximum and minimum) from the fundamental thermal limits (optimal, upper and lower) appropriate for the growth of the wheat crop

In this study, it was relied on thermal rates in determining the biothermal regions suitable for cultivation and production of wheat as one of the critical strategic crops in the study area, where temperature plays a significant role in the success of the life cycle of any plant, as the upper, lower and optimal fundamental thermal limits are of great importance in the life of the plant. Furthermore, the quality of its production affects the size and shape of the plant. The degree of hardness of its leaves and the nature of its fruits 8. The areas suitable for cultivation were determined according to the deviation of their introductory thermal rates from the maximum, minimum and average heat rates for the study area, which will also be explained in detail in the following form:

Deviation of the monthly thermal rates for wheat growth separation from the optimum thermal rates for wheat growth

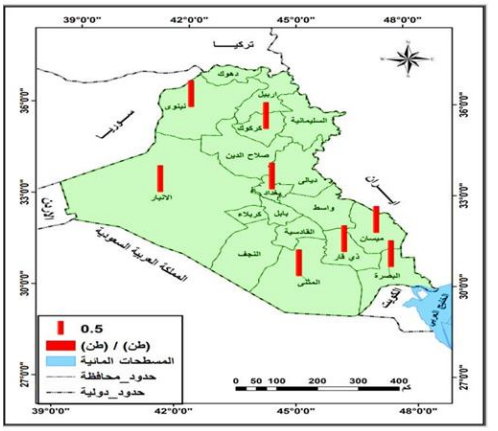
We find from the comparison of Table (5), Figure (2) and Map (2) that there is a negative and positive deviation from the optimum temperature suitable for wheat crop growth (20°C). Furthermore, the negative deviation indicates that there is a decrease in the amount of heat available within the study area from the amount of heat What is needed by the wheat crop and vice versa if the amount of the difference is a positive number, meaning that the available thermal requirements are suitable for the cultivation of this crop.), the values of thermal deviation vary within the months of the growing season between (-0.59 °C) in November to (-7.77 °C) in January. The three southern regions (Basra, Amarah, and Samawah) are (-0.20, -0.2, -1.68 m) for each of them, respectively. The sizeable negative increase starts from Baghdad (-3.25 °C) to Mosul (-6.6 °C) and varies within the growing season in Mosul. The heat deviation values during the growing season of the wheat crop in Mosul ranged from (2 °C) in October too (-12.58).) in January, and the highest monthly averages of thermal deviation values were in January (-9.59°C).

Table 4
The deviation of the monthly thermal rates for wheat growth season from the optimal thermal rates for wheat growth

Study stations	October	November	December	January	February	March	April	Annual average
Mosul	2.00	5.91-	11.10-	12.58-	10.56-	6.55-	1.49-	6.60-
Kirkuk	5.39	3.20-	8.48-	10.50-	8.70-	4.35-	1.13	4.10-
Wet	2.45	5.41-	9.87-	11.94-	9.98-	5.86-	0.05-	5.81-
Baghdad	5.24	3.35-	8.25-	10.04-	7.23-	2.45-	3.30	3.25-
Baghdad	8.33	0.59-	6.02-	7.77-	4.93-	6.97	5.90	0.27
Samawa	7.16	1.67-	6.54-	8.57-	5.98-	0.85-	4.68	1.68-
Aleimara	7.34	1.23-	6.60-	8.29-	5.74-	4.33	5.16	0.72-
Basra	8.86	0.01	5.51-	7.02-	4.45-	0.21	6.53	0.20-

Monthly average	5.85	2.67-	7.80-	9.59-	7.20-	1.07-	3.15	

Source - the researcher's work based on Table (8)

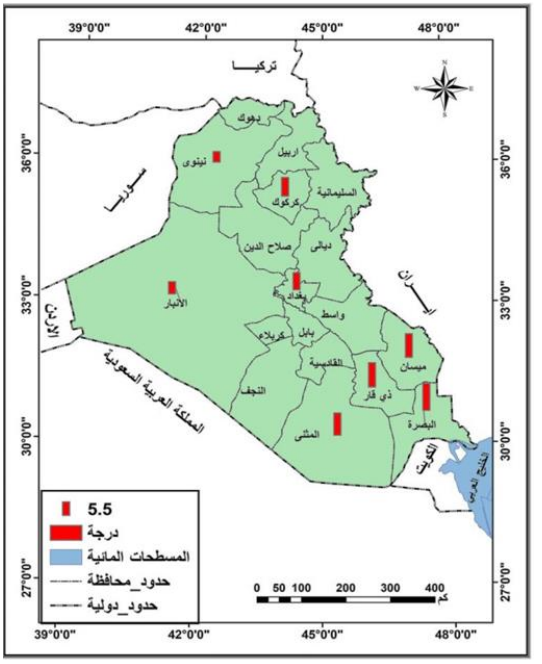


Map 2. The deviation of the monthly thermal rates to separate wheat growth from the optimal thermal rates suitable for wheat growth

