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DEVELOPMENT OF SUBSTRATES FOR AEROPONIC AND HYDROPONIC SYSTEMS

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SPOKE AND WP

Spoke 8, WP 8.1

ABSTRACT

Indoor vertical farming has been increasingly **applied and studied** in the last few years. The **reason** for this is **twofold**: the search for new agricultural techniques to **mitigate the effects of climate change** and the development of ways to **grow crops in harsh environments** [1] . **Hydroponics** and **aeroponics** have **proven to be effective** in these two task. However, they **still lack the energy and material sustainability** [2] to make them commercially viable: the most used **substrates are non-reusable** and are **difficult to dispose** of. The **goal** of this study is to **develop and test new types of substrates** that are more **eco-friendly** and **economically viable** [3] , employing biomaterials as the main component**. Two of such substrates (methylcellulose- and chitosan-based materials) were tested against rockwool by growing lettuce in a Nutrient Film Technique hydroponic system and an aeroponic systems**: during the growth cycle, **some grow parameters were fixed**, like nutrient flow rate, light intensity, pH and EC, while **some final ones were monitored** (substrate absorptivity, wet weight and algae resistance and plants height, width and final weight) **and compared**.

MATERIALS AND METHODS

Materials

The goal was to **test 12 samples** of two new substrates (**methylcellulose- and chitosan-based** materials) against rockwool. **Lettuce** was grown in a **Nutrient Film Technique (NFT) hydroponic system**:

- **8 channels** with independently **adjustable nutrient** water **flow rate**
- Capable of holding **60 plants at a time**.
- **Light** provided by a **dimmable** and **time programmable full-spectrum 400W LED lamp**
- **Automatically measured and controlled** nutrient solution **pH**
- **EC** (electrical conductivity) **manually adjusted**

Methods

Fixed grow parameters:

- **Light** intensity **of 290 μmol·m−2·s−1**
- Samples **near** the **inlet** nutrient **nozzles**
- **pH** of the nutrient solution kept **between 5.8 and 5.2**
- **EC kept between 900 and 1400 μS/cm**
- The **flow rate** in each channel set at **1 L/min**
- **32 days** grow cycle **duration**

Monitored grow parameters:

- **Initial dry weight** of the substrates
- **Wet weight** of the substrates
- **Height** and **leaf area** of the plants
- **Final wet and dry weight** of the plants

