IConBM2026, International Conference on BIOMASS 24-27 May 2026 Bologna, Italy.

Optimization of Microalgal Cultivation for Biostimulant and Biofertilizer Production: Effect of Temperature, Light Intensity, and Photoperiod

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Abstract

Microalgae have gained increased attention as sustainable sources of biostimulants and biofertilizers. However, their performance is strongly affected by the cultivation conditions.

In this study, a Box-Behnken design with three factors at three levels was applied to evaluate the effect of temperature, light intensity, and photoperiod on the cultivation performance, as well as the biofertilizer and biostimulant potential of *Chlorella vulgaris*, *Chlorella* sp., and a mixed culture isolated from anaerobic digestion effluent, under autotrophic conditions.

Preliminary results indicate that cultivation conditions significantly influence biostimulant performance, revealing trends and interactions among the studied variables. Cultivation at 27.5°C generally outperformed 35°C, though the impact of the photoperiod was found to depend on temperature. Moreover, extended dark periods favored biostimulant activity at lower temperatures, while intermediate light-dark cycles were necessary to sustain activity at 35°C. Furthermore, light intensity exhibited a non-linear influence, suggesting a complex metabolic threshold for producing active compounds.

Differences between total biomass and supernatant treatments were also observed, with total biomass resulting in more stable effects. Furthermore, the biostimulant response exhibited a non-linear dose dependency across the range of concentrations tested.

Overall, this study demonstrates the importance of the optimization approach for maximizing the performance of microalgae-based biostimulants and biofertilizers. The application of experimental design provides a robust framework for identifying optimal cultivation conditions and supports the development of efficient and sustainable bio-based agricultural products.

Acknowledgement

This research work was financially supported by the research program “BioBOOST: Development of innovative competitive biostimulants and biofertilizers through cultivation of photosynthetic microorganisms”. The project is implemented in the framework of SUB1.1 call “Clusters of Research Excellence (CREs)” under the National Recovery and Resilience Plan “Greece 2.0” funded by the European Union – NextGenerationEU (Project Number: ΥΠ3ΤΑ-0561393).