

1 Introduction

Long-term manned space exploration missions to the Moon and Mars, can't be considered without a reliable and efficient Life Support System. A fully autonomous system using living organisms ensure oxygen and food regeneration.

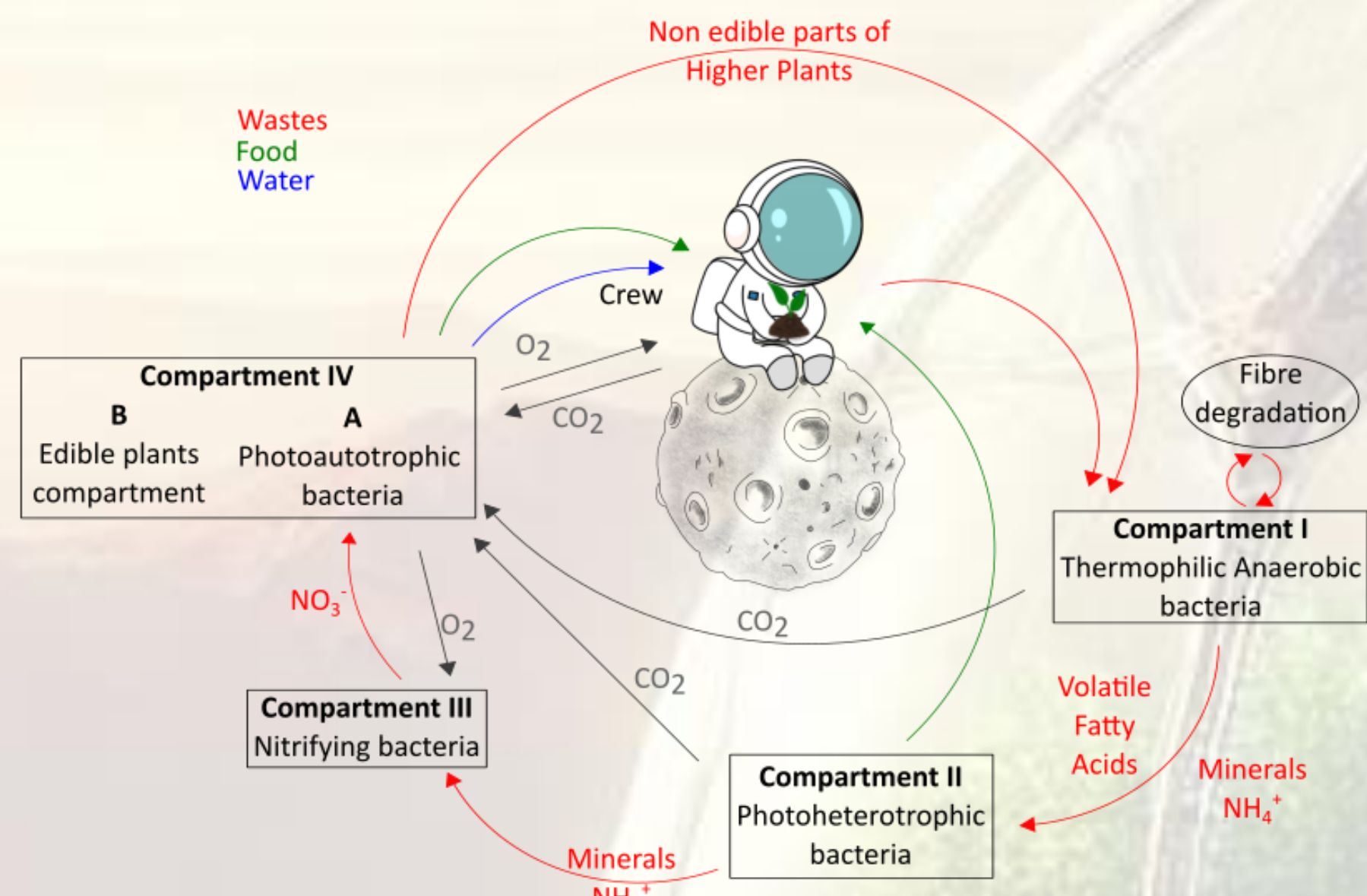


Figure 1. Compartmentalised structure of the MELISSA loop. (Adapted from Lasseur et al., 2010)

To create an efficient system, it is imperative to optimise the growth of edible plants, making the exploration of biostimulants essential. This research is focused on *Limnospira indica* PCC 8005 as biostimulant for plants. An evaluation of morphological characteristics and the impact of biostimulant on rhizospheric and endophytic microbiotas is evaluated.

