

# THE EFFECT OF CLIMATE CHANGE ON CHANGING THE GROWING SEASON OF RICE CROP IN IRAQ

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DOI: 10.17605/OSF.IO/XT8WC

## Abstract

Aim of the study is to Calculate the length of the climatic growth season by feeding the graphic figures prepared with the program (Excel) with the data of the upper and lower limits for the cultivation of agricultural crops and the monthly averages of minimum and maximum temperatures. Climatic growth season determination Based on the intersection of the minimum and maximum temperatures with the upper and lower limits of the studied crops each station fo reach climatic cycle. The actual growth season will determine its beginning according to the prevailing custom and on the experience of the farmer and the inheritance of information through generations in the study area for the cultivation of field crops, while its end determined by compeleting the requirements for each crop of accumulated heat according to the minor climatic cycles for each station of the study area

## INTRODUCTION

The study of the length of the growth season and the amount of heat units accumulated during it, the most modern studies in recent years where climate and plant scientists have begun to pay special attention to them in their various researches, and this method is characterized by being based on agreed principles of climatology and botany and possibility of its applied on climatic and exhaustive studies, Every plant needs in order to grow and mature, to a number of thermal units that accumulate during its life above the minimum limit at which the crop begins to grow above zero growth. <sup>(1)</sup> And every plant needs sum of days which should not average temperature be reduce below zero growth.

**(growth season)**It is the time period the crop need to complete the growth and ripening of the fruits from the stage of sowing the seed until the ripening of the fruits, a number of researchers agree that most of the plants that grow in temperate regions begin their growth in early spring when the daily average of temperature rises to (6 °C).<sup>(2)</sup> It is not very different to define agronomists for the growth season where They explained that it is the period of time required by the crop to complete all stages of its growth from the sowing stage to the harvest stage.<sup>(1)</sup> Or they define it as a period of time ranging from the time of sowing to the time of harvest minus the period of climatic deviations that occur in the climate elements suitable for cultivating the crop during its growth period.<sup>(2)</sup> As for the length of the growth season, it varies from one place to another and from one year to another according to the prevailing climatic characteristics.<sup>(3)</sup>

The ideal growth season is the one that provides the thermal energy or heat units needed by the plant in its growth stages from sowing seeds to harvesting fruits <sup>(4)</sup>.

### **First: Determination of the growth season of rice crop for the five minor cycles**

According to Tab (1) and Figures (1) (2) (3) (4) (5) the rice crop in all stations of the study area, except Zakho, recorded a decrease in its length of growth season and according to the climatic cycles, as follows:

#### **1. Zakho**

It was not possible to determine the growth season for the rice crop in Zakho station because of unavailability of suitable accumulated temperatures for the crop, which amounted to (2800 C°) The length of the growing season extending from the beginning of May to the end of October.

#### **2. Erbil**

The second cycle of the actual growth season in Erbil station, which is (188 days), is the longest period for the rice crop growth season between the climatic cycles, while the accumulated temperature reached (2763 C°) and a climatic growth season (190 days), and in the third cycle the actual growth season reached (185 days) and accumulated temperature (2801 C°) While the climatic growth season reached (189days), in the fourth cycle, the growth season was recorded (180 days), with a difference of (8 days) less than the second cycle and (5 days) less than the third, while the accumulated temperature reached (2805 C°) and the climatic growth season (195 days), and the fifth cycle recorded the shortest period for the actual growth season between the climatic cycles of Zakho Station (163 days), with a difference of (25 days) from the second cycle, (22 days) from the third cycle (17 days) from the previous cycle, while the accumulated for this cycle reached (2807 C°) and the climatic growth season (202 days).

#### **3. Sulaymaniyah**

The actual growth season in the Sulaymaniyah station is similar to the second cycle in the Erbil station, the actual growth season was determined according to the accumulating temperature needed by the rice crop, so the Sulaymaniyah station recorded a duration for the actual growth season in the second, third, fourth and fifth cycle, which amounted to (170, 177, 183, 170 days) respectively, the accumulated temperature determined on the basis of the actual growth season was recorded between each of the climatic cycles, and it was recorded in the second cycle (2552 C°) and in the third cycle (2580 C°) While in the fourth and fifth cycle, values closer to the crop requirement were (2756, 2736 C°), As for the climatic growth season recorded (186, 178, 183, and 183 days), respectively, for the four cycles

