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BEEKEEPING IN THE CONTEXT OF CLIMATE CHANGE

Silvia PĂTRUICĂ, Ioan PEȚ, Eliza SIMIZ

Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" from Timișoara, 119 Calea Aradului Street, Timişoara, Romania

Corresponding author email: elizasimiz@usab-tm.ro

Abstract

Climate change is a global phenomenon, driven by industrialization and deforestation, which over time has led to a reduction in the ozone layer and an increase in carbon dioxide. These have led to changes in the integrity of the ecosystem and biodiversity, affecting bee colonies as well. Temperature and humidity play an important role in the secretion of nectar in honey plants, while also influencing the feeding behavior of bee colonies. The study follows the evolution of the meteorological factors mentioned, in the period 2017-2021, during the production harvests of rapeseed, acacia, linden and sunflower, in April, May, June and July. During the analyzed period, statistically significant differences were registered for the analyzed factors compared to their average (p <0.05), with negative influences on the nectar secretion and implicitly on the capitalization of the harvests.

***Key words**: climate change, bees, nectar secretion*

INTRODUCTION

Meteorological conditions can influence the capitalization of honey sources by bees, but also of their quality (Bartomeus et al.; Scaven et al., 2013). Temperature variations can change the quantity and quality of nectar provided by honey plants (Le Conte and Navajos, 2008; Genersch et al., 2010; Pătruică et al., 2017). High temperatures cause flower fading and shorten the nectar secretion period (Gordo and Sanz, 2010). At the same time, the temperature influences the feeding behavior, but also the pollination activity of the bees (Reddy et al., 2012). Heavy rains or the lack of them for long periods of time negatively influence the secretion of nectar and the harvesting behavior of bee colonies (Pătruică et al., 2020).

Research has shown that climate change is one of the threats to pollinators (Hegland et al., 2009; Schweiger et al., 2010). Some authors believe that there is a close correlation between climate change and bee colony extinction syndrome (Gordo & Sanz, 2006; Switanek et al., 2017).

In addition to the negative effects on pollinators, climate change negatively affects honey production. This bee product, in addition to its therapeutic qualities, can contribute to Europe's sustainability goals because, compared to sugar, honey production does not require the occupation of agricultural land, the use of mineral fertilizers and irrigation for crops (Kendall et al., 2013).

MATERIALS AND METHODS

The study was conducted 10 km from Timisoara, for a period of 5 years, between the 4th of April and 30th of July, 2017-2021. Temperature and humidity monitoring was performed with the Bee Watch Professional 45726158 system, located under a hive in the apiary of Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania", Faculty of Bioengineering of Animal Resources. The daily evolution, during 24 hours (from hour to hour), of the two meteorological factors was followed, during the production harvests of rapeseed, acacia, linden and sunflower. The statistical processing of the resulting data was performed with the IBM SPSS Statistics Version 21 program, the Anova test, with Tukey.

RESULTS AND DISCUSSIONS

Starting with the second decade of April, depending on the date when the sowing was done, until the end of May, rapeseed blooms in the area of Timișoara. The nectar and pollen harvest on this plant overlaps in the first decade of May with the acacia harvest. But to capitalize on these harvests, bee families need favorable weather conditions for nectar secretion and flight. The secretion of rape nectar begins at a temperature of 10° C, the optimum value being reached between 16 and 25°C (Farkas & Zajácz, 2007; Pătruică et al., 2017). The temperature lower than 7 °C shows a negative effect on the secretion of nectar, strongly affecting the flight of bees and implicitly the production of honey (Pătruică et al., 2019).

Following the data in Table 1, we observe that in the last 5 years, the average temperatures registered in April presented statistically significant changes, with an average of the differences of 6.28°C between the minimum temperatures and 8.97°C in the case of the maximum ones. The problem in April is that of the minimum temperatures that are below the secretion temperature of the nectar (Pătruică et al., 2017; Pătruică et al., 2019). The average relative humidity registered statistically significant differences between the 5 analyzed years, ranging from 49.96% to 69.23%, the driest month of April being in 2018 and the rainiest in 2017 and 2021 (Table 1).

Beekeepers from Banat region do not show much interest in rapeseed harvesting, especially in case of early flowering, due to unfavorable weather conditions, but also to the reluctance to some pesticide treatments applied to these crops.

In May, in the area of Timiș County, the harvesting of nectar and pollen in rapeseed and the harvesting of acacia continues. Acacia nectar secretion begins at 10°C, reaches an optimum between 16 and 25 and ceases after 35°C (Farkas & Zajácz, 2007).