2 Results

Biostimulant extract characterisation

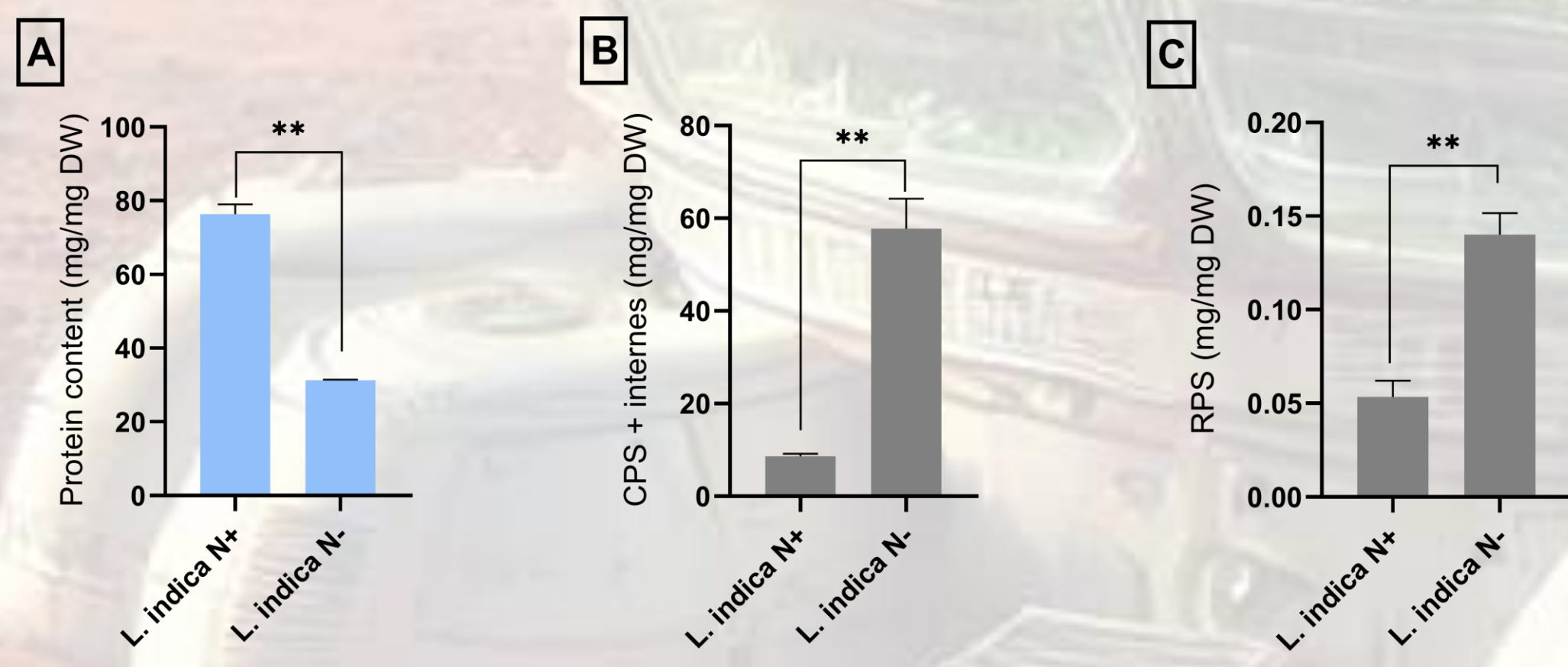


Figure 6. Evaluation of proteins (A) and carbohydrate (B and C) content in *Limnospira indica* PCC8005 biomass (B) and culture media (released components) (C) used as biostimulant solutions after 15 days of cultivation in presence (N+) and absence (N-) of nitrate.

Plant Growth Evaluation

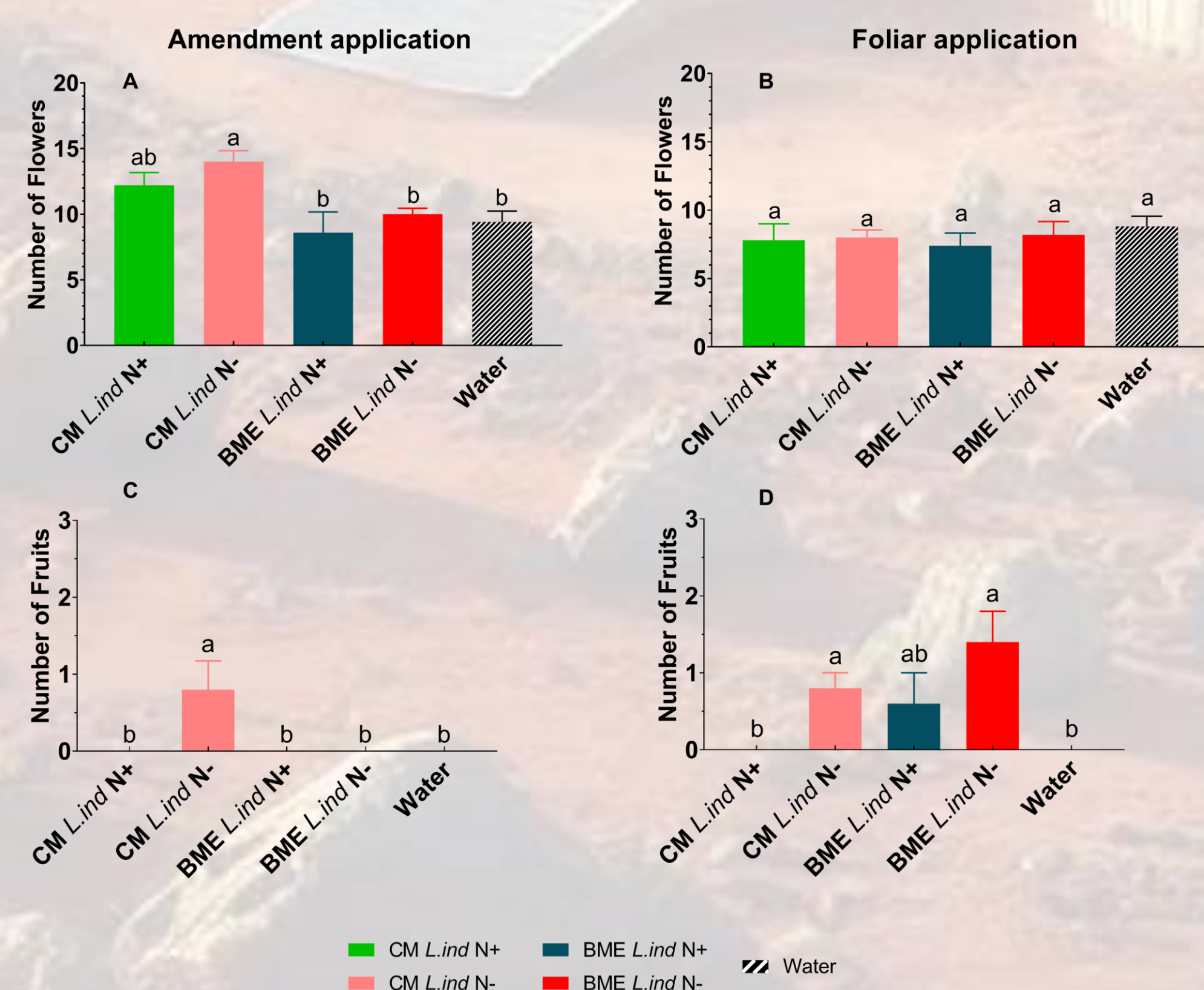
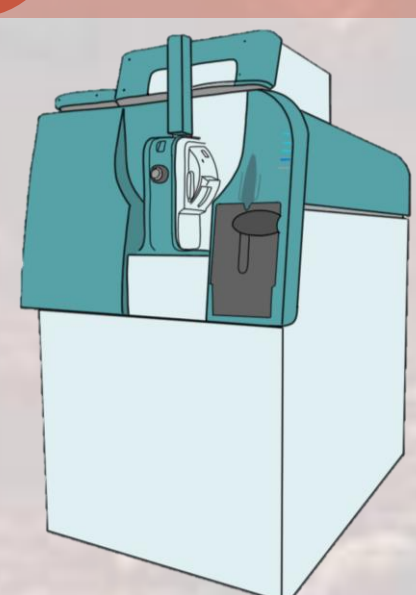


