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The Effect of Climate Change on some Agricultural Crop Production in Basrah Governorate

The Effect of Climate Change on some Agricultural Crop Production in Basrah Governorate

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Abstract. Agricultural production is directly affected by changes in the climatic elements, whether positive or negative, and the impact of this change is reflected in the area, yield and crop production, which affects the crop structure, so this research aims to analyse the impact of climate changes on crops for the period (1983-2022). As a comparative study, this is done by studying the yield and productivity of some crops and the most important appropriate climatic elements affecting their cultivation. These elements include the minimum and maximum temperatures, relative humidity, rainfall and their impact on some grain crops, which are Triticum aestivum, Hordeum vulgare, and vegetable crops, which are Solanum lycopersicum, Solanum melongena, Cucumis sativus and Citrullus lanatus, as they were recorded during these periods. The highest mean maximum temperature was 27.67 °C as a general average for the period 2016-2022, and the lowest was 14 °C for the period 1983-1994. Humidity and rainfall were highest at 52.28% and 21.14% for the period 1994-2005, respectively, and the lowest was 47.42 and 12.42 for the period 2016-2022 and 2005-2. 016 on respectively. As for the yield, it was recorded for the grain crops T. aestivum and H. vulgare, the highest being 341083 and 191917 kg for the period 2016-2022, and the lowest being 19557 and 20272 kg for the periods 1983-1994 and 1994-2005, respectively. As for the yield of vegetable crops, the highest yield was for S. lycopersicum, which was 110,500 kg in 2016-2022, and the highest yield for S. melongena was 40,250 kg for the same period. As for the crops of cucumber and watercress, the highest yields were 2,000,000 and 906,750 kg for the periods 1994-2005 and 2016-2022, respectively, and the lowest was 198,700. And 258,482 kg for the two periods of 2016 -2022 and 1983-1994, respectively. As for C. lanatus, its highest yield was 906,750 for the period 2016-2022, and the lowest was 258,182 kg for the period 1983-1994. The results also included identifying and knowing the productivity of the studied crops, so it recorded the highest and lowest values for it and for different periods of time, as it reached the highest productivity for T. aestivum and H. vulgare crops 4366714 and 33353105 tons for the time period 2016-2022 and 23185143 tons for S. lycopersicum and 1857167 tons and 1274300 for the crop of C. sativus and 1274300 tons for C. lanatus for the same time period and for S. melongena the highest yield was 243709 tons for the period 1994-2005.

Keyword. Climatic elements, Yield, T. aestivum, H. vulgare, Productivity.

1. Introduction

The climate with its various elements is one of the most important natural factors that affect crops, and the cultivation of any crop is closely related to these elements, starting from the stage of germination and growth through the stage of vegetative growth and ending with the stage of maturity and harvest, and that any change in climatic conditions worldwide will negatively affect agricultural production , which negatively affects the amount of food sources available for human consumption, and the fodder resources needed for livestock, but there are many factors that reduce the accuracy of estimating changes in agricultural production in response to climate changes, including the amount of change in the rate of temperature, its geographical distribution, and the amount of accompanying change In the rate of precipitation, and the nature of its distribution during the growing season, which in turn determines the amount of water available to the plants of agricultural crops, especially under rain-fed conditions [1].

The climate is one of the most effective natural factors in influencing plants on the surface of the earth, and each plant and animal has climatic and environmental controls and requirements. The human ability to control the climate is still very limited and is limited to minimizing the influence of its elements and trying to adapt to it. The climatic requirements of each plant vary according to the stages of growth. In general, vegetable crops are similar in their climatic requirements. Temperature and rain are among the most influential climatic elements in the distribution and growth of plants. If these requirements are exceeded or decreased, they will harm plants [2].

Field crops are directly affected by changes in the climatic elements, whether they are positive or negative, more than other crops because they are grown in large areas and it is not possible to control these changes, and in turn the effects of this change are reflected in the area, yield and production of these crops [3].

Cereal crops are among the most important crops, due to the high nutritional value they contain. They are the most widely used and widespread, as they constitute the main food for most of the world's population, amounting to about 99% [4].

These crops contribute greatly to solving the grain crisis in poor communities and the animal protein crisis and provide the raw material for various industries[5]. Oryza, Triticum, Hordeum and Zea mays are among the most important strategic food crops in Iraq because they are the main food source for the population. Cultivated crops in Iraq are dedicated to the cultivation of grains, and these crops have witnessed significant fluctuations in the levels of local production as a result of the expansion of cultivation of other crops, in addition to the drought conditions that the region was exposed to. Wheat cultivation occupies the largest part of the land area for agricultural grain production [6]. Triticum is one of the crops that are resistant to drought and high temperatures, and for this reason, Triticum crop was one of the most widespread crops in the world [7].

Hordeum vulgare is one of the important cereal crops in Iraq, as it is used in the countries of the world as a fodder crop, either in the form of green fodder or grain, and it has multiple medical uses, as food for diabetics, and is used in the manufacture of vinegar, yeast, and bread. to grow it [8]. The cultivation of H. vulgare is one of the most widespread grain crops, due to its ability to ripen quickly and at different degrees. Although it grows in conditions similar to wheat, it is more cold-tolerant and grows in subtropical conditions, where the climate is hotter and drier than the temperate regions.

Vegetable crops are extremely important, as they come after grain crops in terms of their nutritional importance, as they contain a large percentage of carbohydrates that are stored in the plant in the form of starch or the form of sugar. They are also distinguished by their high percentage of vitamins and mineral salts that humans need in their diet [9], and affects vegetables by a group of natural factors, including climate, as it affects the distribution of crops. The decrease, even if there is an increase in yield or productivity, does not represent the real increase in production, because this increase is the result of modern methods of agricultural operations and the use of good varieties, i.e. the use of technologies that reduce the impact of climate change, and this is thus reflected in production costs [10].