Table 1. The evolution of temperature and humidity in April and May

Items	Years					P values
	2017	2018	2019	2020	2021	
April $\bar{x} \pm SD$*						
Min temp (^{0}C)	6.63±4.117^{a}	12.76±2.730^{b}	8.65±3.589^{a,c}	7.59±4.598^{a,c}	6.48±4.817^{a,c}	0.000
Max temp (^{0}C)	17.29±5.541^{a,c}	25.10±4.125^{b}	20.36±4.634^{a}	25.29±3.32^{b}	16.32±5.950^{c}	0.000
Min RU (%)	50.58±16.048^{a}	49.96±10.813^{a}	48.96±17.007^{a}	31.77±7.565^{b}	50.54±15.180^{a}	0.000
Max RU (%)	84.65±9.769^{a}	83.58±8.819^{a}	84.42±10.159^{a}	70.81±11.451^{b}	84.23±12.738^{a}	0.000
May $\bar{x} \pm SD$*						
Min temp (^{0}C)	12.33±2.844^{a}	16.10±3.185^{b}	12.75±3.205^{a}	11.90±3.698^{a}	12.25±4.544^{a}	0.000
Max temp (^{0}C)	25.47±4.381^{a,c}	26.87±3.813^{a}	22.50±4.088^{b,d}	23.32±3.493^{b,c}	24.64±4.405^{a,c,d}	0.000
Min RU (%)	55.65±13.058^{a,c}	50.90±10.768^{c,d}	67.13±11.363^{b}	44.48±11.099^{d,e}	48.87±13.655^{a,d,e}	0.000
Max RU (%)	90.52±5.470^{a,c}	82.06±8.966^{b}	91.23±4.425^{c}	81.48±9.036^{b}	84.71±12.253^{a,b}	0.000

$\bar{x}$ Average; **SD**-standard deviation; RU – relative humidity

$^{a, b, c, d}$Values in the same row with a different superscript differ significantly at $p<0.05$

This month, during the 5 years analyzed, we observed that the average minimum temperatures were between 11.9 and 16.1 °C (Table 1), at first sight optimal for the secretion of nectar in the two plants. From the analysis of the daily average values of May, we observed a very large variability of the minimum temperatures from one day to another. The situation of days with minimum temperatures below the nectar secretion value was as follows: 2 days in 2017 (the lowest 4.3°C), 9 days in 2019 (the lowest 5.3°C), 8 days in 2020 (the lowest 7.1°C) and 9 days in 2021 (the lowest 3.3°C), these temperatures being abnormal for this month. The hottest month of May was in 2018 when the lowest daily minimum temperature recorded was 10.1°C. The average relative humidity varied greatly in the analyzed period, ranging between 50.9% and 81.58% at statistically significant differences between the 5 years (Table 1).

The medium temperature and relative humidity in April and May are presents in the Figure 1.

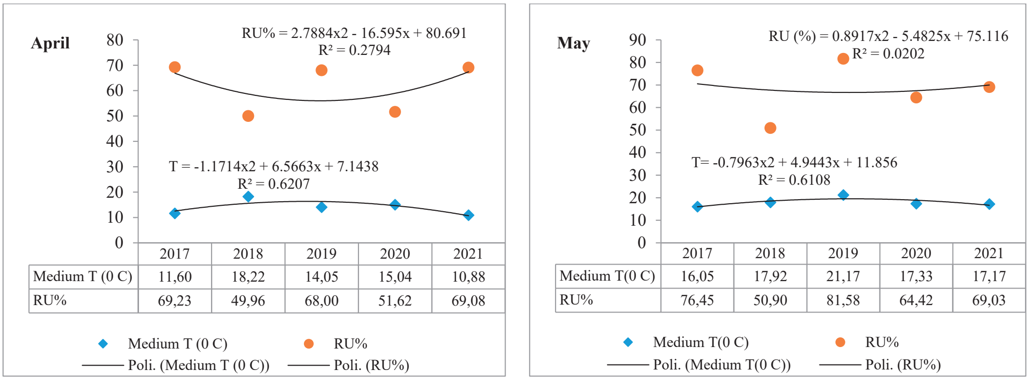


Figure 1. The evolution of the medium temperature and humidity in April and May

Starting with the second decade of June, linden blossoms in the analyzed area, and the sunflower in the third decade, depending on the date of sowing. The optimum secretion temperature of linden nectar is in the range of 18-28°C (Farkas & Zajácz, 2007) and 20-25°C in sunflower (Puškadija et al., 2007).

June 2017-2021 can be characterized by the average minimum temperatures between 15.28°C (in 2017) and 18.44°C (in 2019) and the maximum temperatures between 26.33 (in 2018) and 33.61°C (in 2021) (Table 2). There is a difference between the average maximum temperatures of 7.28°C. Analyzing the daily temperatures, we may observe that, in 2021, the temperature of 33°C was exceeded during 20 days of this month, of which 12 days recorded maximum temperatures above 35°C and 3 days above 40°C. These very high temperatures, unusual for the month of June in Timișoara area, seriously affected the secretion of linden and sunflower nectar.