Figure 7. Evaluation of plant growth of *Solanum lycopersicum* under (A, C, E, G) amendment and (B, D, F, H) foliar application regarding (A, B) plant size at day 35, (C, D) number of flowers at day 35.

3 Future Work



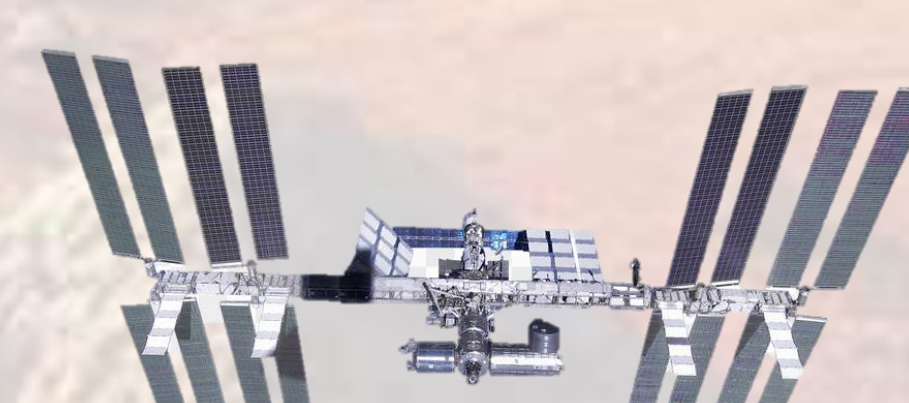
Proteomic analysis on biostimulated seedlings, from early germination to young seedlings.
This analysis at a proteomic level will allow a better comprehension of the impact of biostimulants on *Solanum lycopersicum*.



100 %
Field capacity
40 %
Field capacity

Hydric stress resistance.

This study will foster our understanding of the biostimulant abilities by looking at various characteristics : physiological (stomatal conductance), biochemical (chlorophyll, proline, and anthocyanin content, PAL activity), proteomic analysis.



Impact of Space Environment on *L. indica*.

This study will dive into metabolic impact of space environment on *L. indica*. PBRs flew to ISS in Nov. 2024. Proteomic, lipidomic and metabolomic analysis will be performed after 9 weeks of cultivation onboard ISS to determine modification affecting biostimulant production.

4 Conclusion

These studies are a first step into biostimulation understanding as part of a closed loop system in space. Nevertheless, these studies has shown an interesting positive impact on *Solanum lycopersicum* flowers and fruits production. Biostimulant extract has shown interesting impact on rhizospheric and endophytic microbiota giving us knowledge on their action. Additionally, the impact space environment (e.g., radiation, microgravity) on *L. indica* has to be studied in order to have a better view on how this environment might impact its biostimulant activity.

Acknowledgement These researches has been made possible through the author's involvement in the MELISSA project, ESA's life support system program and Belspo through the ARTEMIS Prodex contrat which pays for Cécile Renaud's PhD grant. This research. was also supported by the European Regional Development Fund and the Walloon Region, Belgium through the Phenix-biocontrol project. Figures were created using Procreate and Inkscape.