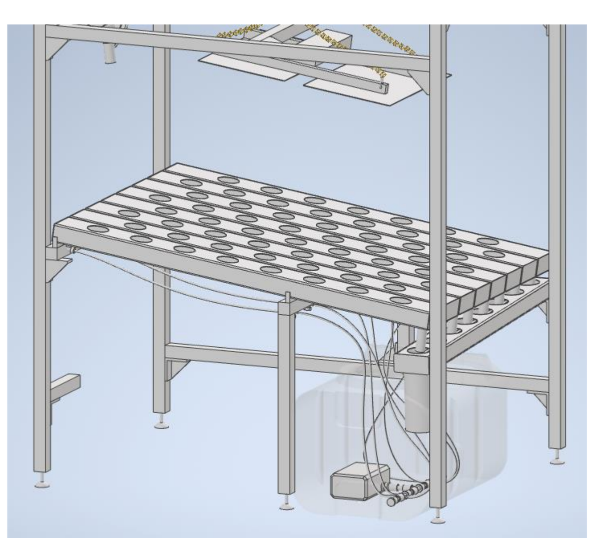

Figure 1: CAD model of the NFT system

Figure 2: Growing lettuce

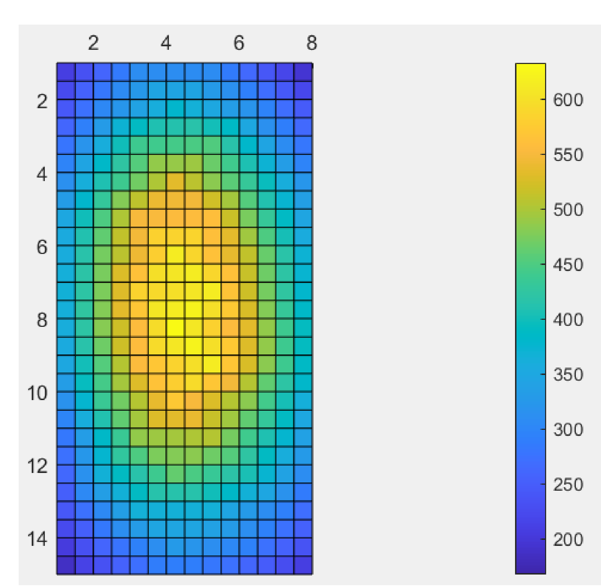

Figure 3: Light map

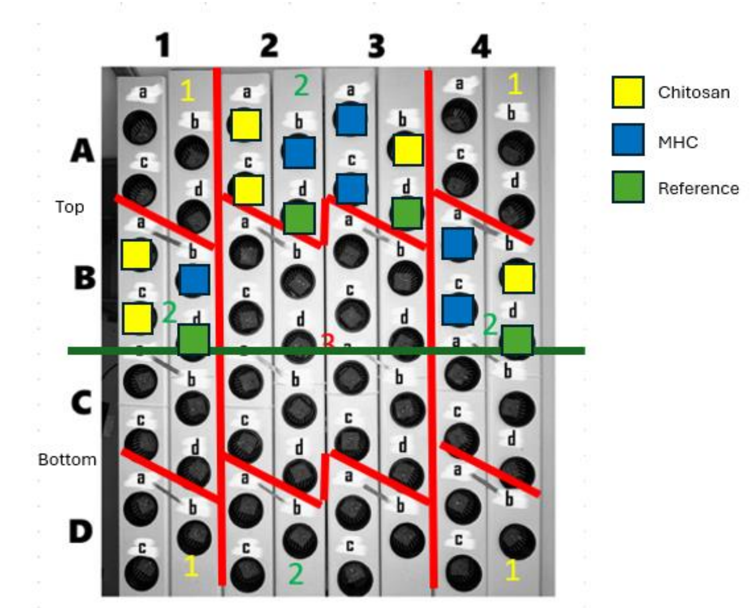

Figure 4: Distribution of the samples in the system

RESULTS AND CONCLUSIONS

Results

- The **new** substrates are **lighter** and can **hold more water** than rockwool
- **MCH** and rockwool **kept** their **shape and weight**, while the **chitosan dissolved** in few days
- **Rockwool** managed to **grow bigger and taller plants**
- **Chitosan** and rockwool showed **good resistance to algae**, while the **MCH** showed **clear algae development**

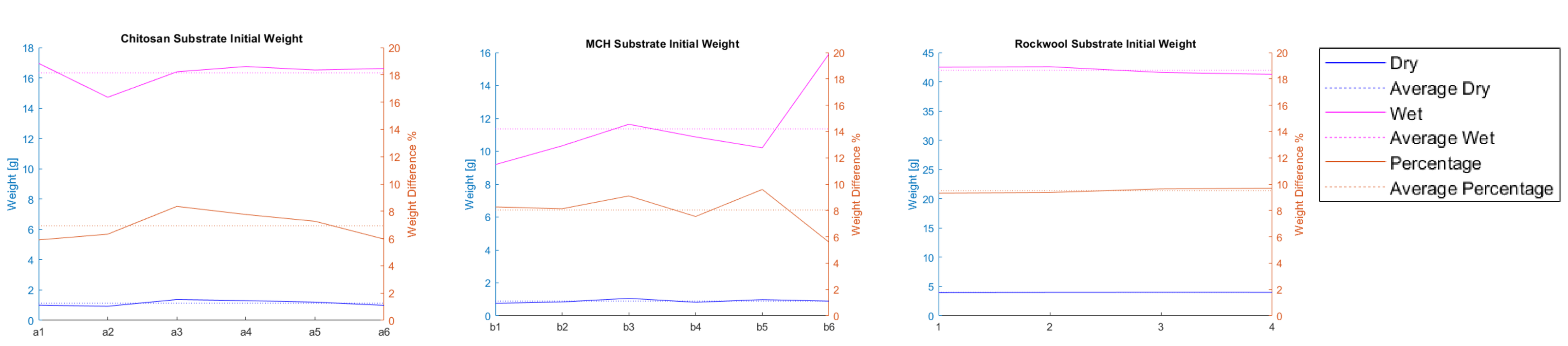

Figure 5: Initial dry weight, initial wet weight and absorptivity

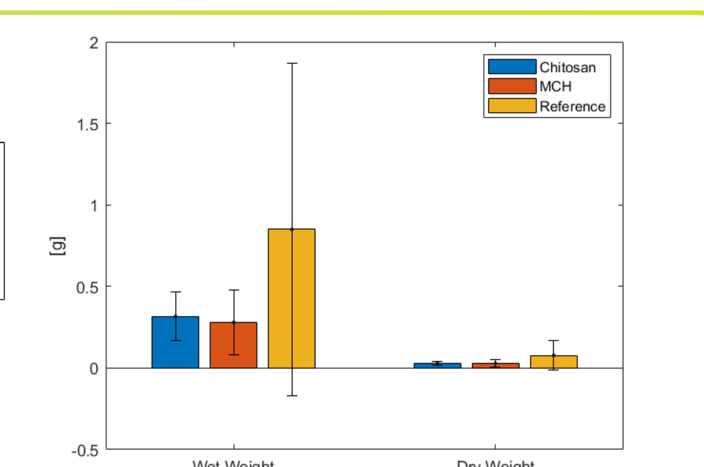

Figure 6: Final wet and dry weight of the plants

Conclusions and future work

- **MCH**, even though **not as good as rockwool**, could be used as a **viable substrate**, especially for its shape retention and low degradation
- **More experiments** and grow cycles **are needed**: the **study** it is **in progress** and the collected data is small**. More tests will be carried out**, not only by **increasing** the sheer **number of samples**, but also by trying **different parameters and systems** (like aeroponics).