**Tab 1: Actual growth season and climatic growth season of rice crop for minor climatic cycles in Iraq**

station name	climatic cycles		beginning of a season climatic growth	End of season climatic growth	length of the growing season climatic (day)	The beginning of the actual growth season	The end of the actual growth season	Actual growing season length (day)	Accumulated tem(c°)
Zakho	Third cycle	1998-1988	May 5th	September 22nd	140				
	Fourth cycle	2009-1999	April 12th	October 11th	182				
	Fifth cycle	2010-2020	Apr-02	October 14th	195				
Erbil	Second cycle	1987-1977	April 8th	October 15th	190	April 9th	October 14th	188	2763
	Third cycle	1998-1988	April 9th	October 15th	189	April10th	October 12th	185	2801
	Fourth cycle	2009-1999	April 5th	October 16th	195	April12th	October 4th	180	2805
	Fifth cycle	2010-2020	April 1st	Oct-20	202	May-01	October 6th	163	2807
Sulaymaniyah	Second cycle	1987-1977	April 13th	October 16th	186	April 1st	October 14th	183	2552
	Third cycle	1998-1988	April 18th	October 13th	178	April 1st	October 12th	177	2580
	Fourth cycle	2009-1999	April 11th	October 11th	183	April 1st	October 4th	175	2756
	Fifth cycle	2010-2020	April 8th	October 9th	183	April 1st	October 7th	170	2736
Mosul	The first cycle	1976-1966	01-Apr	October 25th	208	April 6th	22October thefirst	190	2803
	Second cycle	1987-1977	14-Apr	27-Oct	196	10Nissan	24October thefirst	187	2804
	Third cycle	1998-1988	March 19th	October 20th	205	12-Apr	18October thefirst	189	2800
	Fourth cycle	2009-1999	April 1st	2October 4th	207	12-Apr	10-Oct	181	2808
	Fifth cycle	2010-2020	April 1st	28-Oct	211	10-Apr	06-Oct	179	2801
Paiji	Second cycle	1987-1977	April 1st	October 9th	191	May 5th	October 7th	159	2804
	Third cycle	1998-1988	April 1st	October 13th	195	May 4th	October 6th	154	2804
	Fourth cycle	2009-1999	March 25th	October 13th	202	May 13th	October 4th	144	2801
	Fifth cycle	2010-2020	March 20th	Oct-21	215	May 14th	October 10th	149	2802
Khanaqin	The first cycle	1976-1966	April 6th	October 8th	185	April 21st	06-Oct	168	2801
	Second cycle	1987-1977	April 1st	October 13th	195	May-01	October 10th	154	2802
	Third cycle	1998-1988	Apr-02	October 14th	195	10NoneR	12-Oct	155	2801
	Fourth cycle	2009-1999	March 19th	October 18th	213	May 20th	October 10th	143	2804
	Fifth cycle	2010-2020	March 20th	October 18th	212	May 23rd	October 4th	134	2811
Baghdad	The first cycle	1976-1966	March 31st	October 9th	192	April14th	Oct-02	161	2803
	Second cycle	1987-1977	March 27th	October 6th	193	April26th	03-Oct	160	2808
	Third cycle	1998-1988	March 25th	October 12th	201	03-May	October 8th	158	2806
	Fourth cycle	2009-1999	March 19th	October 13th	208	May 11th	October 6th	148	2812
	Fifth cycle	2010-2020	March 20th	October 17th	211	May 13th	Oct-03	143	2803
Ramadi	Third cycle	1998-1988	March 28th	October 15th	201	April 8th	October 8th	183	2804
	Fourth cycle	2009-1999	March 22nd	October 14th	206	April27th	October 19th	166	2815
	Fifth cycle	2010-2020	March 19th	October 26th	221	May 10th	October 10th	153	2801