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2 Material and Methods

Biostimulant extract preparation

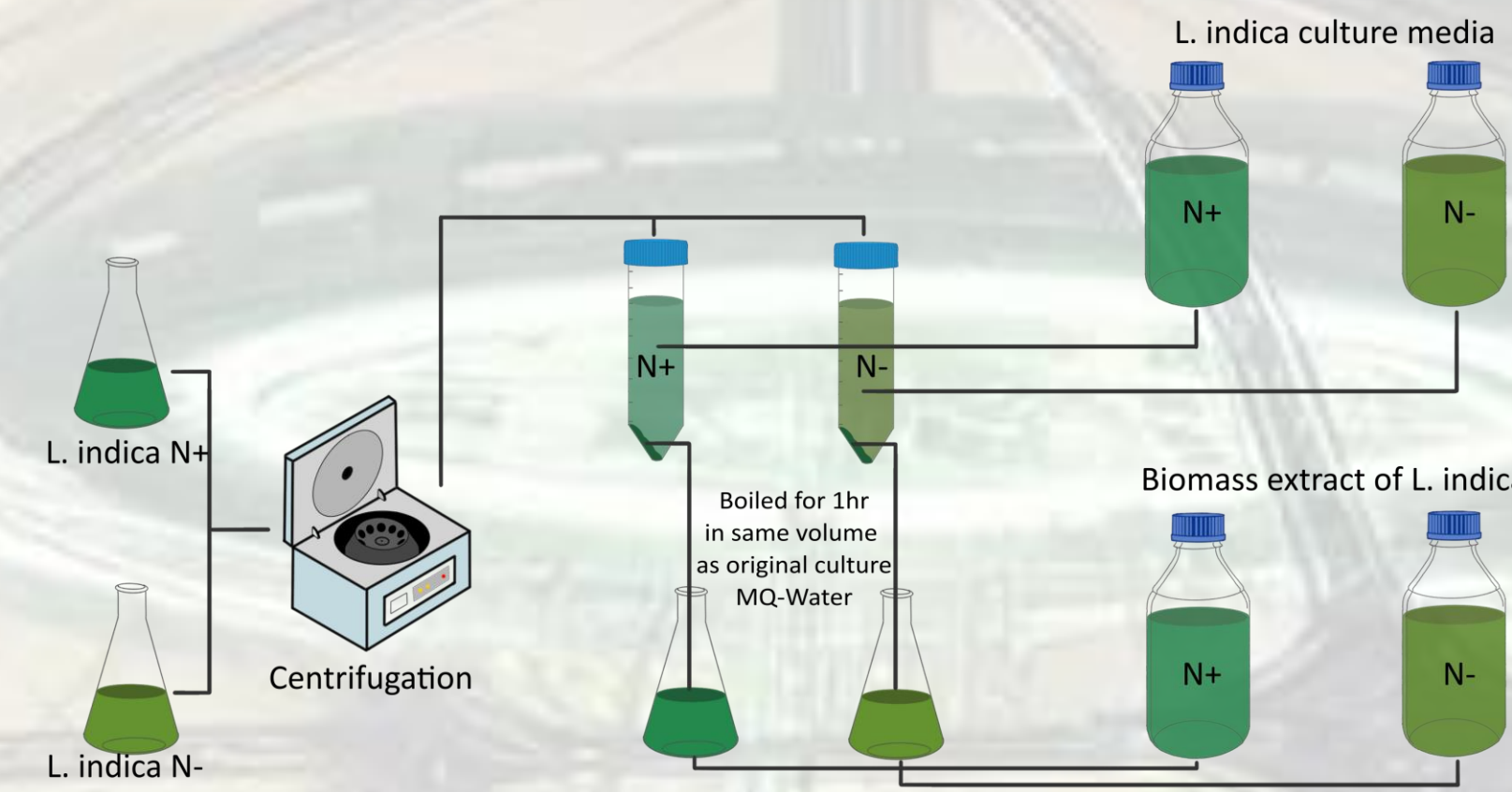


Figure 2. Methods of preparation of biostimulant extracts from *Limnospira indica* PCC 8005