2. Working Methods

Climate information and the yield and productivity of the crops used in this research were collected based on the information of the General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, 2022, as well as on the Department of Meteorology and Seismic Monitoring, Al-Hussein Neighborhood in Basra Governorate, and the Directorate of Agriculture in Basra Governorate. Planning Department.

As the general rates were taken for each time period, which consists of 11 years, with four periods from 1983 to 2022, which included (1983-1994, 1994-2005, 2005-2026, and 2016-2022).

3. Results and Discussion

Figure (1) shows the rates of change in the minimum temperatures and the trend line, as it was observed that the minimum temperature varied between 14 °C and 15 °C for the two time periods 1983-1994 and 2016-2022, respectively, and this shows that as the years progressed, the temperatures increased, as shown by the line The trend is from low to high, and this increase negatively affects agricultural crops, whether they are vegetables, grains, trees, or other crops.

Also, the average maximum temperatures were highest in the period 2016-2022 at a rate of 27.6 °C, and the trend line was upward from the lowest period to the highest period of time, as the maximum temperature recorded for the lowest period of 1984-1994 was 25.77 °C, with a difference between the two periods by about 2 °C. A large temperature will greatly affect most crops, especially summer.

It is clear from this that the minimum temperatures tend to rise during the study period, and that this rise will affect the plants as it leads to yellowing, which reduces the productivity of some crops. Low temperatures play a major role in agricultural production because of their great impact on the physiological processes in plants, because there is a carrying capacity for some plants, and the low temperature is harmful that threatens the life of the plant, which leads to the emergence of physiological diseases and The increase in temperature affects the increase in the rate of plant loss of water through transpiration or evaporation, which causes the plant to wilt, in addition to its effect on the processes of pollination, flowering and fruiting in the plant. And its rise in the hot months may pose a threat to the physiological processes carried out by the plant and may lead to its death or the emergence of some diseases and pests. This does not mean that all plants cannot bear this rise in temperature. Some plants consider the height a reason for their maturation and increased production[11].

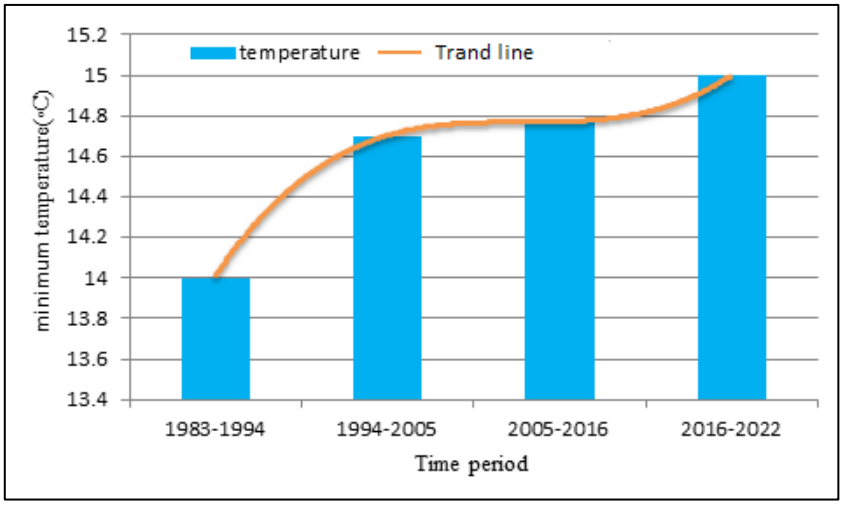

Figure 1. The general average minimum temperatures and the trend line.

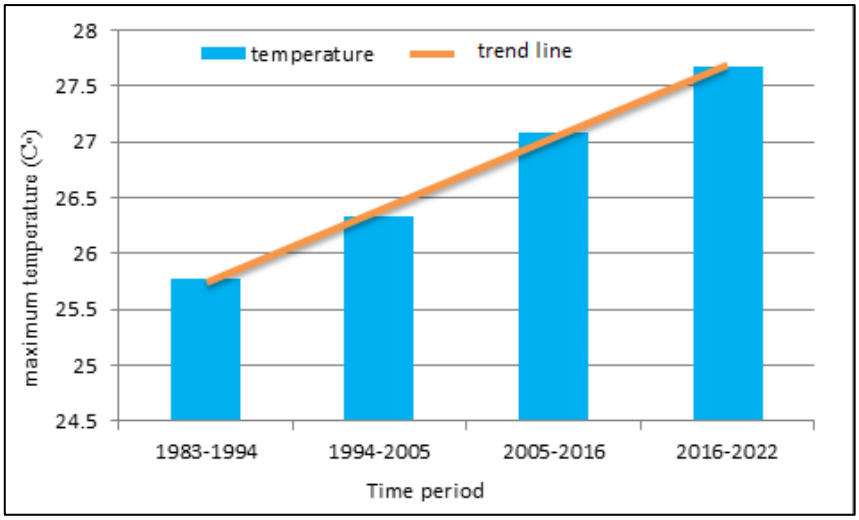

Figure 2. The general mean maximum temperatures and the trend line.

Figures (3 and 4) show the changes in rainfall and humidity rates for the period from 1983 to 1994, as it was observed that the amount of precipitation fluctuated between the study periods, reaching the highest 21.14% for the period 1994-2005, and the lowest amount of precipitation was for the period 2005-2016, which amounted to 12.42%. As for the percentage of humidity, the rates of which were reflected on the basis of the amount of precipitation, the highest was 52.28% for the same period of precipitation, and the lowest was 47.42% for the period 2016-2022, with a fluctuating trend line for the precipitation and humidity factors.