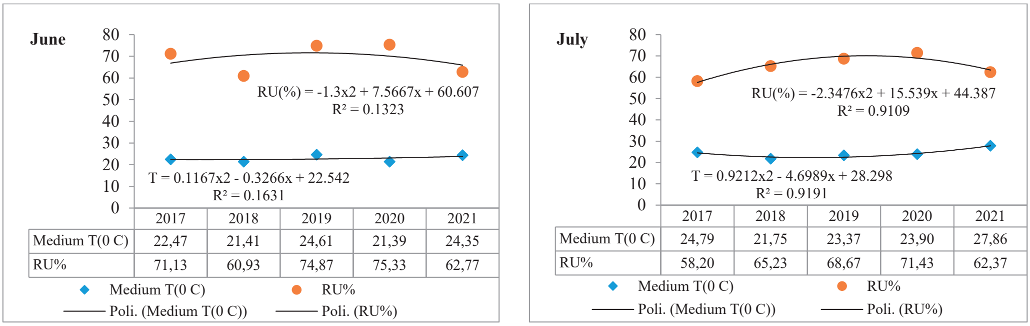
Table 2. The evolution of temperature and humidity in June and July (2017-2021)

Items	Years					P values
	2017	2018	2019	2020	2021	
June $\bar{x} \pm SD$*						
Min temp (^{0}C)	15.28±2.868^{a}	16.93±3.592 ^{a,b}	18.44±3.298 ^{b}	17.46±3.199 ^{a,b}	17.11±5.451 ^{a,b}	0.031
Max temp (^{0}C)	30.21±3.800 ^{a}	26.33±3.428^{b,c}	31.31±2.570^{a,d}	26.75±4.402^{c}	33.61±5.635 ^{d}	0.000
Min RU (%)	46.27±11.419^{a}	60.93±10.808^{b}	56.37±8.680^{b}	57.97±14.817^{b}	38.23±5.721^{c}	0.000
Max RU (%)	91.00±5.825^{a}	89.10±5.909^{a,b}	87.47±7.951 ^{a,b}	88.10±7.45^{a,b}	84.03±11.247^{b}	0.017
July $\bar{x} \pm SD$*						
Min temp (^{0}C)	15.80±3.325 ^{a}	16.58±2.828 ^{a}	16.48±3.601^{a}	17.353±4.384 ^{a}	20.65±4.045 ^{b}	0.000
Max temp (^{0}C)	32.40±4.650 ^{a,c}	27.16±2.665 ^{b}	30.67±3.509 ^{c}	31.34±4.144 ^{c}	34.13±3.69 ^{a}	0.000
Min RU (%)	35.57±8.653^{a}	60.93±10.808^{b}	47.03±7.889^{b}	48.67±10.223^{b}	42.80±11.364^{c}	0.000
Max RU (%)	85.50±7.899^{a,c}	90.50±3.875^{a}	86.03±7.020^{a,c}	89.03±10.036^{a}	82.03±12.104^{b}	0.002

$\bar{x}$ Media; **SD**-standard deviation; RU – relative humidity
^{a,b,c,d}Values in the same row with a different superscript differ significantly at $p<0.05$

In July, the main harvest of nectar and pollen is in sunflower. During the analyzed period, the averages of the minimum temperatures were in the range of 15.80-20.65°C, and the maximums in the range of 27.16-34.13°C, with very large daily variations (Table 2). Unusual minimum temperatures were recorded in July 2018 (7.6°C) and 2019 (8.7°C). In terms of maximum temperatures, the warmest month of July was recorded in 2021 (18 days with average maximum temperatures above 33°C) followed by 2017 (13 days with average maximum temperatures above 33°C) and the year 2020 (12 days), consequently so many days unsuitable for nectar secretion. In 2018, the maximum daily temperatures did not exceed the threshold of 32°C, being the month of July with the most precipitation among the analyzed years.

The medium temperature and relative humidity in June and July are presents in the Figure 2.



June	2017	2018	2019	2020	2021
Medium T(0 C)	22,47	21,41	24,61	21,39	24,35
RU%	71,13	60,93	74,87	75,33	62,77

July	2017	2018	2019	2020	2021
Medium T(0 C)	24,79	21,75	23,37	23,90	27,86
RU%	58,20	65,23	68,67	71,43	62,37

Figure 2. The evolution of the medium temperature and humidity in June and July

CONCLUSIONS

Nectar secretion was severely affected by climate change during the period analyzed. During the rapeseed harvest, during the 5 years, the average of the minimum temperatures registered a difference of 6.28°C and that of the maximum temperatures of 8.48°C, with many days below the minimum nectar secretion temperature. Temperature variations between minimum and maximum averages ranged from 4.2-4.37°C during acacia harvesting, 3.16-7.38°C during linden harvesting and 4.85-6.97°C during sunflower harvesting. Very large differences in daily minimum and maximum temperatures (0.5°C- 30.2°C for rapeseed; 4.3°C-31.9°C for acacia; 7.3°C-42.7°C for linden; 7.9°C-40.9°C for sunflower), to which periods of heavy rain or drought are added, severely affect the behavior of bee colonies, honey production and even the apparition of diseases.

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