Biostimulant extract characterisation

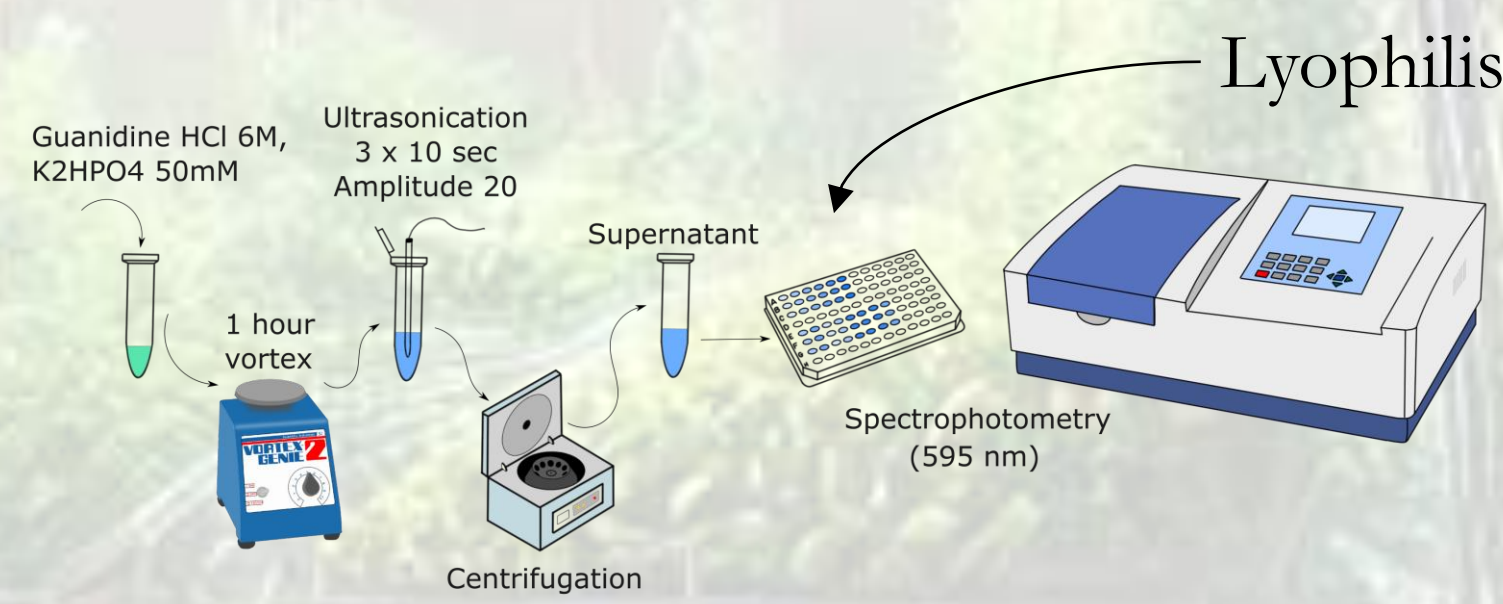


Figure 4. Total protein content by Bradford 1976 method

Biostimulation experiments

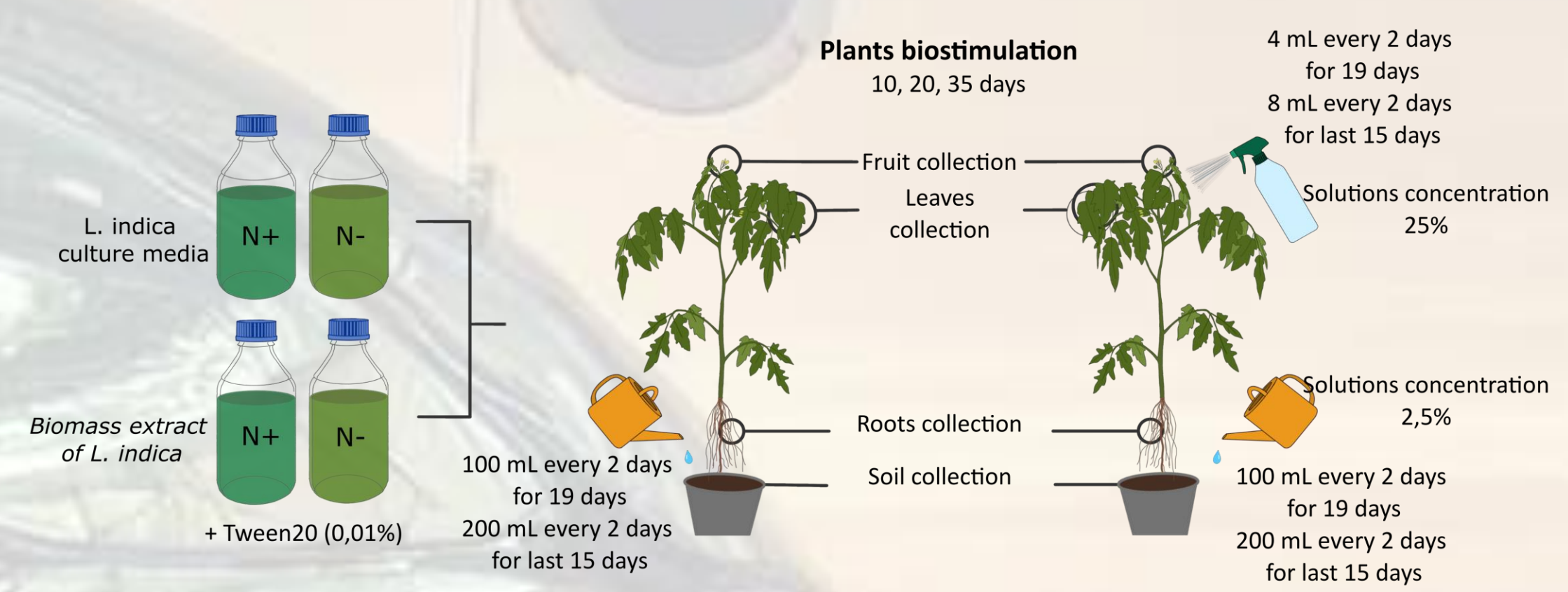


Figure 3. Biostimulation experiment procedure on *Solanum lycopersicum* plant growth