The low and high relative humidity will have a negative impact on various plants, and among these effects is the delay in the growth of most plants if this is accompanied by a rise in temperature. And any decrease in its rates in the hot season will double the amount of irrigation in a way that leads to disruption of life and plant processes, as moisture plays a major role in agricultural production, especially with high temperatures, which constitutes a suitable environment for the spread and development of diseases [12]. The amount of rain has a positive effect on the cultivation of agricultural crops, as the amount of rain that falls during the winter season is stored in the soil and forms a reserve source to meet the plant's need for a period of time not too long. Sufficient rain in the months of December and the second, as it is of great importance for winter crops [13].

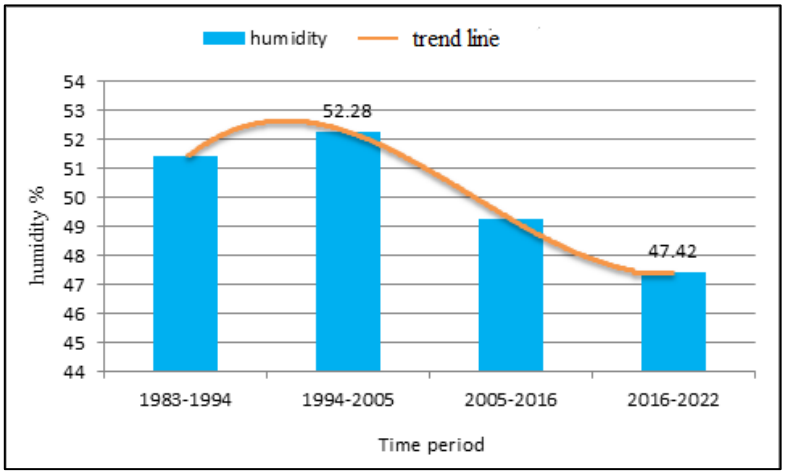

Figure 3. The general average humidity percentage and the trend line.

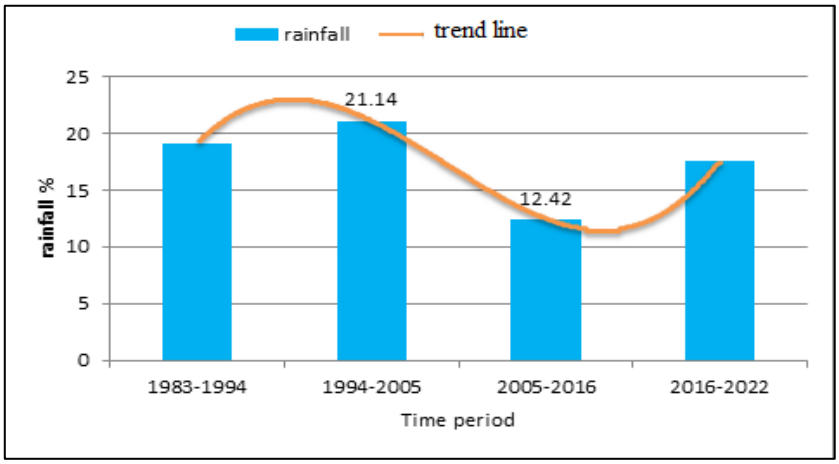

Figure 4. The general average percentage of precipitation and the trend line.

Table (1) shows changes in ideal soil temperature rates for the growth of some agricultural crops the optimum temperature for growth of crops Solanum lycopersicum and Solanum melongena was 29 °C, and for crops Cucumis sativus and Abelmoschus esculentus was 35 °C, and the lowest was 27 °C for crop Citrullus lanatus.

Table 1. Maximum, minimum, and ideal soil temperature for germination of summer vegetable crops (°C).

Vegetable crops	Temperature (°C)		
	Ideal	Highest	Lowest
Solanum lycopersicum	29	35	10
Solanum melongena	29	35	15
Cucumis sativus	35	40	15
Abelmoschus esculentus	35	40	15
Citrullus lanatus	27	40	15

3.1. The Yield

Figure (5) shows the rates of change in the yield of T. aestivum and H. vulgare during the studied period, as it was noted that the highest yield was in the period 2016-2022, which amounted to about 341083 and 191917 kg, respectively, and the lowest was 19557 and 20272 kg for the two periods 1983-1994 and 1994- 2005 respectively. The reason for the increase in crop yields despite the deterioration of environmental conditions may be due to several things, including the production of varieties that are resistant to high temperatures and lack of rain, as well as the use of modern technologies in plowing and cultivating the land and modern irrigation methods, as well as genetically hybrid seeds, good fertilizers and pesticides.

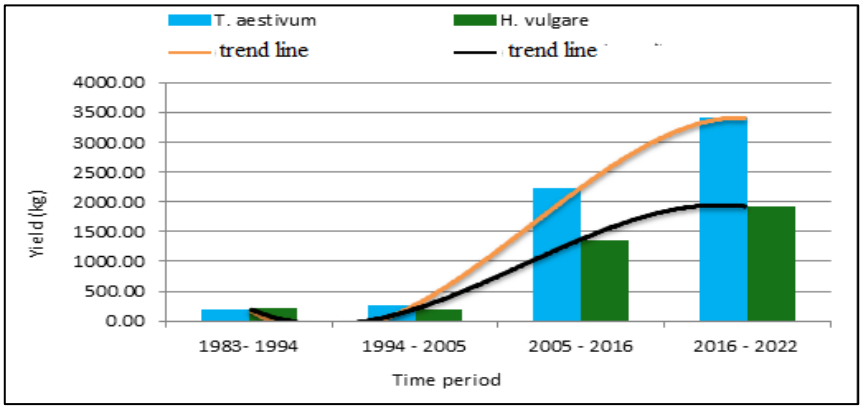

Figure 5. Changes in the yield rate of T. aestivum and H. vulgare crops during the studied time periods.