Hay	The first cycle	1976-1966	March 19th	October 18th	213	May 16th	October 15th	152	2808
	Second period	1987-1977	March 13th	Oct-22	223	May 26th	October 12th	139	2820
	Third cycle	1998-1988	March 12th	October 30th	232	Jun-01	October 13th	135	2801
	Fourth cycle	2009-1999	March 6th	Oct-23	231	June 5th	October 10th	129	2809
	Fifth cycle	2010-2020	Mar-01	October 28th	241	June 4th	October 8th	125	2801
Najaf	The first cycle	1976-1966	March 18th	21 see the first	217	May 18th	October 12th	147	2824
	Second cycle	1987-1977	March 16th	October 19th	217	May 22nd	October 13th	144	2803
	Third cycle	1998-1988	March 14th	October 25th	226	May 26th	October 20th	147	2822
	Fourth cycle	2009-1999	March 7th	Oct-23	230	Jun-01	October 15th	137	2819
	Fifth cycle	2010-2020	Mar-03	Oct-29	240	22juryn	27-Oct	127	2811
Diwaniyah	The first cycle	1976-1966	March 19th	October 17th	212	May 8th	12-Oct	157	2823
	Second cycle	1987-1977	March 17th	October 18th	215	May 17th	October 9th	145	2805
	Third cycle	1998-1988	March 13th	October 26th	227	May 11th	October 12th	153	2805
	Fourth cycle	2009-1999	March 10th	Oct-22	226	Jun-01	October 17th	139	2808
	Fifth cycle	2010-2020	March 6th	October 25th	233	June 4th	October 16th	134	2800
Nasiriah	The first cycle	1976-1966	March 12th	October 25th	227	20-May	21-Oct	154	2823
	Second period	1987-1977	March 12th	October 19th	221	May 27th	16-Oct	142	2800
	Third cycle	1998-1988	March 8th	October 25th	231	June 7th	October 24th	139	2812
	Fourth cycle	2009-1999	March 6th	October 25th	233	June 13th	October 20th	129	2801
	Fifth cycle	2010-2020	February 28th	October 30th	244	June 16th	October 20th	126	2800
Amara	Second cycle	1987-1977	March 12th	October 19th	221	May 26th	October 10th	143	2800
	Third cycle	1998-1988	March 11th	October 25th	228	Jun-01	October 16th	138	2806
	Fourth cycle	2009-1999	March 8th	Oct-23	229	June 6th	October 12th	128	2806
	Fifth cycle	2010-2020	March 5th	October 28th	237	June 14th	October 19th	127	2813
Basra	The first cycle	1976-1966	March 8th	October 25th	231	May 10th	October 15th	157	2800
	Second cycle	1987-1977	March 6th	October 26th	234	Jun-01	October 22nd	144	2800
	Third cycle	1998-1988	March 4th	Nov-03	243	June 7th	October 19th	134	2810
	Fourth cycle	2009-1999	February 23rd	Oct-29	248	Jun-10	October 14th	126	2801
	Fifth cycle	2010-2020	February 24th	Nov-02	251	June 18th	October 18th	122	2814

Source:

1. Ministry Transportation, General Authority for Meteorology and Seismic Monitoring, Climate Department, Baghdad, unpublished data
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data

#### 4. Mosul

season of actual growth in the Mosul station witnesses a variation between the climatic cycles, as it was recorded in the first cycle (190 days) and an accumulated temperature suitable for the crop requirement (2803 C°) While the climatic growth season reached (208 days), and in the second cycle, the actual growth season recorded (187 days) and an accumulated temperature of (2804 °C).°While the climatic growth season reached (196 days), the third cycle witnessed the recording of the actual growth season for a period of (189 days) and accumulated temperature of (2797 C°) and climatic growth season (154 days), and the fourth cycle recorded a period of actual growth season that amounted to (181 days), with a difference less than the first cycle (9 days), the second (6 days), and the third (8 days), while the accumulated temperature reached (2808 °C).°As for the fifth cycle, the actual growth season (179 days) was recorded, with a difference less than the fourth cycle by two days and less than the first cycle (11 days), the second (8 days) and the third (10 days), while the accumulated temperature reached (2801 C.°) and the climatic growth season (211 days).

