A comparative study of the impact of greywater and freshwater irrigation on plant growth and biomass production

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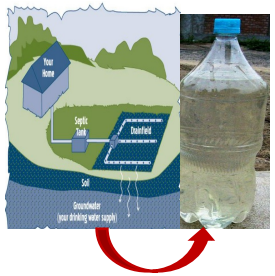
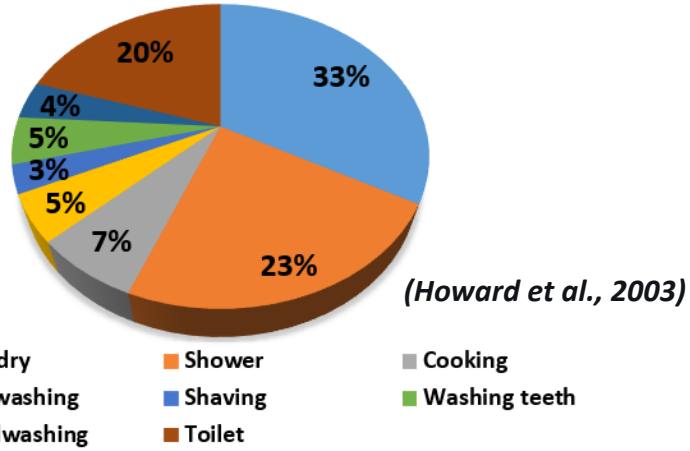
Background: Importance of greywater usage



Worldwide annual greywater generation (70% of Domestic wastewater)



(Howard et al., 2003)

Different sources

Different compositions

Sustainable Development Goals, 2030

Sustainable vegetative green wall

Specific research objectives

Comparison of the growth performance of plants irrigated with freshwater and greywater

To analyze plant morphological characteristics based on irrigation treatment.

To analyze the biomass characteristics of plant parts based on the irrigation treatment.

Compare soil properties post-irrigation for freshwater and greywater in relation to initial soil state.

Experimental methodology

Synthetic greywater recipe

Ingredient	Quantity (mg/L)	Brand
Moisturizer	10	Nivea (Intensive moisture body milk)
Toothpaste	32.5	Colgate herbal
Deodorant	10	Nivea men
Sunflower oil	7	Orima
Handwash	720	Lux perfumed handwash – Golden allure
Shampoo	720	Head and shoulders classic clean
Shower gel	64	Palmolive aroma
Washing powder	150	Tide automatic

Plant growth test

Mixed bare soil

Ruellia tuberosa plant

Total wt.: 450 g
Potting soil: sand=1:2

Water application

Freshwater

Greywater

90 Days

5 replicates

Plant setup

Harvested

- ✓ Evapotranspiration test
- ✓ Plant growth
- ✓ Number of chlorosis leaf
- ✓ Number of branches and leaf
- ✓ Chlorophyll content

Characterization

Freshwater

Greywater

Plant and soil biomass

Characterization

- Dry weight biomass test
- SEM, EDS, FT-IR
- Phosphorus retained
- Mineral retained