The results of figures (6 and 7) show the change in the yield rates of the studied agricultural crops, including S. lycopersicum, during the studied time periods from 1983 to 2022, as it recorded the highest rate of 110500 kg for the period 2016-2022. The crop of S. melongena also recorded the highest yield, amounting to 40250 kg for the same period. Its cause is due to the modern techniques used in agriculture, including hybrid seeds that are resistant to the harshest conditions, modern irrigation methods, available fertilizers of all kinds, the plant's needs, and modern mulching methods to preserve these crops.

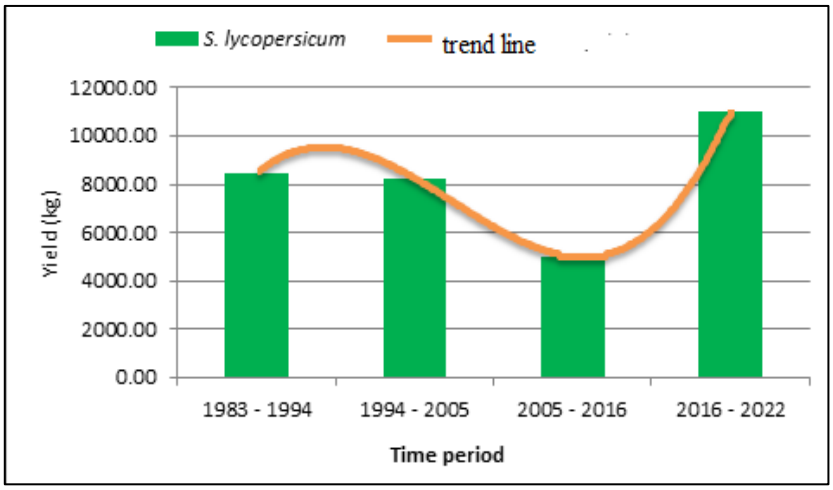

Figure 6. Change in yield rates of S. lycopersicum crop during the studied time periods.

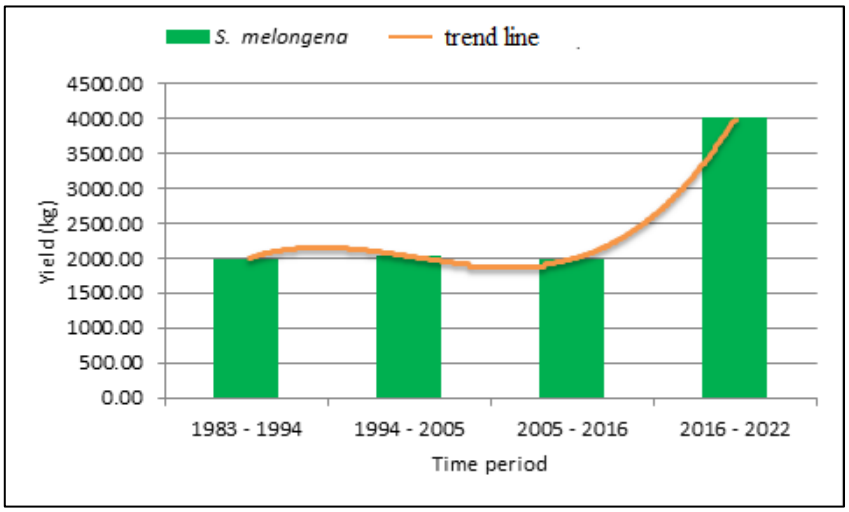

Figure 7. Change in yield rates of S. melongena crop during the studied time periods.

As for the two crops, *C. lanatus* and *C. sativus*, they recorded the highest yields of 2000.1 and 9067.5 kg for the periods 1990-2016 and 2016-2022, respectively, while the lowest yield was 1987 and 2581.82 kg for the periods 2016-2022 and 1983, respectively. (Fig. 8 and 9).

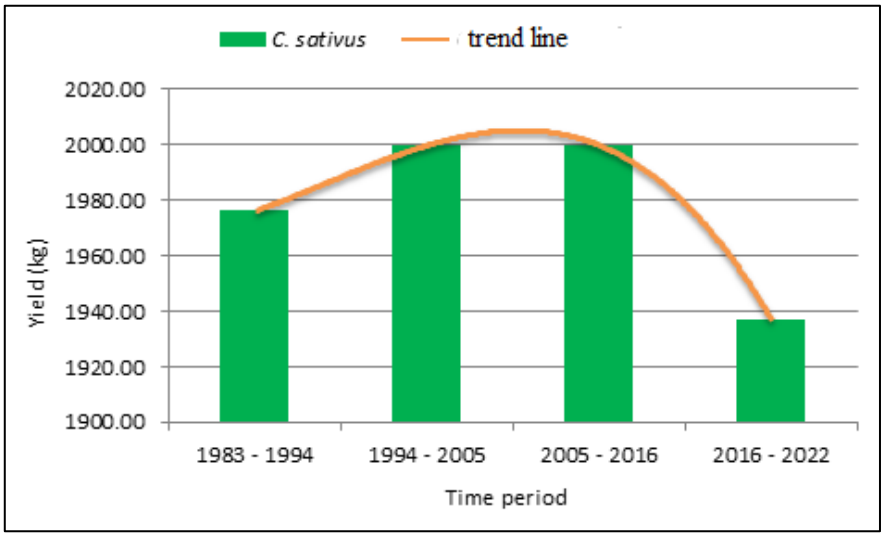

Figure 8. Change in yield rates of C. sativus crop during the studied time periods.