#### 5. paiji

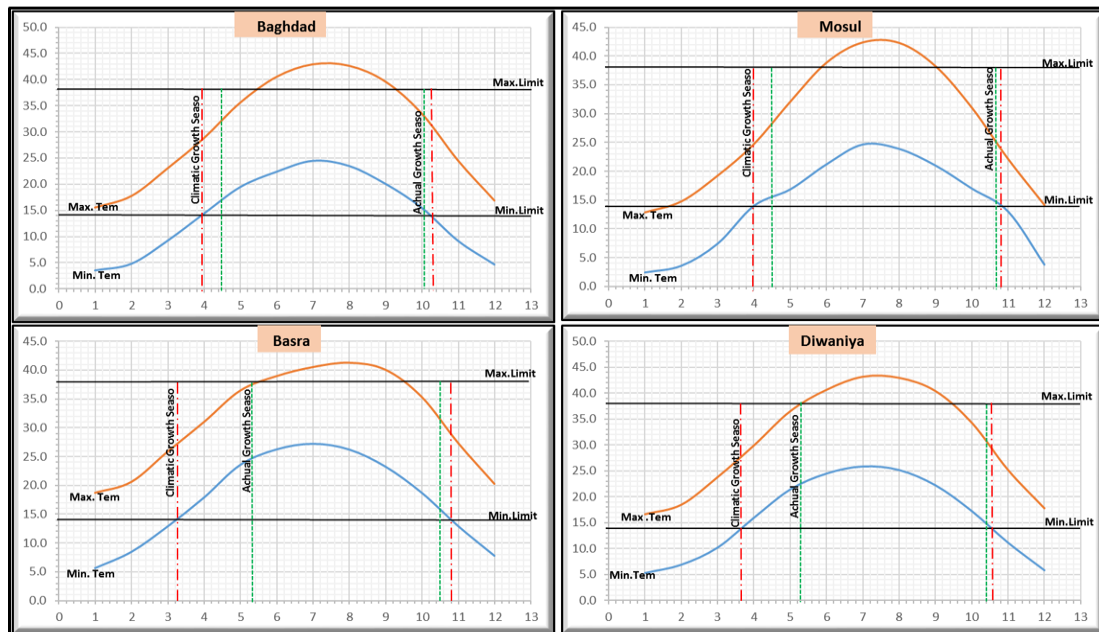
The length of the actual growth season in Baiji station is lower than that of the previous stations, as it recorded in the second cycle a period of (159 days) and accumulated temperature of (2804 C°) While the climatic growth season reached (191 days), and in the third cycle, the actual growth season was recorded (154 days) and the cumulated temperature was (2804 C°) while the climatic growth season reached (195 days), in the fourth cycle the actual growth season reached (144 days), with a difference less than the second cycle (15 days) and the third (10)days, while the accumulated temperature reached (2801 C.°) and the climatic growth season (202 days), and the fifth cycle recorded a longer period for the season of actual growth by five days than the previous cycle, which amounted to (149 days), and an increase from the second cycle by ten days and the third cycle by five days, while the accumulated temperature of the fifth cycle was recorded (2801C°) in the climatic growth season (215 days).

#### 6. Khanaqin

It is clear that the actual growth in Khanaqin station recorded a decrease starting from the first and second cycles, which reached (168, 154 days) respectively, and with accumulated temperature of (2801, 2802 C°) respectively and a climatic growth season (185 and 195 days), respectively. In the third cycle, the actual growth season reached (155 days) and accumulated temperature (2801 C°) and a climatic growth season (195 days), and the actual growth season decreased in the fourth cycle to record (143 days), decreasing from the first cycle (25 days), the second (11 days), and the third (12 days), while the accumulated temperature reached (2804 C°) and the climatic growth season (213 days), and the fifth cycle recorded the shortest period for the growth season (134 days), decreasing from the first cycle (34 days), the second (20 days), the third (21 days), and the fourth (9) days, while the accumulated temperature reached (2811 C°) and the climatic growth season (212 days).



