Acta Universitatis Sapientiae
Agriculture and Environment, **16** (2024) 41–47

DOI: 10.47745/ausae-2024-0004

The maturity of the dates and the sum of the temperatures

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Manuscript received May 25, 2024; revised June 30, 2024; accepted August 11, 2024

Abstract. The date palm (*Phoenix dactylifera* L.) is a mesophilic tree cultivated in dry areas. Determination of the thermal index ensuring the ripening dates of the Degletnour, Ghars, and Heloua varieties in the period of 1999–2020 in the Biskra region was performed. We collected temperature data on the Biskra region and then processed the data and calculated the thermal indices of the Biskra region and the indices of the Degletnour, Ghars, and Heloua varieties. The heat index corresponds to the sum of the average daily temperatures during the fruiting period minus the zero flowering temperature of 18 °C. Our results show that in the Biskra region the average daily temperatures increase by 18 °C and even more from April to October, lasting 120 days. In the Degletnour variety, the flowering period extends over a period of 180 days from May to October, in the Ghars variety the flowering period extends over a period of 150 days from May to September, and in the Heloua variety the flowering period extends over a period of 122 days from May to August. The thermal index of the Biskra region is 2022.89 °C. The thermal index of the varieties Degletnour is 1937.24 °C, for Ghars is 1797.58 °C, and for Heloua is 1502.23 °C.

Keywords: date palm, variety, flowering time, heat index, maturity

1. Introduction

The date palm (*Phoenix dactylifera* L.) is a mesophilic plant and one of the most important crops in dry areas. It is a perennial plant that has long been domesticated and cultivated by humans for its fruit. In fact, it is the backbone of the oasis ecosystem in the Sahara. The limiting factors for date palm cultivation are high temperatures, the almost complete absence of rain, and low humidity [1].

All climatic factors are directly related to the success or failure of date palm cultivation, production, and the quality of their fruits. Therefore, when studying the extent and suitability of a particular area for the cultivation of the date palm or any of its varieties, it is necessary to take into account as many climatic factors as possible over the longest period possible.

According to [2], temperature is one of the most important factors that influence and determine the success of commercial palm cultivation and production in a given area, as it has a negative or positive impact on the flowering time and the speed of fruit growth and reaching the final stage of maturity in addition to their direct impact on the quality of the resulting dates. We mention some temperatures of particular importance that are directly related to the vegetative and fruitful growth of the date palm such as: B. the vegetative zero point, the flowering zero point, and the dormant phase [3], [4], [5], [6], [7], [8]. The best areas for growing date palms are those where the average maximum temperature is between 35 and 38 °C and the minimum temperature is between 4 and 13 °C [9], [10].

Preliminary data on temperatures in a region is still essential to pinpoint where the different varieties are grown [11]. The cultivars showed varying abilities to withstand the temperature drop, and this is believed to be due to cultivar-specific genetic factors related to the morphological characteristics of some cultivars [2].

What is the sum of the temperature in the region? What is the heat requirement for ripening dates of different varieties? The aim of this study is to determine the temperature sum for the ripening of dates.

2. Materials and methods

Our study was conducted in the Biskra region (*Figure 1*).

The temperature data used comes from the period from 1999 to 2020 (*Table 1*). The data show that the average temperatures in January, February, and March are below the blooming zero point, which is 18 °C. However, this does not include them in the calculation of the heat index.

Table 1. Temperatures for the period of 1999–2020

Month	Mean temperature (°C)	Maximum temperature (°C)	Minimum temperature (°C)
January	11.65	16.60	6.57
February	12.75	17.81	7.49
March	16.68	21.65	10.85
April	20.86	25.88	14.59
May	25.28	29.97	18.64
June	30.13	35.07	23.07

Month	Mean temperature (°C)	Maximum temperature (°C)	Minimum temperature (°C)
July	33.34	38.27	26.37
August	32.34	37.04	25.76
September	27.85	32.35	22.02
October	22.51	27.26	16.97
November	16.01	20.71	11.15
December	12.36	16.74	7.67

Note: Mean temperature = (Maximum temperature + Minimum temperature)/2.