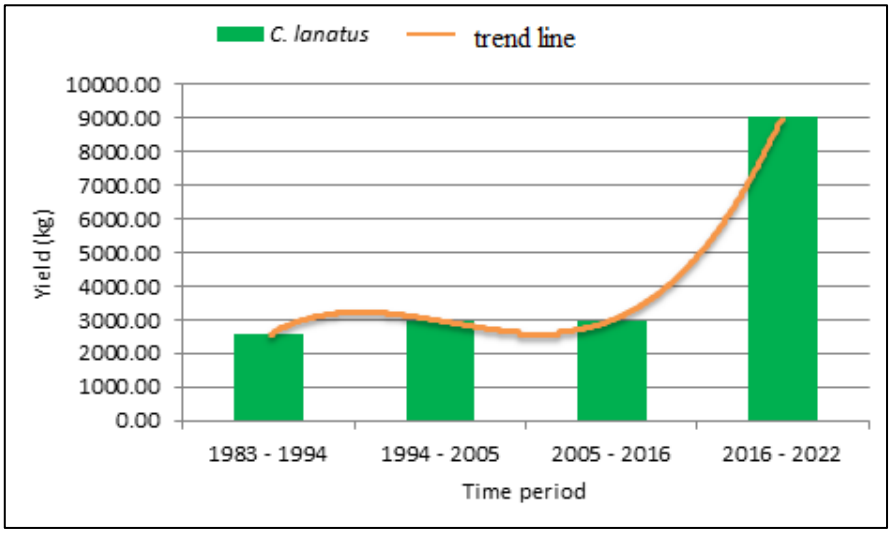

Figure 9. Change in yield rates of C. lanatus crop during the studied time periods.

3.2. Productivity

Figure (10) shows the rate of changes in the productivity rates of grain crops, namely T. aestivum and H. vulgare, during the studied period, The highest productivity of wheat and barley crops amounted to about 4,366,714 and 521,762 tons for the period 2005-2016, respectively, and the lowest was recorded in the period 1983-1994 for the two crops as well, which amounted to 106,223 and 67,882, respectively.

Figures (11, 12, 13, 14 and 15) show the annual changes in the productivity rates of S. lycopersicum, S. melongena, C. sativus, A. esculentus, and C. lanatus during the study periods, as they recorded the highest productivity for 23,185,143 and 2437.09 tons for the period 2016-2022 and 1994-2005, respectively. As for the two crops of A. esculentus and C. sativus was the highest productivity of 4633467 and 1857167 tons, respectively, in 2016-2022, and the lowest 278414 and 274427 tons, respectively, in the time period 1983-1994, while C. lanatus was the highest and lowest productivity of 1274300 and 312445 tons for the two periods 2016-2022 and 1994-2005 respectively. The reason may be because most agricultural crops, whether they are grains or vegetables, have the best temperature for their growth to be (15-35 ° C), and at a temperature less than (15 ° C), growth stops, which leads to falling and death of flower buds, as well as stopping the vegetative growth of these plants. Hence the low amount of production [9].

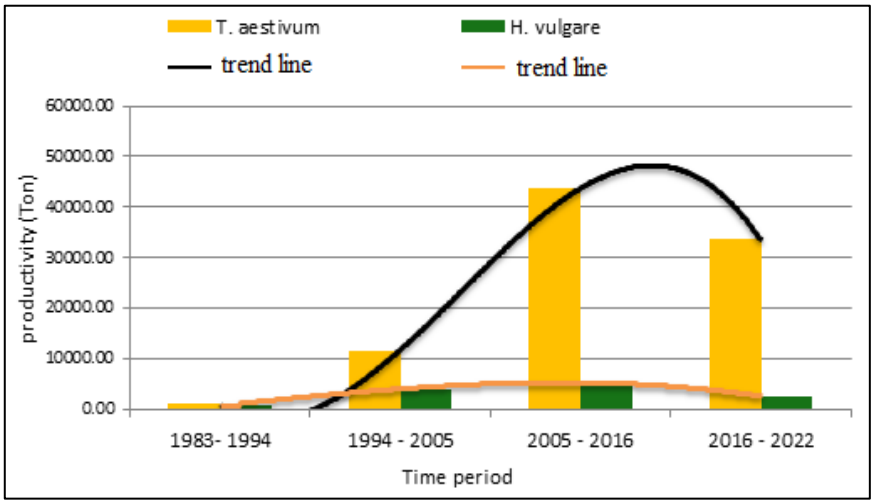

Figure 10. Changes in the productivity rate of T. aestivum and H. vulgare crops during the studied time periods.

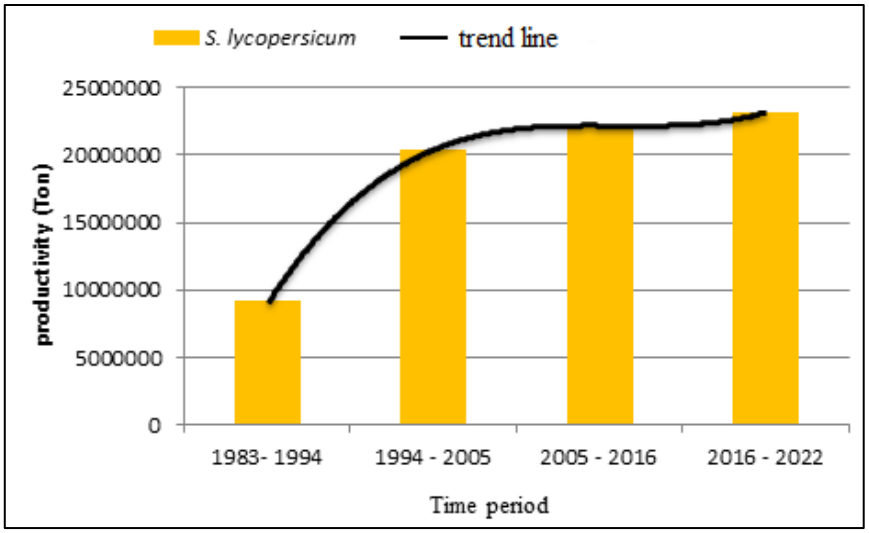

Figure 11. Change in the productivity rates of the S. lycopersicum crop during the studied time periods.

