

## Research Problem

- Only 2.5% of the Earth's water is freshwater, and just 0.3% is accessible for human use.
- By 2050, the global population is expected to reach 9.8 billion, requiring a 50% increase in food production.
- Food demand puts growing pressure on limited water and land resources.
- Hydroponics offers a promising solution due to its water efficiency and adaptability.
- However, wastewater reuse in hydroponic systems presents challenges with microbial contamination and water quality.
- **This study addresses these concerns by developing sustainable, simple, and synergistic water treatment strategies of FILTRATION AND UV-C to optimize wastewater reuse in hydroponic romaine lettuce production.**

## Objectives

- To validate the effectiveness of filtration and UV-C treatment for safe water reuse in hydroponics.
- To assess the use of treated wastewater on the growth and nutritional quality of romaine lettuce.

## Materials And Methods

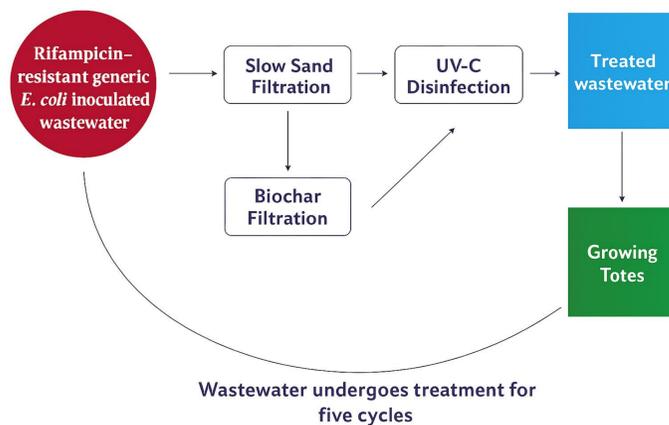


Figure 1: Wastewater treatment model



Figure 2: A deep water culture system

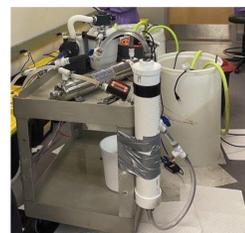


Figure 3: The wastewater treatment system

## Results

**KEY:**  
SSF – SLOW SAND FILTRATION UV-C – ULTRAVIOLET DISINFECTION



Figure 3: Color change after SSF+UV-C treatment



Figure 4: Color change after SSF+BIOCHAR+UV-C treatment

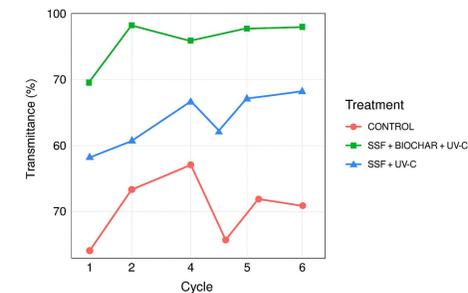


Figure 5: Transmittance after treatment across cycles

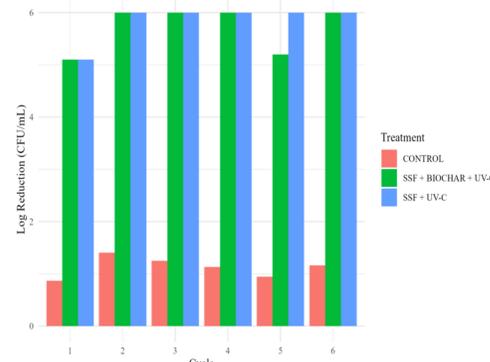


Figure 6: Microbial log reduction after treatment across cycles

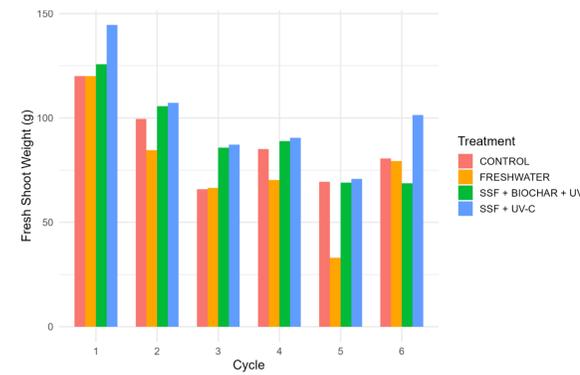


Figure 7: Fresh shoot weight across cycles

Table 1: Nitrate(NO<sup>3</sup>-N)mg/L concentrations after treatment across cycles

Treatment	n	Cycle	NO <sup>3</sup> -N(mg/L)
Control	3	1	87.37±2.63 <sup>Bbc</sup>
		2	81.55±1.32 <sup>Bab</sup>
		3	74.69±6.55 <sup>Bab</sup>
		4	90.37±17.91 <sup>Bc</sup>
		5	74.37±3.63 <sup>Ba</sup>
		6	72.89±6.48 <sup>Ba</sup>
SSF+UV-C	3	1	79.09±9.13 <sup>Bbc</sup>
		2	80.48±16.83 <sup>Bab</sup>
		3	76.30±7.95 <sup>Bab</sup>
		4	100.16±12.08 <sup>Bc</sup>
		5	81.02±5.90 <sup>Ba</sup>
		6	78.18±9.49 <sup>Ba</sup>
SSF+BIOCHAR+UV-C	3	1	81.41±3.57 <sup>Abc</sup>
		2	67.12±12.22 <sup>Aab</sup>
		3	66.35±3.20 <sup>Aab</sup>
		4	86.14±11.45 <sup>Ac</sup>
		5	46.44±16.94 <sup>Aa</sup>
		6	47.58±17.64 <sup>Aa</sup>

Values are presented as mean ± standard deviation(SD). Different uppercase letters within each column indicate significant differences among treatments; different lowercase letters indicate significant differences across cycles (p < 0.05).

## Discussion

- Effluent from SSF + UV-C had a greenish tint, while water from SSF + Biochar + UV-C appeared clear (resulting in the highest UV-C transmittance at 254nm).
- Both treatments achieved >4 log CFU/mL reduction of *E. coli*.
- Nitrate (NO<sup>3</sup>-N) levels were lowest in SSF + Biochar + UV-C treated water because of biochar's adsorption capacity for removing chemical contaminants.
- Romaine lettuce grown with SSF+UV-C-treated water had the highest shoot weight, and there was no significant difference between SSF + Biochar + UV-C and control water.
- Romaine lettuce grown with freshwater had the lowest shoot weight, producing 24.6% less than the highest-performing treatment (SSF + UV-C).
- Shoot weight declined by 35.3% between Cycle 1 and Cycle 6, a reduction that was statistically significant (p < 0.001).

## Conclusion

- Both treatment strategies, SSF + UV-C and SSF + Biochar + UV-C produced microbiologically safe water with no detectable generic *E. coli*/100 mL, suitable for hydroponic reuse.
- SSF + UV-C demonstrated the highest *E. coli* reduction (≥6 log CFU/mL) and consistently supported the highest romaine lettuce shoot weight, making it optimal for food safety and crop productivity.
- SSF + Biochar + UV-C resulted in the clearest effluent with the lowest nitrate concentrations, minimizing nutrient buildup and potential toxicity.
- Reclaimed water from SSF + UV-C remained effective for up to four growing cycles, supporting long-term reuse in hydroponics

## References

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