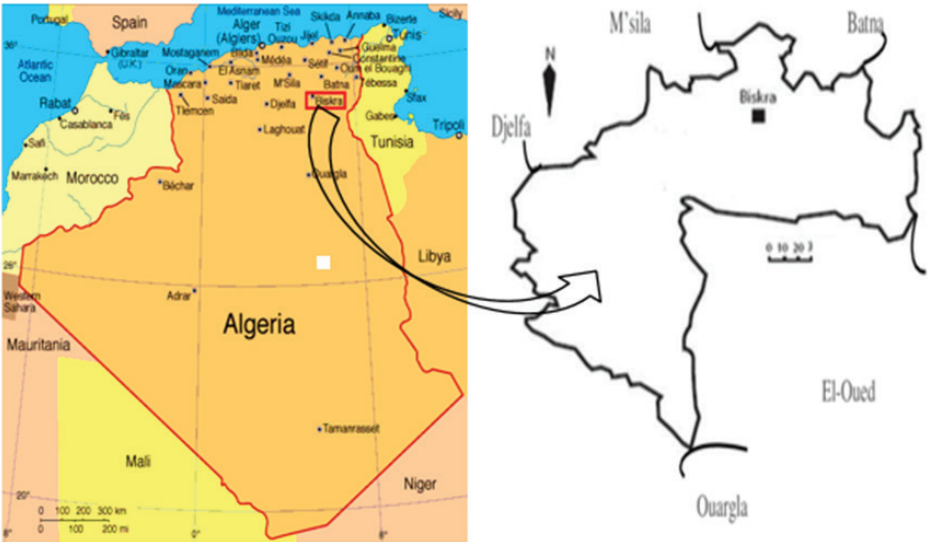

Figure 1. The map of the Biskra region where the study is carried out

Plant material

We took three palm varieties, Deglet Nour, Ghars, and Halwa, to learn the timing of flowering, pollination, and fruit setting, as well as the timing of harvest. We also collected temperature data throughout the year. The vegetation zero point is 10 °C [12], [13], [14], [15], [2]. The flowering zero point is 18 °C [16], [17], [18], [19], [2].

According to [20], the thermal index is equal to the sum of average daily temperatures greater than or equal to 18 °C, from which 18 °C is subtracted for each day during the period from flowering to ripening of dates. The ripening day is an empirical measure for calculating heat development, which is used to estimate the ripening time. The value of the number of degree days is the average between the maximum and minimum temperature of the day, from which we subtract the

base temperature (zero fruiting); for date palm, zero flowering is 18 °C. The thermal index is the sum of degree days from the start of flowering to harvest.

3. Results and discussions

Our results (*Table 2* and *Figure 3*) show that in the Biskra region average daily temperatures increase by more than 18 °C for 120 days from April to October. In the Degletnour variety, the fruiting period begins with fruit setting and ends when the dates are ripe, extending over 180 days from May to October. In the Ghars variety, the fruiting period begins with fruit setting and ends with the ripening of the dates. It extends over a period of 150 days from May to September. In the Heloua variety, the fruiting period begins with fruit setting and ends with the ripening of the dates, spread over a period of 120 days from May to August. In addition, *Table 2* and *Figure 2* show that the thermal index for the Biskra region is 2022.89 °C. The thermal index of the Degletnour variety is 1937.24 °C. The heat index of the Ghars variety is 1797.58 °C, and the heat index of the Heloua variety is 1502.23 °C.

Table 2. Temperatures and thermal index

Month	**(A) Number of days**	**(B) Mean temperature of the month (°C)**	**(D) Temperature units above 18 °C**	**(E) The sum of the temperatures (°C) per month**			
				the region of Biskra	**cultivar Degletnour**	**cultivar Ghars**	**cultivar Heloua**
January	31	11.65					
February	28	12.75					
March	31	16.68					
April	30	20.86	2.86	85.65			
May	30	25.28	7.28	218.25	218.25	218.25	218.25
June	30	30.13	12.13	363.9	363.9	363.9	363.9
July	31	33.34	15.34	475.54	475.54	475.54	475.54
August	31	32.34	14.34	444.54	444.54	444.54	444.54
September	30	27.85	9.85	295.35	295.35	295.35	
October	31	22.51	4.51	139.66	139.66		
November	30	16.01					
December	31	12.36					
Sum				2022.89	1937.24	1797.58	1502.23

Notes: D = B - 18; E = A * D.