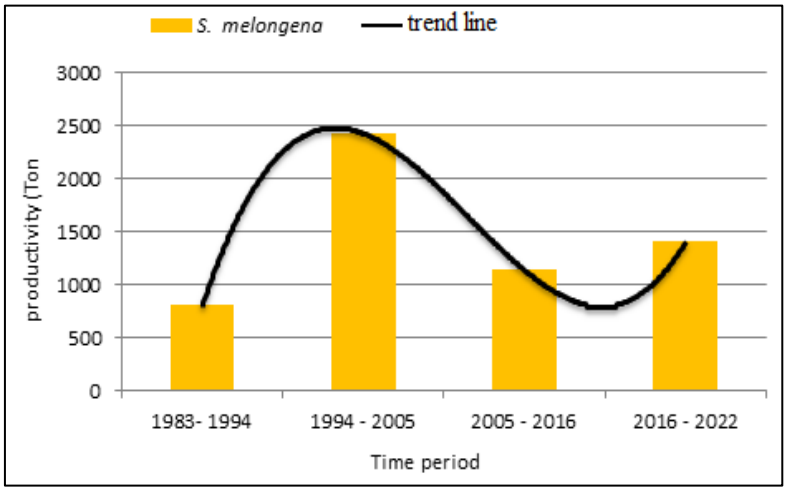

Figure 12. Change in the productivity rates of the S. melongena crop during the studied time periods.

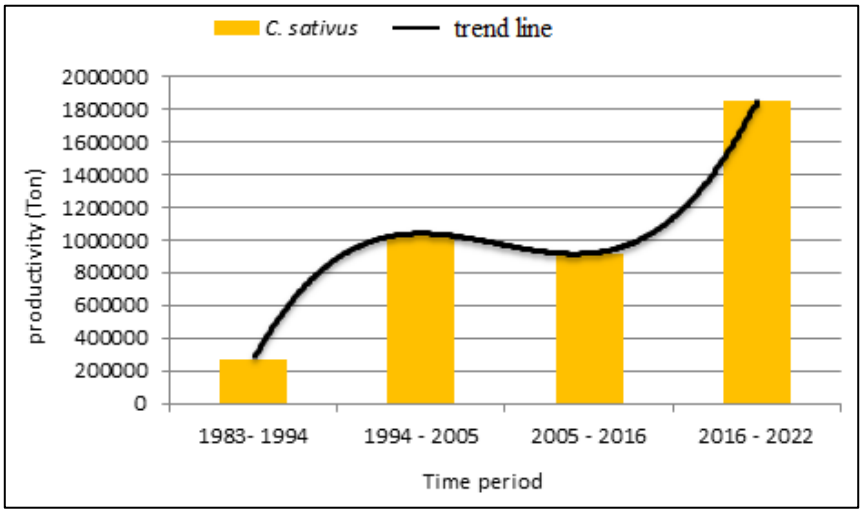

Figure 13. Change in the productivity rates of the C. sativus crop during the studied time periods.

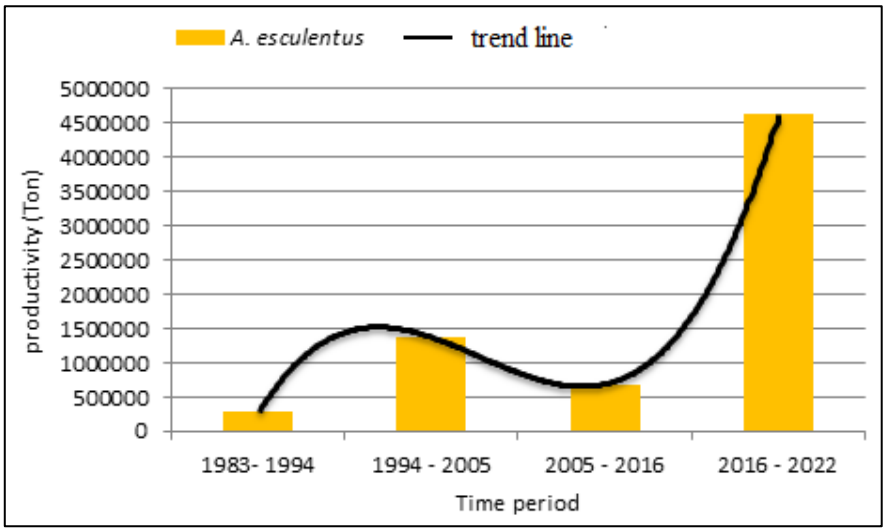

Figure 14. Change in the productivity rates of the A. esculentus crop during the studied time periods.