Results and Discussion

Physicochemical Characteristics

Water characteristics

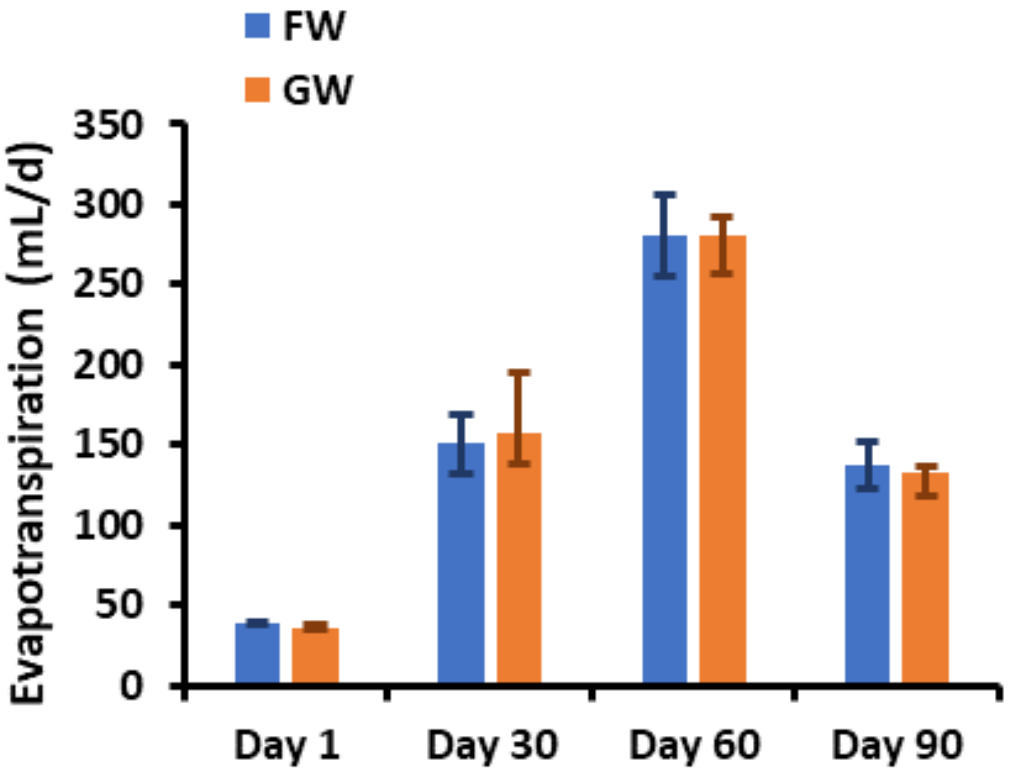
Parameter	Freshwater	Greywater
pH	7.7 ± 0.4	7.1 ± 0.5
ECE (µS/cm)	139 ± 9.2	1250 ± 18.6
COD (mg/L)	0.6 ± 1.2	663 ± 6.4
TOC (mg/L)	0.2 ± 0.1	336 ± 3.8
PO_4^{3-} (mg/L)	0.09 ± 0.1	5.2 ± 2.3
NH_3^+ (mg/L)	0.06 ± 0.1	3.6 ± 1.4

Media characteristics

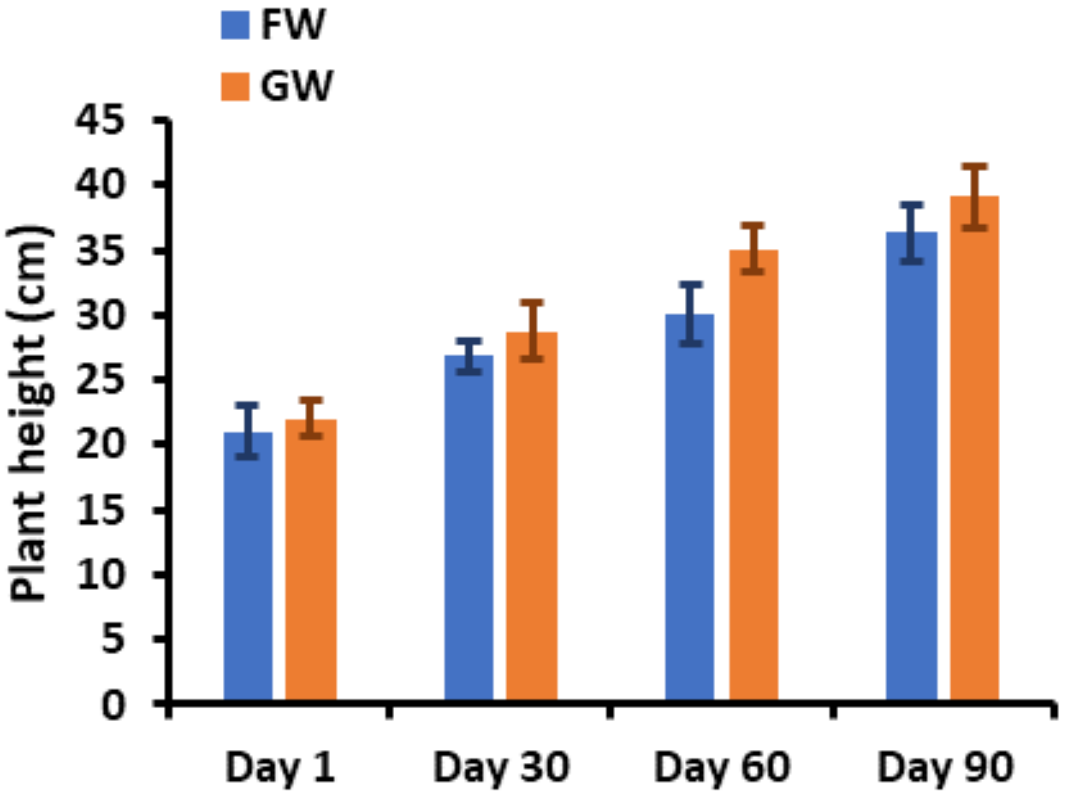
Parameter	Value
Water holding capacity (%)	43.6 ± 2.4
pH	6.8 ± 0.5
ECE (µS/cm)	835.9 ± 1.4
Porosity (%)	60.0 ± 2.0
Bulk density (g/cm^3)	0.4 ± 0.1
Particle density (g/cm^3)	1.5 ± 0.6
Moisture content (%)	55.9 ± 1.1
BET surface area (m^2/g)	1.3 ± 0.8
Zeta potential (mV)	-20.3 ± 1.7
C: H: N: S (%)	28.5: 2.5: 1.0: 0