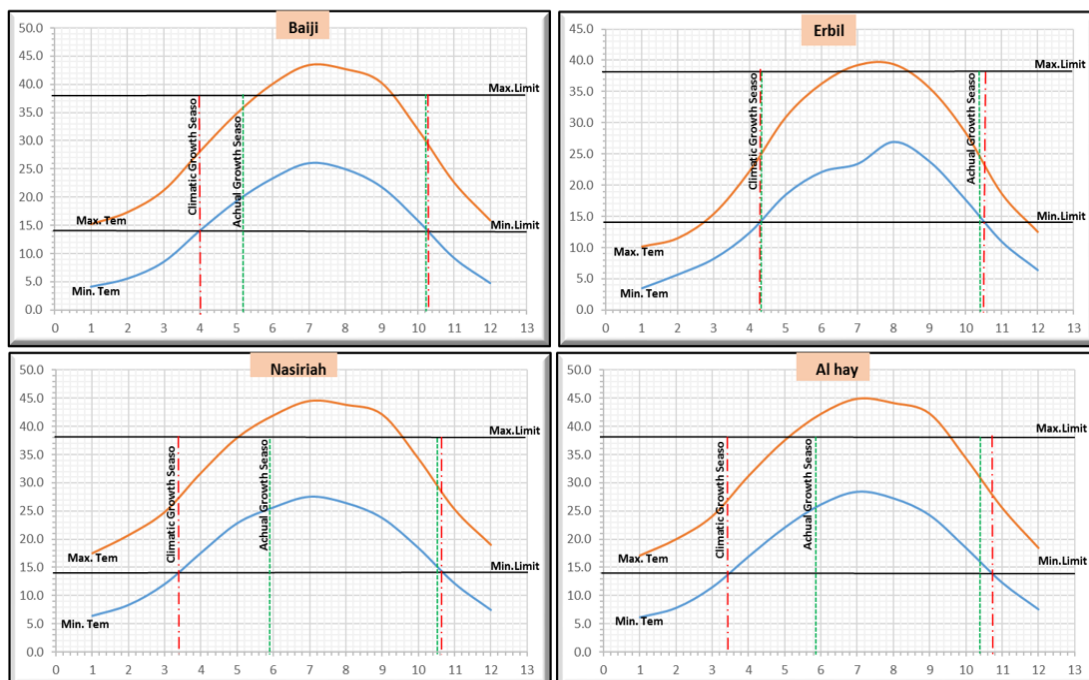
**Fig 1: Actual growth season and climatic growth season of rice crop in Mosul, Baghdad, Diwaniyah and Basra stations for the first cycle (1966-1976)**



Source: according to researcher:

1. Ministry of Transportation, General Authority of Meteorology and Seismic Monitoring, Climate Department, Baghdad, unpublished data.
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data

**Fig 2: Actual growth season and climatic growth season of the rice crop in Erbil, Baiji, Al-Hay and Nasiriah stations for the second cycle of the period (1977-1987)**



Source Accredited researcher:

1. Ministry of Transportation, General Authority Meteorology and Seismic Monitoring, Climate Department, Baghdad, unpublished data
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data.

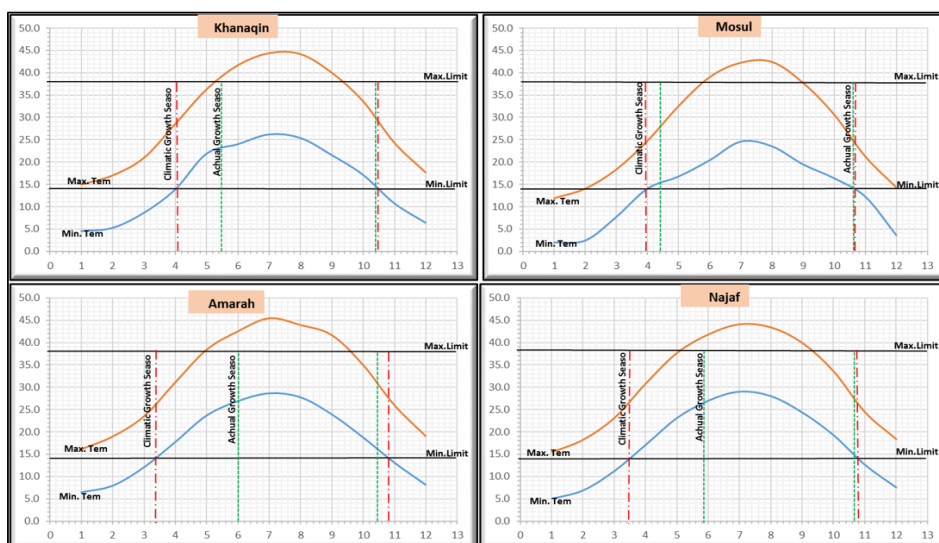
## 7. Baghdad

The actual growth season of the Baghdad station recorded a gradual decrease as it recorded in the first and second cycle a period of (161,160 days) respectively, and a cumulated temperature of (2803, 2808 C°) While the climatic growth season recorded (192,193 days), and in the third cycle, the actual growth season decreased to (158 days) and a cumulated temperature of (2806 C°) and a climatic growth season that reached (201 days), while the fourth cycle had an actual growth season that reached (148 days), with a difference of (13 days) less than the first cycle (12 days) from the second, and (10 days) from the third, while the accumulated temperature reached (2812 C°) and the climatic growth season (208 days) while fifth cycle recorded the shortest period for the actual growth season (143 days), decreasing from the first cycle (18 days), the second (17 days), the third (15 days) and the fourth (5 days), while the accumulated temperature reached (2803 C°) and the climatic growth season (211 days).