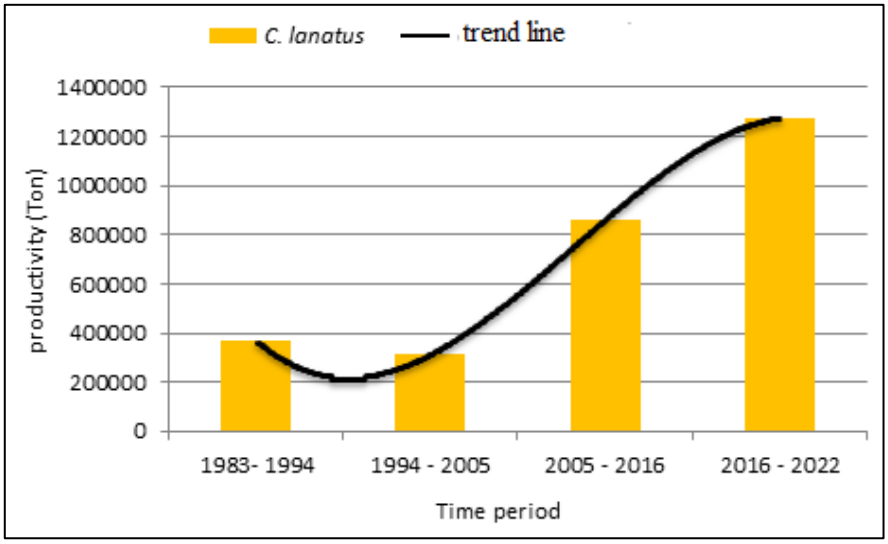

Figure 15. Change in the productivity rates of the C. lanatus crop during the studied time periods.

3.3. The Relationship Between the Crop Yield Rate Per Cycle and Climate Changes

It is clear from Table (2) that there is a correlation relationship with *T. aestivum* yield, as it is negative with the minimum and maximum temperatures at a rate of (-0.06), which is a very weak inverse correlation, while it is noted that there is a very weak direct correlation relationship with both evaporation at a rate of (0.09), and humidity at a rate of (0.12), while it is clear that there is a strong direct correlation with the rain element at a rate of (0.84). High temperature affects the speed of germination, affects the branches and small leaves, and reduces the number of ears. In addition, it leads to an increase in deep ears and affects pollination and fertilization rates (Rashid, 1981)[13]. Climate changes play a role in the decline in wheat crop yields, as more than (60%) of the areas cultivated with *T. aestivum* depend on perpetual agriculture, as the fluctuation and interruption of rain leads to the destruction of large areas of crops and the failure of seeds to germinate and thus a decrease in yields (Rashid, 1981)[13].

It is noted from Table (2) that there is a weak and negative inverse correlation of *H. vulgare* productivity with evaporation at a rate of (-0.03), while the correlation relationship with the moisture element reached a rate of (0.00), meaning there is no correlation, while it is noted that there is a direct correlation relationship. Weak with both rain (+0.38) and temperature (+0.44). As is known, plants are exposed to wilting or death during extreme heat waves. Therefore, plants must be compensated for the rise in temperature by increasing their water rations to compensate for the shortfall caused by high evaporation/transpiration values (Shubbar and Al-Moussawi, 2016)[14]. Cereal crops need large quantities of water at the beginning of their cultivation, so they are planted when the rainy season begins. However, when they begin to produce ears, they need moderate or relatively high temperatures to mature, and humidity is not preferred because it causes fungal diseases in the ears, thus reducing the yield or lack of grains.

It is clear from Table (2) that the yield of the *S. lycopersicum* crop has a weak direct correlation with the maximum and minimum temperature components at a rate of (+0.45), while the relationship with the rain and evaporation components is a very weak direct relationship with a ratio of (+0.11) for both of them, respectively, and there is no correlation with the relative humidity element, as its value reached (0.00). High temperatures lead to the formation of wide, dark green leaves, and thick stems, while when they drop below (10°C), growth stops. *S. lycopersicum* does not set fruits at low temperatures below (12°C) due to the death of the pollen grains, which leads to failure to complete. The process of pollination and fertilization of flowers, and its cultivation is best when there is a humidity level of (60-65%). High humidity causes many damages, such as the spread of fungal diseases and a lack of absorption of nutrients, especially calcium, as a result of a lack of transpiration, which leads to the appearance of blossom-end rot disease on the fruits, in addition to a lack of Contractions, but with good ventilation, the spread of these diseases can be reduced. The climatic changes witnessed in the study area played a role in causing negative changes in the yield of *S. lycopersicum*, as the rise in temperature rates above the upper limits of its growth (37°C) led to a decrease in its yield. Temperatures have a significant impact on the physiological processes of plants, and their effect varies according to the life stage of the plant, such as its effect on seed germination and vegetative growth (Al-Fadhli, 2008)[15]. The rise in temperature makes the fruits of *S. lycopersicum* more juicy compared to species that grow in cold regions (Abdel-Al *et al*. 1975)[16].

Also, the yield of *S. melongena* was associated with a weak or strong positive relationship with all the elements studied (Table 2). Temperature plays a major and influential role in the yield of *S. melongena* as it is the determining factor for the failure or success of agricultural crops because it determines the physiological processes and that the appropriate temperature for the crop Eggplant is at 36°C where the plant can give the best productivity, as the study area witnessed high temperature rates, which affects the rate of water loss from the plant, especially if the relative humidity in the air is low and in the process of photosynthesis, and the temperature is (15°C). The best minimum level within which the crop grows vegetative, and the crop is affected by the night temperature falling below (10°C), as fruit setting weakens and the effectiveness of pollen decreases (Abdel-Al *et al*., 1975)[16]. While the germination rate is low (about 18-20 days) when the daytime temperature drops below (13°C), as it leads to heterogeneity in fruit set, distortion of pollen grains, and irregular formation of fruits. When

the temperature continues to drop, it will lead to the fall of flowers and leaves. And the destruction of the crop, (Hassan, 2001)[17].

