Growing Green: Environmental Assessment of Struvite Fertilization in Hydroponic Tomato Cultivation

***Guido Evangelista[1]; Gara Villalba[1,2]; Verónica Arcas[1]; Francesco Orsini[3]; Xavier Gabarrell[1,2].**

[1]Institut de Ciència i Tecnologia Ambientals (ICTA-UAB) SosteniPra Research Group. Universitat Autònoma de Barcelona - Building Z - Campus UAB, 08193- Bellaterra,Barcelona, Spain.

[2] Department of Chemical, Biological and Environmental Engineering, Universitat Autònoma de Barcelona (UAB), Campus UAB, 08193 Bellaterra, Barcelona, Spain

[3] University of Bologna, Department of Agricultural and Food Sciences, Alma Mater Studiorum, viale Fanin 44, 40127 Bologna, Italy

***Corresponding author e-mail: guido.evangelista@uab.cat**

Introduction

Tomato stands as one of the most popular and extensively cultivated vegetable crops globally. It plays an essential role in the agriculture sector and holds significant cultural and culinary importance for various populations. However, its cultivation is responsible for many ecological concerns, related to water consumption, use of mineral fertilizers and overall resource consumption[1]. Struvite ($MgNH_4PO_4$), a recovered salt from wastewater treatment plants, has shown to be a valid alternative for phosphate inputs to various horticultural crops[2]. This research aims to assess the impact of struvite fertilization on both yield and environmental performance of hydroponically grown tomatoes.

Objectives

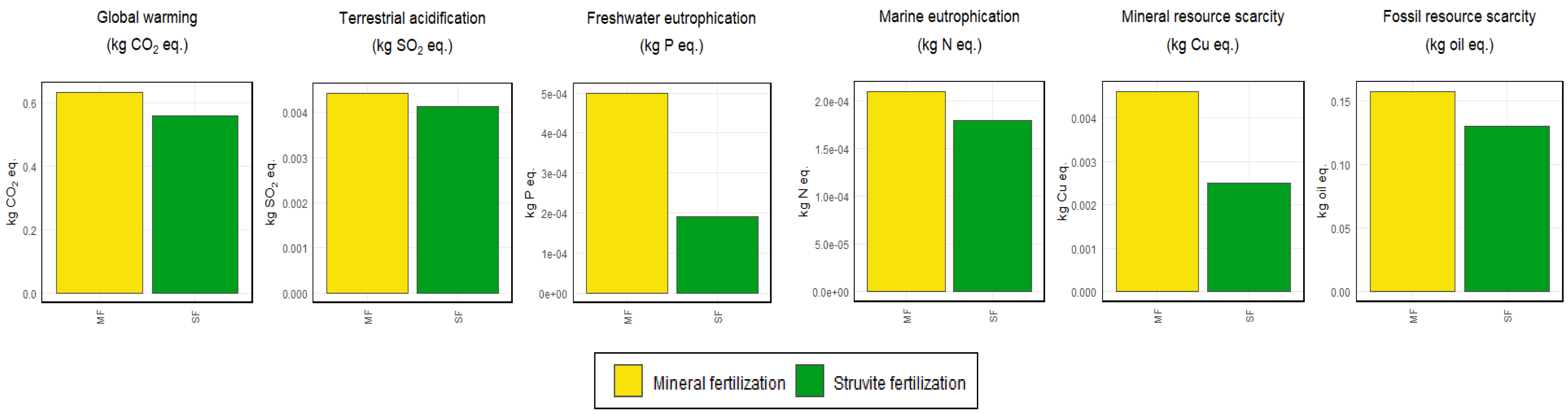
- Compare the yield: evaluate whether struvite fertilization can produce a comparable yield to convertional fertilizers.
- Environmental impact: assess the environmental impact of the two systems by using the Life Cycle Assessment methodology.

Methodology

Tomato plants (Solanum lycopersicum L., var. Montgrí) were grown from March to July 2023 in a Mediterranean integrated rooftop greenhouse (iRTG). Two different fertilization methods were employed: a) a control treatment, with all the nutrients provided by mineral fertilization through a fertigation system and b) a sector where plants received a nutrient solution lacking P, Mg^{2+} and NH_4^+ supplied to them through struvite grains. The Life Cycle Assessment (LCA) methodology was used to evaluate the two fertilization models. The chosen functional unit for this study was 1 kg of fresh tomato and the impact categories considered were the following: global warming (GW), freshwater eutrophication (FE), marine eutrophication (ME), terrestrial acidification (TA), mineral resource scarcity (MRS) and fossil resource scarcity (FRS).

Results

The yield of the two sectors showed no significant differences, with 7.02 $kg \cdot m^{-2}$ produced by the mineral fertilization treatment and 7.12 $kg \cdot m^{-2}$ produced by the plants with struvite. For the environmental impact, the sector with struvite fertilization was the less impacting in all categories compared to the mineral one, as show in Figure 1. The impact related to FRS was reduced by 17% for the plants fertilized with struvite while, for MRS, the impact was 46% lower. Due to the adoption of a slow-release fertilizer, FE was reduced by 63% while, regarding ME, the impact was 1.14 lower compared to the plants with mineral fertilization. The slightest difference between the two treatments were found among the GW and TA categories, where crops with struvite fertilization showed a lower impact of 12% and 7%, respectively.



Conclusions

The results of this study show that, both in terms of productivity and environmental impact, the adoption of struvite fertilization can be a viable alternative to produce greenhouse tomatoes in the Mediterranean region.

Acknowledgements

This study was funded by the Catalan Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) under the grant 2021SGR00734 Sostenipra and MOVE4EDU PID2021-126845OB-C21 funded by MCIN/AEI/10.13039/501100011033/FEDER, UE, MOVE4EDU PID2021-126845OB-C22 funded by MCIN/AEI/10.13039/501100011033/FEDER, UE.

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MOVE4EDU
Ministerio de Ciencia e Innovación under grant n° PID2021-126845OB-C21

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Ministerio de Ciencia e Innovación under grant n° TED2021- 561 130047B-C21