Source - researcher's work based on 1- Table (10), 2- arc view 20. Program

Deviation of the highest monthly thermal rates of wheat growth separate from the maximum thermal rates of wheat growth

We find from the comparison of Table (6), Figure (3) and Map (3) that the thermal deviation values of the maximum thermal rates in the study area with the higher thermal requirements of the wheat crop (40 °C). A gradual decrease characterised all positive values and their annual rates. as we headed From north to south, it reached Mosul (19.56°C) and Basra (13.79°C), and its monthly rates were at the lowest in the months of the growing season in April (10.18°C). Parts of the study area and its highest value was in Mosul (14.15°C), and its lowest value was in Nasiriyah (7.49°C). The highest monthly average of the temperature deviation values was within the months of the growing season in January (23.90°C). The monthly averages of the temperature deviation values in the study area during this month. Furthermore, the highest value was in Mosul (26.83°C), and the lowest was in Basra (21.36°C).



Map 3. The deviation of the maximum monthly thermal rates for the season of wheat growth from the maximum thermal growth rates for wheat
Source - researcher's work based on 1- Table (11), 2- Using Arcmp.10.6

Deviation of the minimum monthly thermal rates to separate wheat growth from the minimum thermal rates for wheat growth

We find from the comparison of Table (7), Figure (4) and Map (4) that with regard the thermal deviation values of the minimum thermal rates in the study area from the minimum thermal requirements for the wheat crop (3 °C), they were all positive and negative values, and their annual rates were characterised by a gradual rise The more we headed from north to south, where it reached in Mosul (4.43 °C) and Basra (11.07 °C). Their monthly rates were at their lowest within the months of the growing season in January (2.38 °C), and the monthly averages of thermal deviation values varied during This month. Between the study areas, the highest positive value was in Basra (5.27 °C), and its lowest negative value was in Mosul and Rutbah (-0.38 °C) and (-0.35 °C) for each of them, respectively. The highest average monthly values of thermal deviation were reached. It is among the months of the growing season in October (11.54°C). The monthly averages of the temperature deviation values in the study area during this month. Moreover, the highest value was in Basra (18.71 °C), and the lowest was in Mosul (11.54 °C).

Conclusions

- Studies conducted on the growth stages of field crops have found that each type or variety has a minimum, maximum and optimum temperature, known as the primary temperature.
- The study found that there is a maximum temperature, and if it exceeds it upwards (height) that crop stops growing, in addition to that, every

agricultural crop also has an optimum temperature that lies between the two advanced limits, and these three limits are called the basic heat limits for growth of crops, as it begins growth is slow at the minimum temperature. It gradually increases with rising temperatures until it reaches the most appropriate limit (the optimum temperature), at which the plant increases in growth, and if it exceeds it to a maximum degree, then the plant's growth decreases until growth stops. These thermal limits differ. The basic principles differ significantly according to general agricultural crops and field crops.

References

1. Fadel Abdel Abbas Amer, Abdel Hassan Madfoun Abu Rahil, a geographical analysis of the characteristics of the climate and their relationship to the cultivation of wheat and barley crops in the province of Babylon, University of Kufa, College of Arts, p.16.
2. Muhammad Khamis Al-Zawka, Agricultural Geography, University Knowledge House for Printing, Publishing and Distribution, 2000 AD, pp. 109-110
3. Muhammad Mahmoud Muhammad Zangana, a spatial analysis of the impact of climate on the cultivation and production of some field crops in Iraq, previous source, pp. 89-90.
4. Naim Al-Zahir, Biogeography, Second Arabic Edition, Al-Yazuri Scientific Publishing and Distribution House, Amman, 2015, p. 74.
5. Normatova, S. A. ., Botirov, M. T. ., Ruzmatova, K. K. ., & Mamarasulov, J. O. ugli . (2021). Hygienic basis for contamination of food products and production of dairy products until 2030. International Journal of Health & Medical Sciences, 4(1), 123-128. https://doi.org/10.31295/ijhms.v4n1.1592
6. Omer, A. M. (2017). Identifying, developing, and moving sustainable communities through application of bioenergy for energy or materials: future perspective through energy efficiency. International Journal of Life Sciences, 1(1), 9–39. https://doi.org/10.21744/ijls.v1i1.9
7. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). The COVID-19 pandemic. *International Journal of Health Sciences*, *5*(2), vi-ix. https://doi.org/10.53730/ijhs.v5n2.2937
8. Wasan Majid Abdullah Al-Harbi, The effect of climate on the requirements of field crops, their diseases and pests in Maysan Governorate, PhD thesis, University of Basra, College of Education for Human Sciences, 2019, pp. 53, 56, 64, 70.