Biostimulant extract characterisation

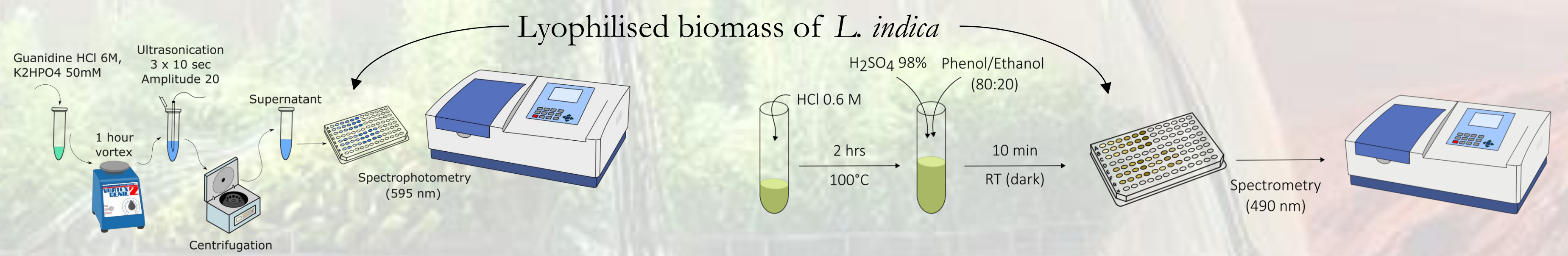
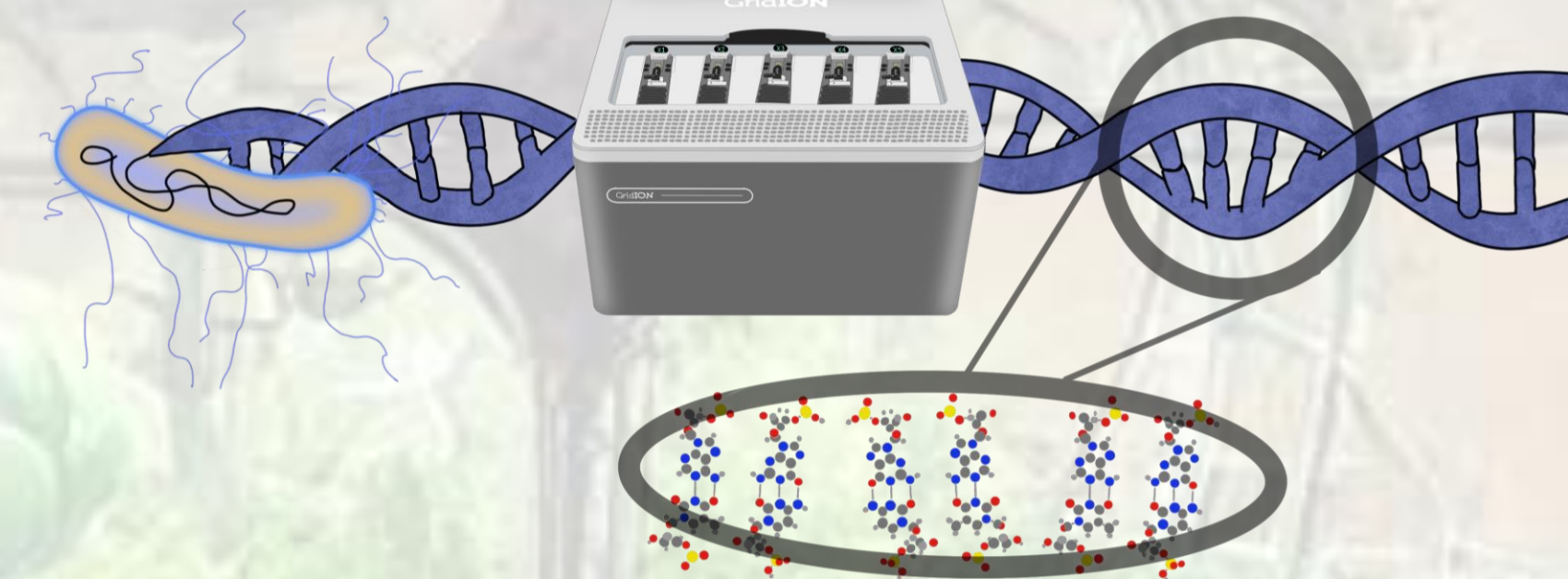


