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ANALYSIS OF THE INFLUENCE OF METEOROLOGICAL FACTORS ON HONEY BEE COLONIES DURING THE OVERWINTERING PERIOD

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Abstract: Honey bee colonies (*Apis mellifera*) play an essential role in biodiversity conservation and agricultural productivity. Colony survival during winter is strongly influenced by meteorological conditions, which affect food consumption, hive thermoregulation, and bee mortality. Recent advances in precision apiculture allow the continuous monitoring of environmental and biological parameters through smart digital systems. This study evaluates the influence of temperature, humidity, wind speed, UV radiation, and precipitation on colony performance during the overwintering period.

• Introduction

Honey bee colonies of *Apis mellifera carpatica* play an essential role in biodiversity conservation, crop pollination, and food security. Meteorological factors such as temperature, humidity, wind speed, and precipitation directly influence colony activity and overwintering success. Climate change and increasing weather instability can negatively affect food consumption, thermoregulation, and colony survival during winter. Recent advances in precision apiculture have enabled the use of smart monitoring systems capable of continuously recording biological and environmental parameters. The BeeConn monitoring system provides real-time data regarding hive dynamics and weather conditions, supporting improved colony management. Therefore, this study aims to evaluate the influence of key meteorological factors on honey bee colonies during the overwintering period using BeeConn smart technologies.

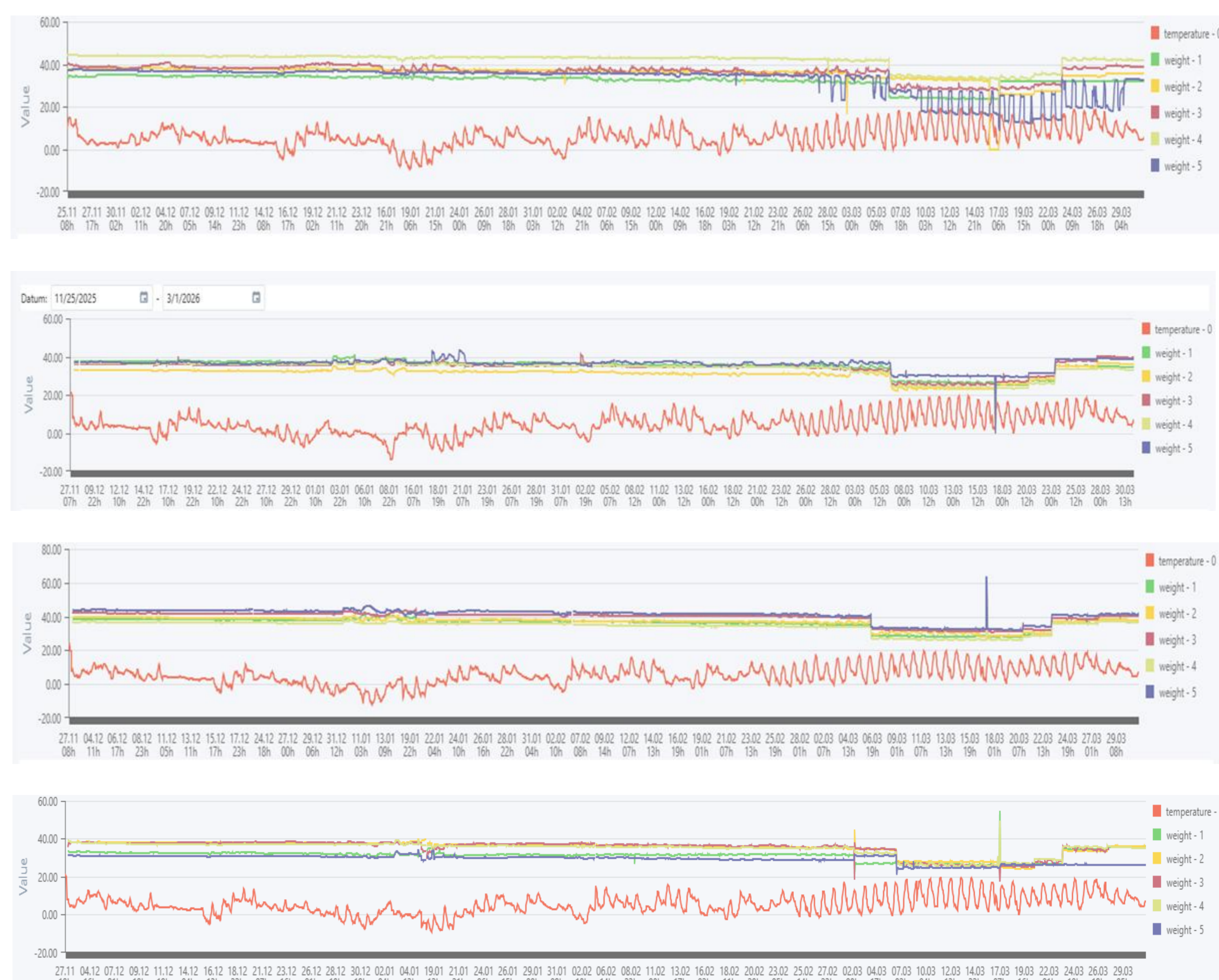
• Material and method



The study was conducted between 25.11.2025 and 01.03.2026 in the teaching apiary of the University of Life Sciences "King Mihai I" from Timișoara. Twenty colonies of *Apis mellifera carpatica* were monitored during the overwintering period under the climatic conditions specific to western Romania. BeeConn meteorological stations recorded air temperature, relative humidity, wind speed, UV radiation, and precipitation. These data were correlated with biological parameters monitored in the hives, including weight variation, food reserves, and bee mortality during the overwintering period. Mortality was evaluated through periodic inspections and collection of dead bees.

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• Results and discussions



During the overwintering period, temperatures recorded by the BeeConn system varied between -9.07°C and 16.49°C , indicating important thermal fluctuations. Hive weight showed a general decreasing trend caused by food reserve consumption and thermoregulation during winter. The cold episode recorded between 18–21 January represented a significant stress factor for the colonies. Overall, the results highlight the strong influence of meteorological conditions on honey bee colony dynamics during overwintering.

• Conclusions

Meteorological factors significantly influenced the overwintering dynamics of *Apis mellifera carpatica* colonies, affecting food consumption and hive weight variation during the cold season. The BeeConn monitoring system proved useful for continuously evaluating colony responses to environmental changes and supports the development of precision beekeeping practices.