## 8. Ramadi

Ramadi station records a longer period for the actual growth season than the Baghdad and Khanaqin stations, as it was recorded in the third cycle (183 days) and a cumulated temperature of (2804 C°) and a climatic growth season (201 days), and in the fourth cycle the actual growth season reached (166 days) with a difference less than the previous cycle (17 days) and with accumulated temperature of (2815 C°) and a climatic growth season that reached (206 days), while in the fifth cycle, the actual growth season was recorded (153 days), with a difference less than the third cycle (30 days) and the fourth (13 days), with accumulated temperature of (2801 C°) and a climatic growth season (221 day)

**Fig 3: Actual growth season and climatic growth season of rice crop in Mosul, Khanaqin, Najaf and Amarah stations for the third cycle (1988-1998)**



Source : researcher:

1. Ministry of Transportation, General Authority of Meteorology and Seismic Monitoring, Climate Department ,Baghdad , un published data .
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data

### **9. Al hay**

the actual growth season in Hay station recorded in the first cycle (152 days) and an accumulated temperature determined on the basis of which the actual growth season amounted to (2808 C°) and a climatic growth season that reached (213 days), and in the second and third cycles the actual growth season recorded (139, 135 days) respectively, with a cumulated temperature of (2801, 2820 C°) respectively and a climatic growth season (223, 232 days), respectively. As for the fourth cycle, the actual growth season reached (129 days), decreasing from the first cycle (23 days), the second (10)days, and the third( six) days, while the accumulated temperature reached (2809 C°) and the climatic growth season (231 days), and in the fifth cycle the actual growth season recorded a decrease from the previous cycles as it reached (125 days) and a decrease from the first cycle (27 days) and from the second (13 days) and from the third nine days and from the fourth four days while the accumulated temperature reached ( 2801 C°) and the climatic growth season (241 days).

### **10. Najaf**

Najaf station recorded a values of the actual growth season closer from Hay station the first, second And the third cycle reached to(147, 142, 147day) respectively and accumulated temperature reached(2824, 2803, 2822C°) while climatic growth season reached to (217, 217, 226day),while fourth cycle the actual growth Season (137day)by a difference(10 )days from the first and third cycles and (7) days from second cycle, As the accumulated temperature reached (2819C°)And the climatic growth season (230day),And in cycle Fifth register higher decrease for actual growth Season in station of Najaf (127day)And decreasing from first and third cycle(20) day and the second about(17day) fourth cycle about (10 days), And the accumulated temperature reached (2811C°)And climatic growth season (240day).

### **11. Diwaniyah**

The length of the actual growth season varies between the climatic cycles at Al-Diwaniya station, as it was recorded in the first, second, and third cycle (153, 145, and 157 days) , respectively, and a cumulated temperature (2823, 2805,2805 C°) While the climatic growth season reached (212, 215, and 227 days), respectively, and in the fourth cycle, the actual growth season reached (139 days) and the cumulated temperature was (2808 C°) and a season of climatic growth reached (226 days), while the fifth cycle was recorded for the season of actual growth (134 days), with a difference less than the first cycle (23 days), the second (11 days), the third (19 days) and the fourth five days, while the accumulated temperature reached (2800 C°) and the climatic growth season (233 days).