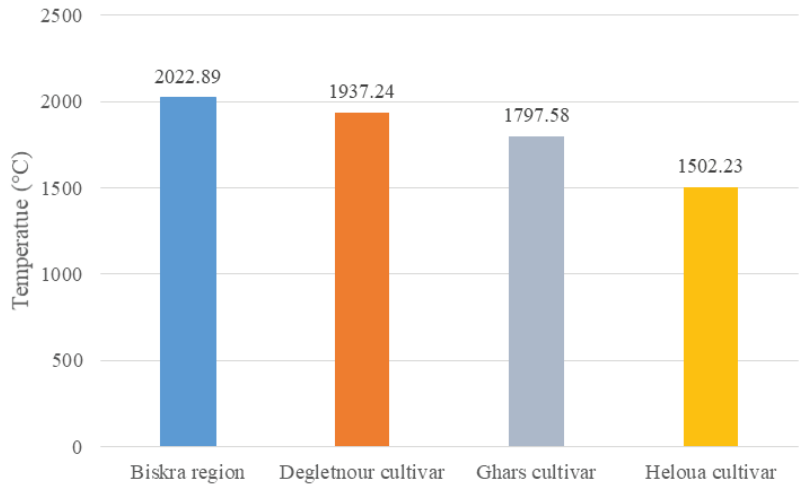

Figure 2. Presentation of heat index

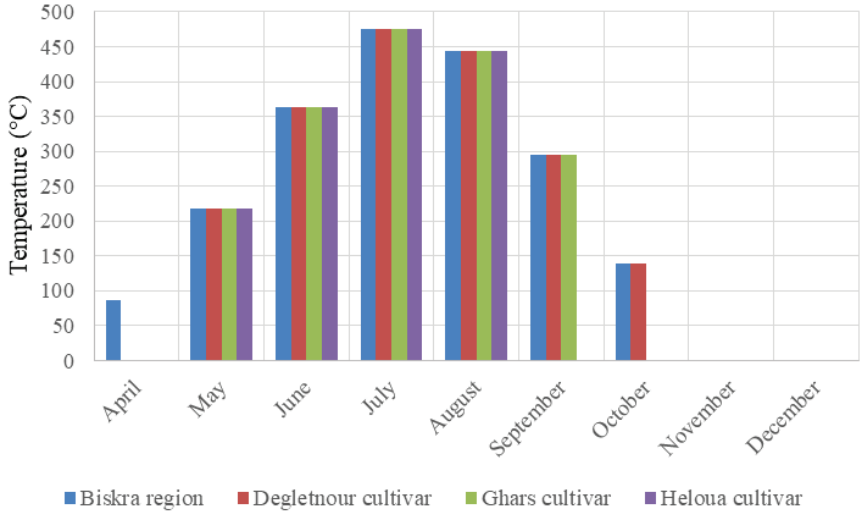

Figure 3. Presentation of monthly heat index

Based on the fruiting period and heat index of the studied varieties, the Heloua variety is early, the Ghars variety is in season, and the Degletnour variety is late. Previously, [21] conducted a study on the temperature sum in the Marrakesh region. The thermal index of the Biskra region is 2022.89 °C; this recorded index is included in the range of indices (2337–3898 °C) cited by [22], [23], and [16]. The heat index of the Degletnour variety is 1937.24 °C. The heat index of the Ghars variety is 1797.58 °C. Daily average temperatures in the Biskra region begin to rise by 18 °C and even more from April to October and last 213 days. For the Degletnour variety,

the flowering period is 180 days from May to October. For the Ghars variety, the flowering period is 150 days from May to September. The Heloua variety has a flowering period of 120 days from May to August. The heat index of the Biskra region is 2022.89 °C. The heat index of the Degletnour variety is 1937.24 °C. The heat index of the Ghars variety is 1797.58 °C, and the heat index of the Heloua variety is 1502.23 °C. Based on the fruiting period and heat index of the studied varieties, the Heloua variety is early, the Ghars variety is in season, and the Degletnour variety is late. According to [20], the fruiting period of the date palm begins with fruit setting and ends with the ripening of the dates. The duration varies between 120 and 200 days depending on the variety and local climatic conditions.

In Touggourt, the length of the fruiting period varies between 150 days for early varieties, for example Ghars, and 180 days for Degletnour, with a thermal index of 1854 in Touggourt, 1620 in Bechar, 1170 in Elkantara, and 990 in Laghouat. According to [1], the duration of fruit development is 100 to 200 days depending on the variety and environmental conditions. The sum of the temperatures must reach 5,000 °C for the early varieties and 6,000 °C for the late varieties.

4. Conclusions

The Biskra region daily average temperatures start to rise by 18 °C and above from April to October, lasting 213 days. For the Degletnour cultivar, the flowering time spans 180 days from May to October. For the Ghars cultivar, the flowering time spans 150 days from May to September. For the Heloua cultivar, the flowering period spans 120 days from May to August. The thermal index of the Biskra region is 2022.89 °C. The thermal index of the Degletnour cultivar is 1937.24 °C. The heat index of the Ghars cultivar is 1797.58 °C, and the heat index of the Heloua cultivar is 1502.23 °C.

Acknowledgements

The authors' thanks go to the farmers of the Ziban region.

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