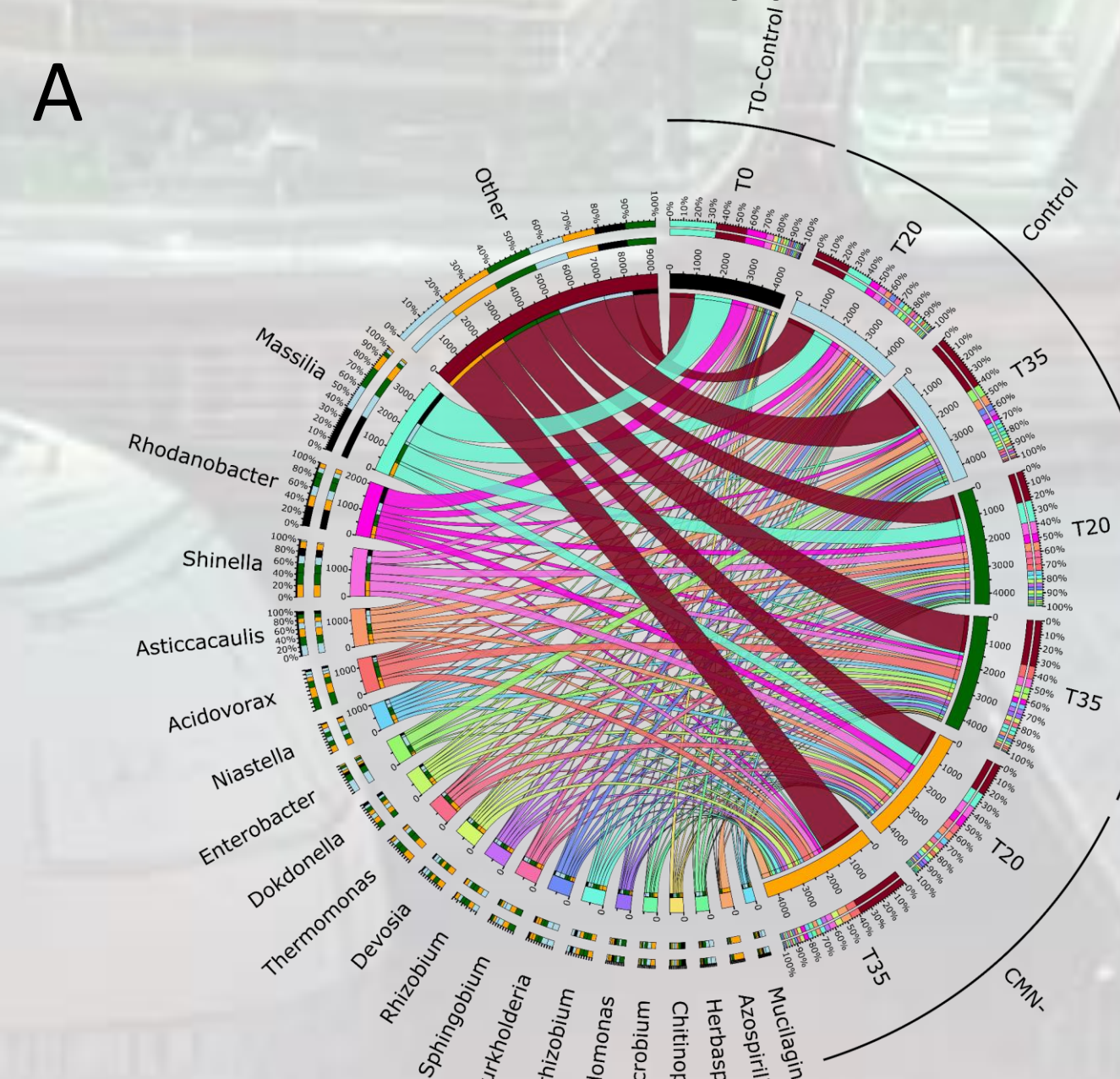
Figure 5. Total carbohydrate content by Dubois et al. 1956 method