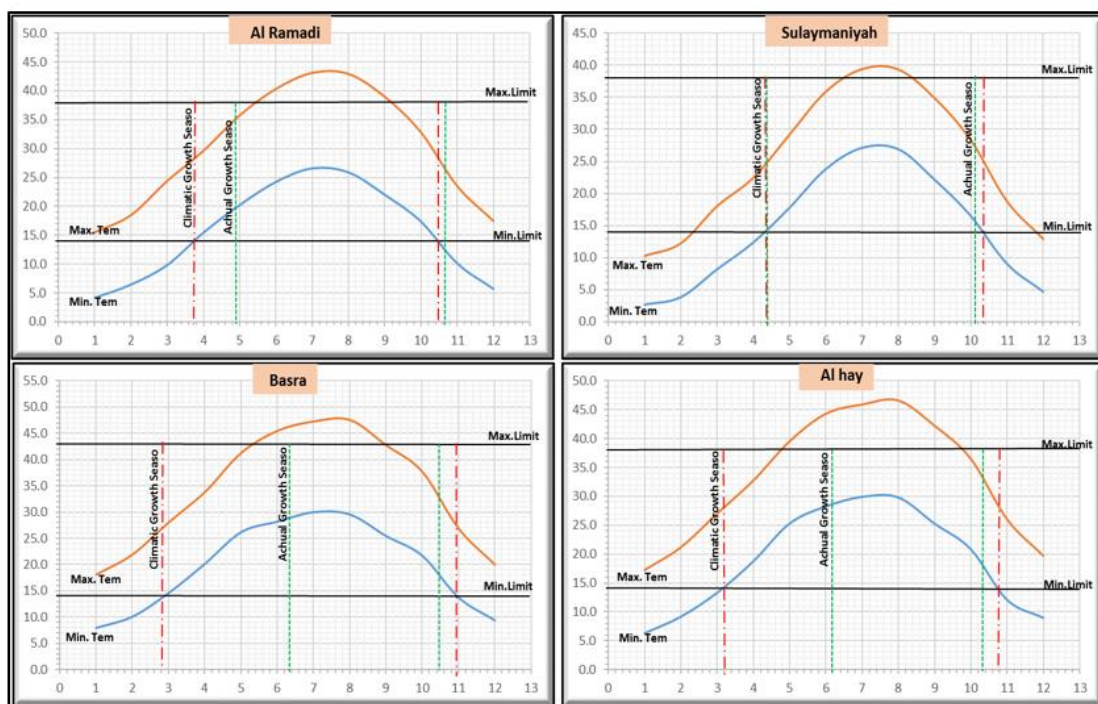
### **12. Nasiriah**

Al-Nasiriah station witnesses a decrease in the actual growth season in its length compared to the previous stations, as it recorded in the first and second cycle a (142,154 days) , respectively, and accumulated temperature of (2800,2823C°) and a



climatic growth season (227 and 221 days) respectively, and in the third cycle the actual growth season decreased to (139 days) and accumulated temperature of (2812C°) While the season of climatic growth reached (231 days), and as for the fourth cycle, the actual growth season recorded (129 days), a decrease from the first cycle (25 days), the second (13 days), and the third cycle (10) days, while the accumulated temperature reached (2801 C°)And the climatic growth season was (233 days), and in the fifth cycle the actual growth season reached (126 days), with a decrease from the first cycle (28 days), the second (16 days), the third (13 days), and the fourth( 3 days), while the accumulated temperature reached (2800 C°)And the season of climatic growth (244 days).

**Fig 4: Actual growth season and climatic growth season of the rice crop in Sulaymaniyah, Ramadi, Al-Hay and Basra stations for the fourth cycle (1999-2009)**



Source : researcher:

1. Ministry of Transportation, General Authority of Meteorology and Seismic Monitoring, Climate Department ,Baghdad , un published data .
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data