Results: Plant characterization

Evapotranspiration



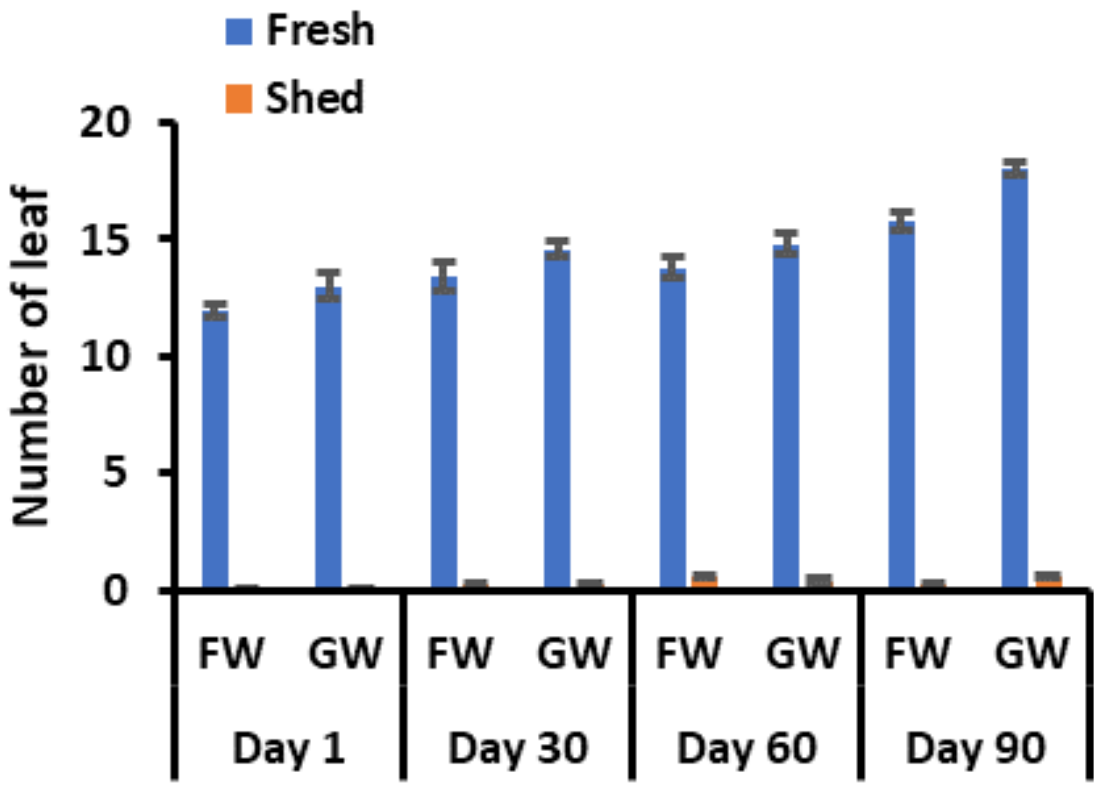
Plant height



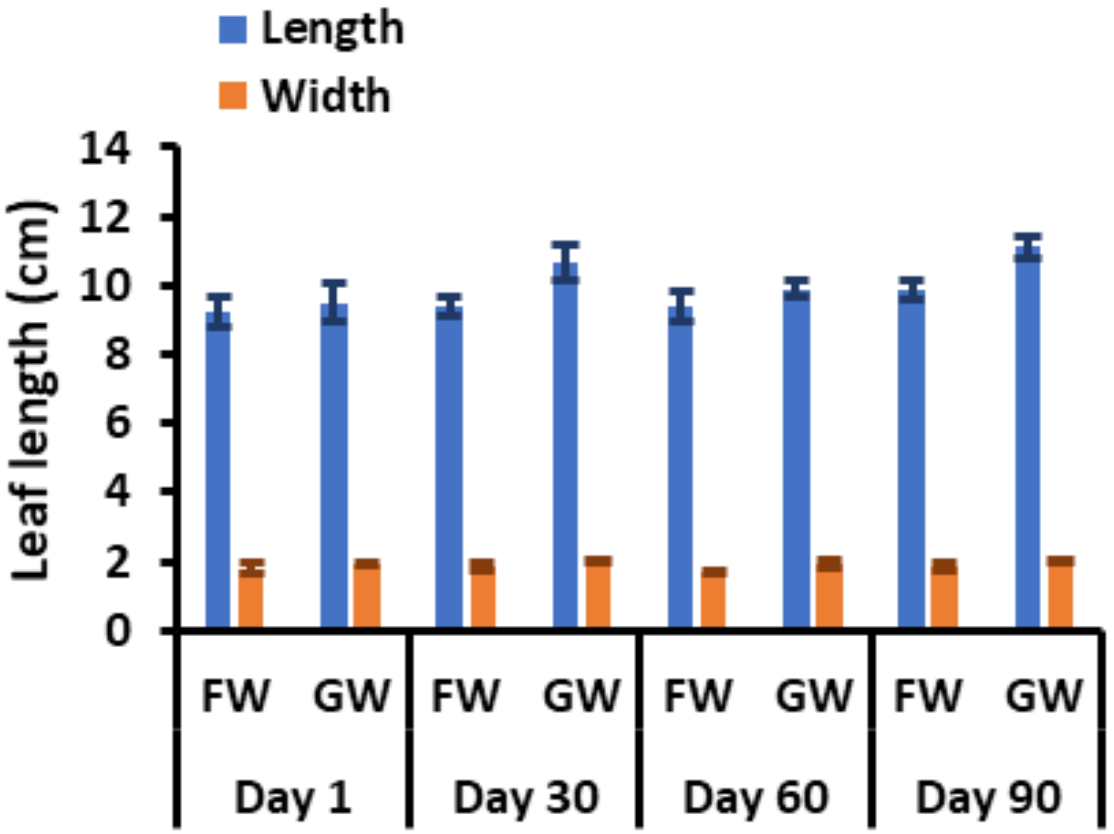