The yield of *A. esculentus* was associated with a weak inverse correlation with the minimum and maximum temperature at a rate of (-0.47). As for the rest of the elements, the relationship was direct (Table, 2). The reason may be that *A. esculentus* needs a hot atmosphere for the purpose of vegetative growth, and the degree The temperature (18°C) is the most appropriate minimum during which the crop grows, and this does not mean that it cannot tolerate any negative deviation from that temperature. That is, it is not necessary that a drop in temperature below this limit lead to the death of the crop permanently, but rather this negatively affects its natural growth process. It causes harm in terms of delaying germination and slow growth, which leads to its stunting and failure to bear fruit (Rasool et al., 1986)[18]. When the temperature continues to drop below (10°C) for a long period, this will affect the growth of leaves and flowers, and the resulting pods will mature in an irregular shape. When the temperature drops below (5°C), growth stops completely, and when the decrease continues, they die (Abdel-Al, 1975)[16] .

It is clear from Table (2) that the irrigation crop has a very weak direct correlation with both the minimum and maximum temperatures at a rate of (+0.22) for both, then with evaporation at a rate of (+0.25), while the relationship was weakly positive with rain. (+0.38) as well as evaporation (+0.31). Raglan is considered one of the crops that is sensitive to cold, as it is affected by frost and its vegetative and fruit growth decreases, and sometimes it leads to the death of the crop. The minimum temperature suitable for its growth is (18°C), and if it falls below that limit, seed germination may be delayed, and if it falls below zero degrees Celsius, the seeds She dies (Kelly, 1985)[19]. If the temperature drops between (5-10°C) at the beginning of its vegetative growth, the plant's growth stops, leading to the crop being stunted and the fruits growing deformed (Al-Masoudi, 2007)[20].

The *C. lanatus* crop has a very weak positive correlation with all the climate elements studied, which are the minimum and maximum temperatures, humidity, evaporation, and precipitation (Table 2). It is considered *C. lanatus* is one of the crops that is sensitive to cold, as it is affected by frost and its vegetative and fruit growth decreases, sometimes leading to the death of the crop. The minimum temperature suitable for its growth is (18°C), and if it falls below that limit, seed germination may be delayed, and if it falls below zero degrees Celsius. If the temperature drops between (5-10°C) at the beginning of its vegetative growth, the plant's growth stops, leading to the crop being stunted and the fruits growing deformed (Al-Masoudi, 2007) [20].

Table 2. Correlation between yield/kg of cereal crops and climatic elements.

Climatic requirements / The crop	**Temperatures great (C◦)**	**Temperatures minor (C◦)**	**Rainfall/ml**	**Humidity %**	**Evaporation**
Triticum aestivum	0.06-	0.06-	0.84	0.12	0.09
Hordeum vulgare	0.44	0.44	0.38	0.00	0.03-
Solanum lycopersicum	0.45	0.45	0.11	0.00-	0.11
Solanum melongena	0.27	0.27	0.35	0.27	0.20
Abelmoschus esculentus	0.47-	0.47-	0.98	0.57	0.70
Cucumis sativus	0.78	0.78	0.08	0.79	0.77-
Citrullus lanatus	0.22	0.22	0.38	0.31	0.25

Conclusions

Through the results, a discrepancy was found in the appropriate growth requirements for the growth of crops in line with the need of the crops or their inadequacy such as temperature, rainfall and relative humidity area, which greatly increased production.

References

[1] Al-Awda AAS, Mukhlis S, Al-Tamimi OA 2014 Arab J of Arid Environments, 7 (1-2): 6-17.
[2] Ajeel W M 2022 University of Al-Qadisiyah, Maysan Research Journal, 36 (18): 191-235.
[3] Al-Asadi K AW, Yassin B R, Al-Amoud F A F 2019 J of the College of Education for Human Sciences, Dhi Qar University, 9(1): 991-940.

[4] Al-Dulaimi M D A 2011 Anbar University Jl of Human Sciences, 4 (2): 10-18.
[5] Hamza S A 2013 Maysan University J for Academic Studies 12 (23): 377p.
[6] Maatouq S S 2015 Maysan Research J 11(21): 238-246.
[7] Al-Jassim K A H 2019 341p.
[8] Al-Farij LM, Al-Obaidi R H, Al-Zirgawi M AR 2015 Dhi Qar University J of Agricultural Research 2 (4): 313-324.
[9] Al-Amoud F A F 2015 PhD thesis, College of Education for Human Sciences, University of Basra, 436 p.
[10] Amer SJ 2017 Thesis, College of Education, Ibn Rushd, Baghdad 363p.
[11] Sayed, M A J 2017 master thesis Basra Univ. College of Education for Human Sciences 350 p.
[12] Al-Ani K S 1988, College of Education, University of Baghdad 467p.
[13] Fadih S A 2013 Master Thesis College of Education for Human Sciences Univ. of Basra.
[14] Saeed, Kamel, Irfan Rashid, 1981, Al-Wissam Offset Press, Baghdad.
[15] Al-Mousawi, AS, Muhannad, K S 2016, Journal of Kufa Studies, No. 41.
[16] Al-Budairi, WMA, 2008, Master's thesis, College of Arts, Al-Qadisiyah University.
[17] Abdel-Al Z, Al-Sayed M, Al-Shall, Abdel-Aziz Khalafallah, Muhammad AQ, Al-Khader Al-Intag, 1975 Part 2, New Publications House, Alexandria,.
[18] Al-Hassan, AJM, 2001, Master's thesis, College of Arts, University of Basrah,.
[19] Rasool, T N Abdullah S A, Karim SA, 1986, Dar Al-Kutub Directorate for Printing and Publishing, University of Mosul,.
[20] Al-Khafaji, MA, Al-Mukhtar FA H, 1989, House of Wisdom.