16S sequencing



Endophytic microbiota response to culture media based biostimulants

Amendment application



Foliar application

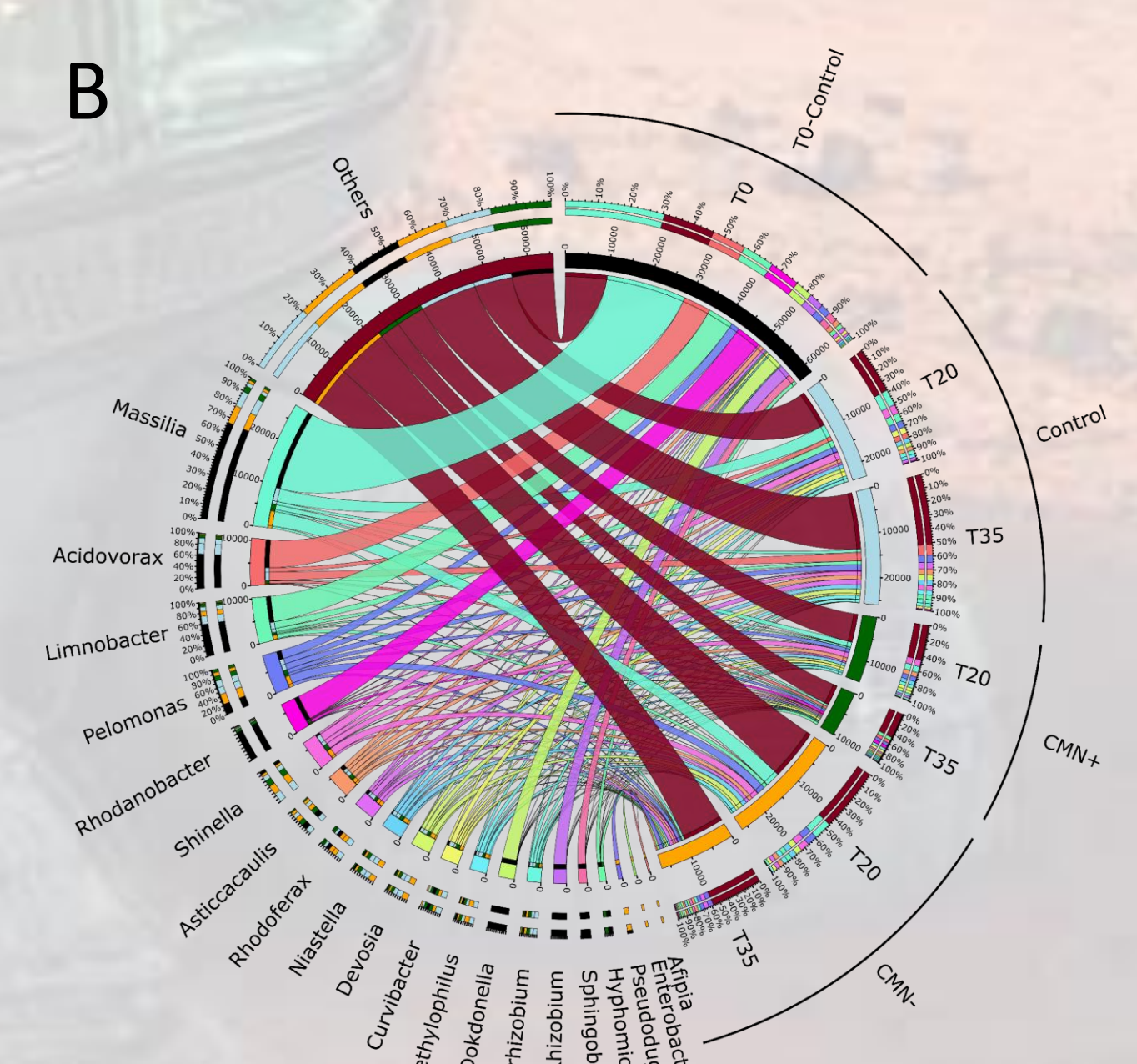


Figure 8. Circos graphs (Krzyszowski et al. 2009) representing the relative abundance endophytic microbiota at T0, T20 and T35 following the application of *L. indica* culture media based biostimulant via amendment (A) and foliar (B) treatment.

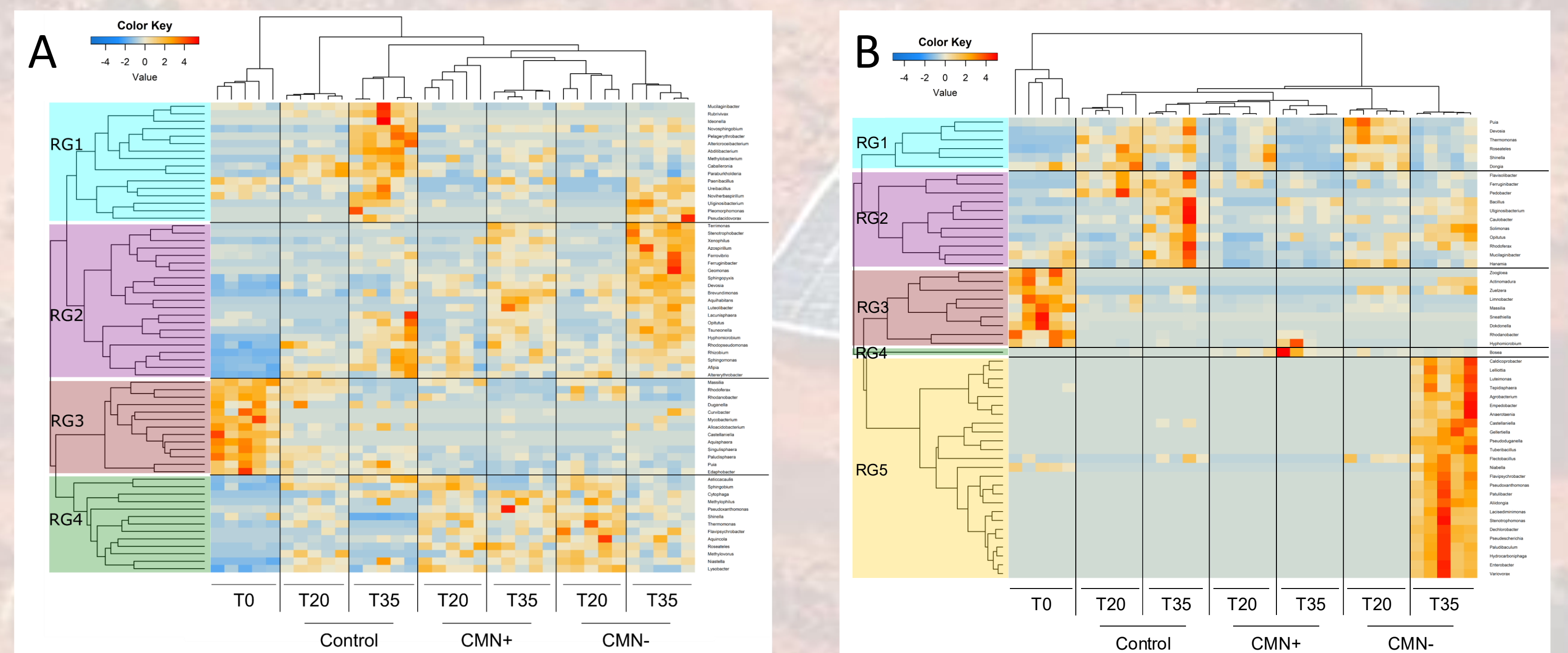


Figure 9. Heatmap of the genera significantly affected by the biostimulant solutions from the endophytic microbiota at T0, T20 and T35 following the application of *L. indica* culture media based biostimulant via amendment (A) and foliar (B) treatment.