GW: Greywater; FW: Fresh water

Results: Plant characterization

Number of leaves



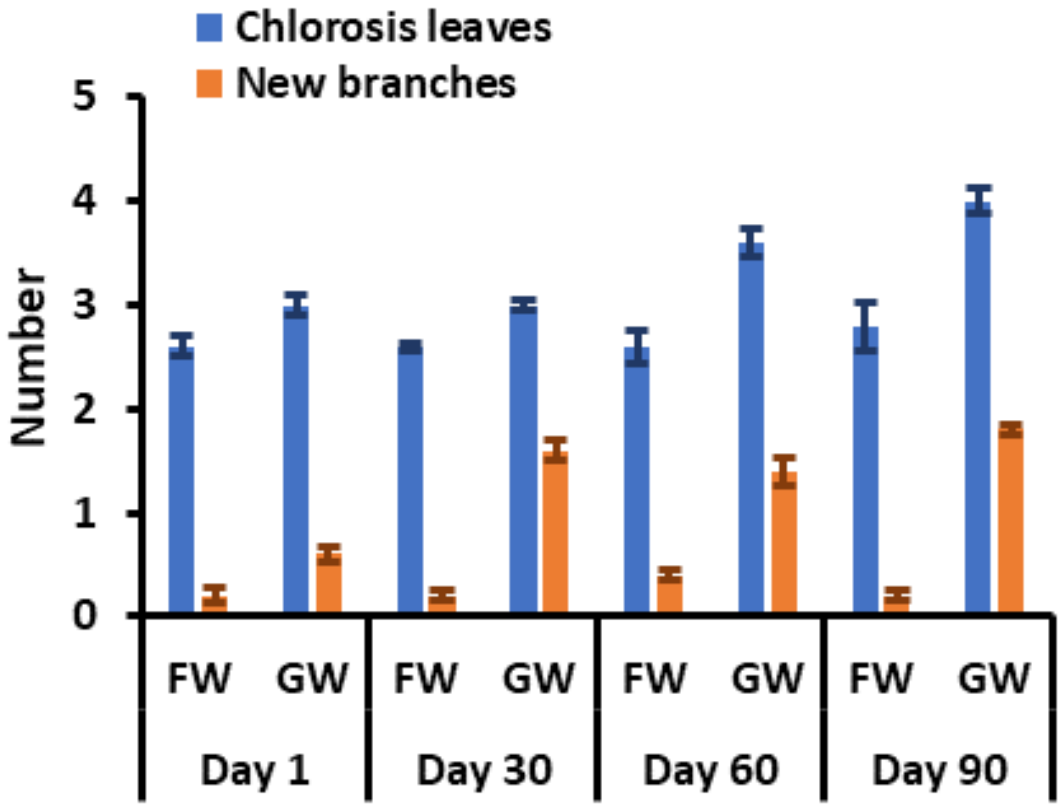
