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ANALYSIS OF ENVIRONMENTAL CONDITIONS ON TOMATO PRODUCTION IN A RESEARCH GREENHOUSE

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INTRODUCTION

The current study focused on the environmental conditions within a research greenhouse located in Bucharest, Romania. Three environmental factors conditions were analyzed: inside temperature, relative humidity and CO_2 concentration. All three play a key role in the growth and development of plants, ultimately determining the yield. The research objective was to evaluate the recorded environmental factors in relation to the optimal ones. A potential solution for optimizing production was explored. Following the research objective, these research questions were addressed: „how do the recorded environmental conditions compare to the optimal factors?" and „what is a potential solution for optimizing production?". Based on the research questions, these hypotheses were tested: „the recorded environmental conditions are suboptimal" and „greenhouse technology upgrade is a potential solution for optimizing production".

MATERIALS AND METHODS

The research was undergone in a greenhouse part of the University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAMV) campus. The environmental factors were monitored for ten days, from August 1st to August 10th, 2021. To monitor and export the data, the Priva climate control software was used.

RESULTS AND DISCUSSIONS

The results indicate significant differences between the recorded environmental conditions and the optimal factors. Inside temperature was higher than the optimal one for the whole duration of the analysis (Fig. 1).

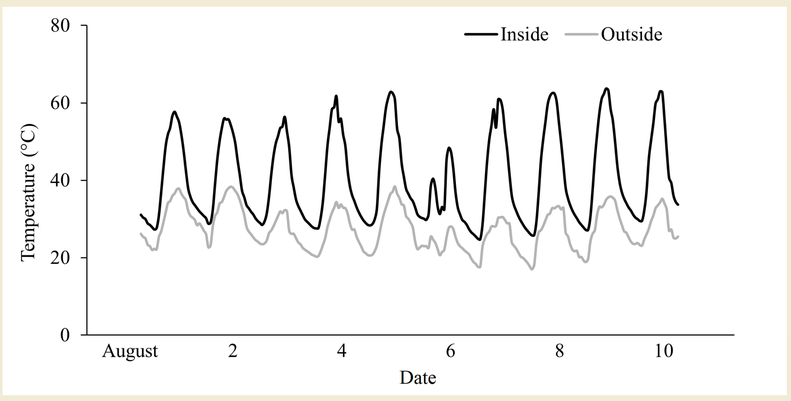

Fig. 1. Temperature inside (black) and outside (gray) the greenhouse.

The highest recorded inside temperature was 66°C on August 9th at 15:00. This is more than double the optimal temperature for tomato production of 25°C. This threshold was only reached several times early in the morning, the lowest recorded value being 24°C on August 7th at 7:00. Comparing the outside temperature with the one recorded inside the greenhouse, the latter is significantly higher. For example, the outside temperature was 35°C when the maximum of 66°C was reached inside the greenhouse.

Analyzing the relative humidity, the value recorded inside the greenhouse was significantly lower than the optimal one (Fig. 2).

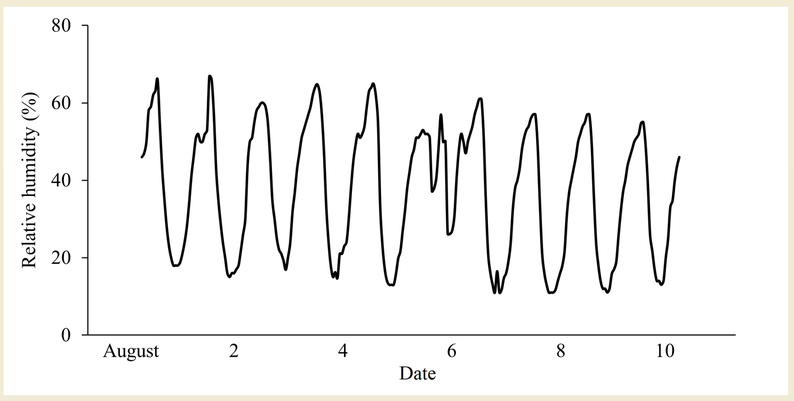

Fig. 2. Relative humidity inside the greenhouse.

The lowest recorded relative humidity was 11% on August 7th at 13:00. Maximizing the tomato production requires an optimal relative humidity of 65%. This threshold was reached several times, with the highest value recorded at 67% on August 2nd at 6:00. However, the relative humidity was below the optimal value for most of the research period, thus closing the stomata and ultimately reducing the CO_2 uptake at the foliar level. Similarly to temperature and CO_2 concentration, relative humidity is a limiting factor in plants' growth and development.

For the same period of time, the results indicated a lower CO_2 concentration compared to the optimal value (Fig. 3).

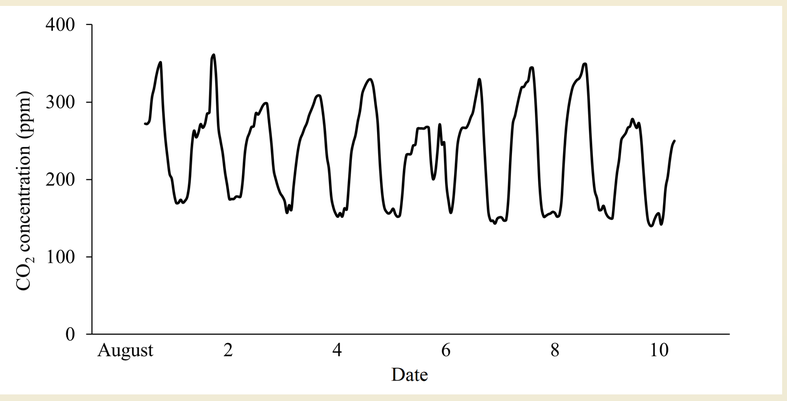

Fig. 3. CO_2 concentration inside the greenhouse.

The lowest recorded CO_2 concentration was 141 ppm on August 10th at 12:00. For tomato production, the optimal CO_2 concentration is within the 400-600 ppm range. Furthermore, the highest recorded value was 361 ppm on August 2nd at 7:00, indicating suboptimal conditions throughout the whole study.

A low CO_2 concentration translates into altered photosynthetic rates, the photorespiration increasing as the CO_2 levels decrease. Ultimately, this affects the yield.

The results illustrate the need for an improved control of the environmental factors. The climate conditions in Southern Romania account for warm summers, the average outside temperature raising yearly due to the climate change effects. With the current USAMV greenhouse technology, these conditions translate into severe plant stress, reducing the yield. Specifically, the optimal environmental conditions cannot be obtained with the fossil fuel based gas boiler. Using this system, the greenhouse is not cooled enough during the warmest periods of summer and is not warmed enough during the coldest winter time.

A sustainable solution is that of ground-source heat pumps. Multiple studies illustrate the benefits of this technology, the high energetic and cost efficiency being the biggest advantage. Future studies should take this solution into account for the USAMV greenhouse.

The first hypothesis was accepted as the recorded environmental conditions were proven to be suboptimal. Furthermore, the second hypothesis stating that greenhouse technology upgrade is a potential solution for optimizing production was also accepted as the ground-source heat pumps technology was suggested.

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CONCLUSIONS

1. Within the USAMV greenhouse, significant differences were found between the recorded environmental conditions and their corresponding optimal values.
2. In order to reduce these differences and reach the optimal factors, greenhouse technology upgrade is required. Thus, a ground-source heat pump based system is a potential sustainable solution.