### 13. Amara

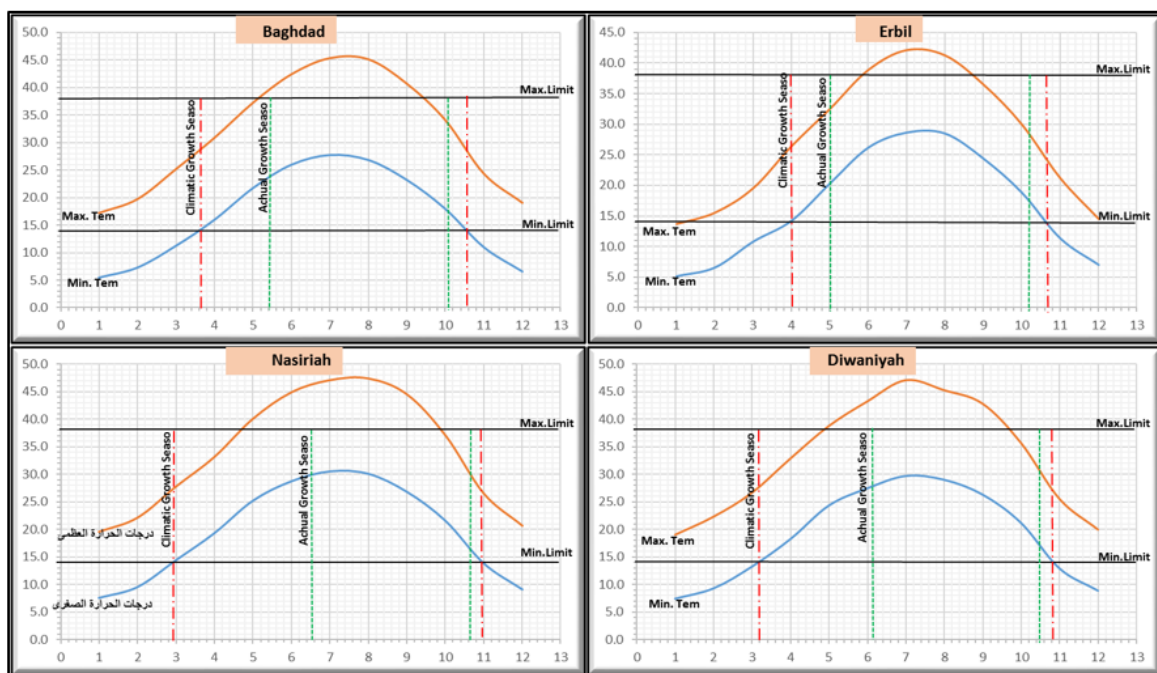
the actual growth season in Al-Amara station recorded values closer to Al-Nasiriyah station, as it was recorded in the second and third cycles (143, 138 days) and a cumulated temperature of (2800, 2806 C°) While the climatic growth season was recorded (221, 228 days), in the fourth cycle the actual growth season was (128 days) and a decrease from the second cycle (15 days) and the third cycle (10days), while the accumulated temperature reached (2806 C°) and the climatic growth season (229 days). In the fifth cycle, the actual growth season decreased to (127 days), with a

difference less than the second cycle (16 days), the third (11 days), and the fourth one day, while the accumulated temperature reached (2813 C°) and the climatic growth season (237 days).

#### 14. Basra

The actual growth season at Basra station in the first and second cycle recorded (144,157 days) respectively, and accumulated temperature of (2800 C°) for the two cycles and a climatic growth season that reached (231 and 234 days) respectively, and in the third cycle the actual growth season reached (134 days) and a cumulated temperature (2810 C°) while the climatic growth season reached (243 days), and in the fourth cycle, the actual growth season decreased to (126 days) and with accumulated temperature of (2801 C°) and a climatic growth season (248 days), and the fifth cycle witnessed the recording of the actual growth season for the shortest period between climatic cycles, which reached (122 days), with a difference less than the first cycle (35 days), the second (22 days), the third (12 days) and the fourth four days, while the accumulated temperature reached (2814 C°) and the climatic growth season (251 days)

**Fig 5: The actual growth season and the climatic growth season of the rice crop in the stations of Erbil, Baghdad, Diwaniyah and Nasiriyah for the fifth cycle (2010-2020)**



Source : researcher:

1. Ministry of Transportation, General of Authority of Meteorology and Seismic Monitoring, Climate Department ,Baghdad , un published data .
2. General Directorate of Meteorology and Seismic Monitoring in the Kurdistan Region, Erbil, unpublished data

## CONCLUSIONS

1. It is not possible to grow the rice crop in the Zakho station, because there is no sufficient accumulated temperature for the crop, which are (2800 m°).
2. The climatic growth season records the longest period in the fifth cycle, which extends from (2009-2020) in the Basra station, south of the study area, which amounted to (251 days). Because of climatic change
3. The Sulaymaniyah station in the north of the study area witnessed recording of the shortest climatic growth season, which reached (183 days) in the fourth and fifth cycles, as a result of its location, which is relatively far from the equator and the factor of altitude above sea level, so the days available for crop cultivation are fewer.
4. It is clear that the actual growth season recorded opposite values to the climatic growth season. The longest period was recorded in the Mosul station in the north of the study area in the first cycle (1966-1976) for (190 days) as the crop needs this long period to complete its requirements of accumulated temperatures.
5. The actual growth season recorded the shortest period in the Basra station, south of the study area, and it reached (122 days) in the fifth cycle (2009-2020), due to the location of the station, which is relatively close to the equator, and recording the highest temperatures in the study area, which makes the crop reach thermal units. needed in the shortest period of time.

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