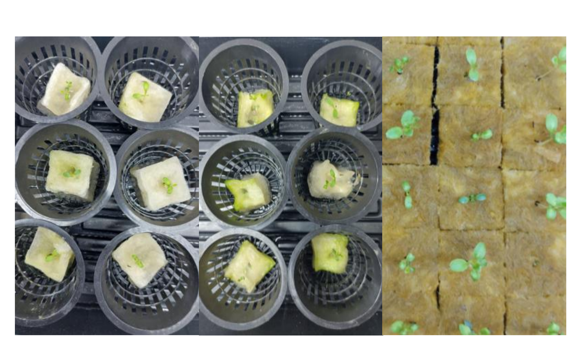

Figure 7: Lettuce sprouting on developed substrates

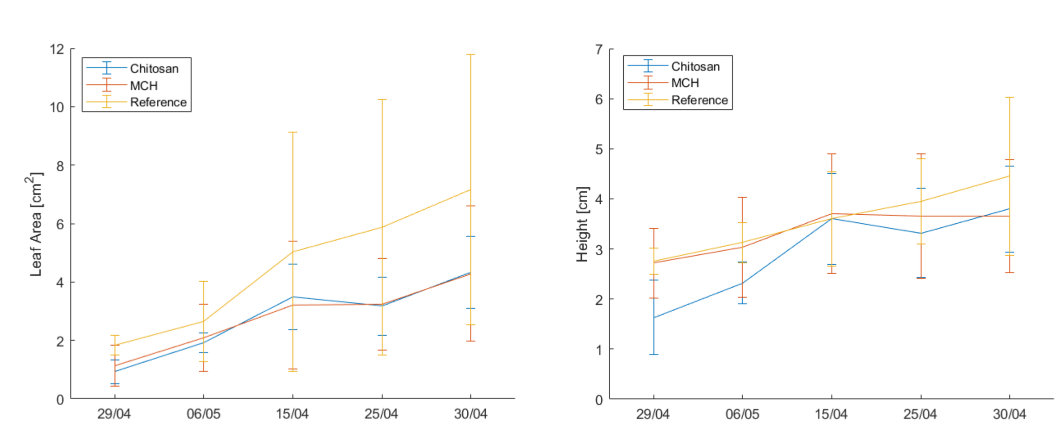

Figure 8: Evolution of height and leaf area of the plants

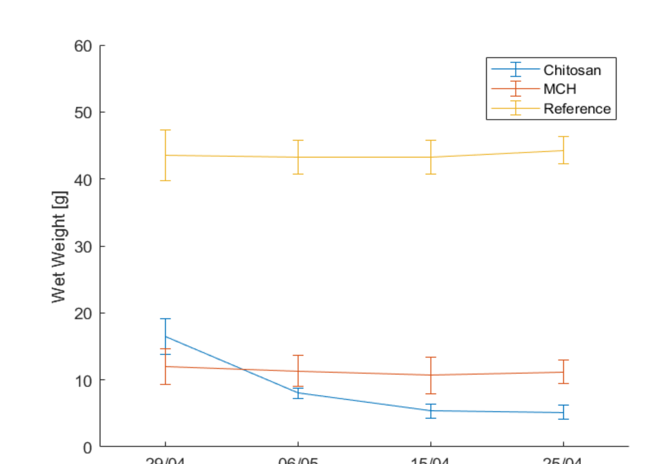

Figure 9: Evolution of the wet weight

REFERENCES

[1] Resh, Howard M. *Hydroponic food production: a definitive guidebook for the advanced home gardener and the commercial hydroponic grower*. CRC press, 2022.
[2] Sharma, Swayam, Namrata Dhanda, and Rajat Verma. "Urban vertical farming: a review." *2023 13th International Conference on Cloud Computing, Data Science & Engineering (Confluence)*. IEEE, 2023.
[3] Bonetti, Lorenzo, Luigi De Nardo, and Silvia Farè. "Crosslinking strategies in modulating methylcellulose hydrogel properties." *Soft Matter* 19.41 (2023): 7869-7884.

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