Leaf length



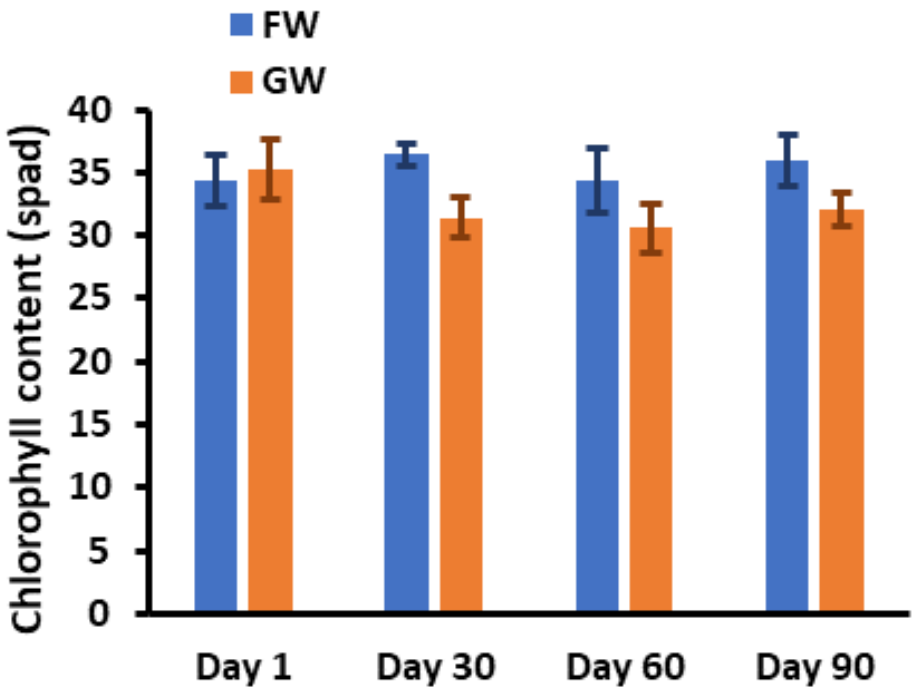
GW: Greywater; FW: Fresh water

Results: Plant characterization

Leaf chlorosis and new branches

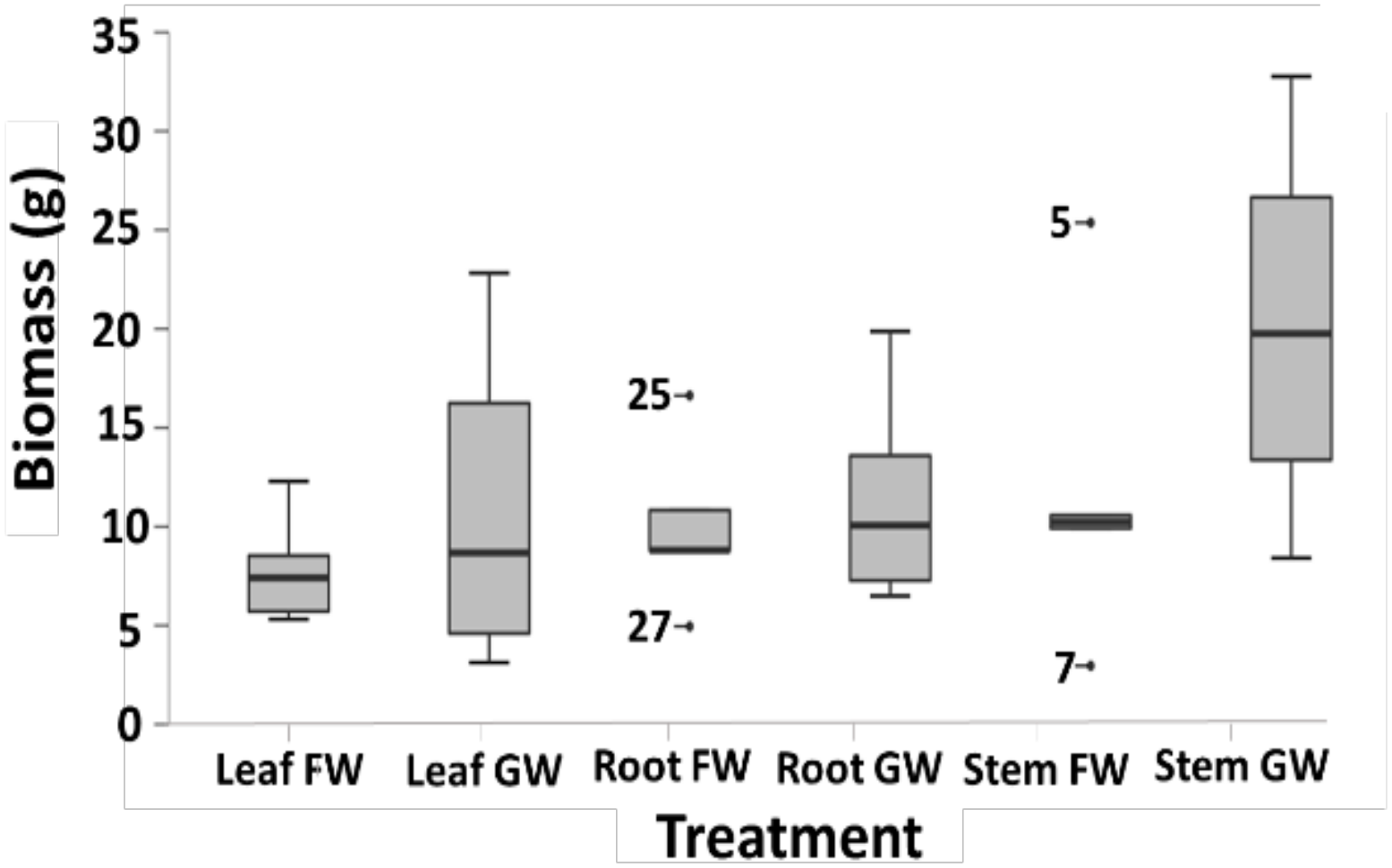


Chlorophyll content



GW: Greywater; FW: Fresh water

Results: Plant characterization

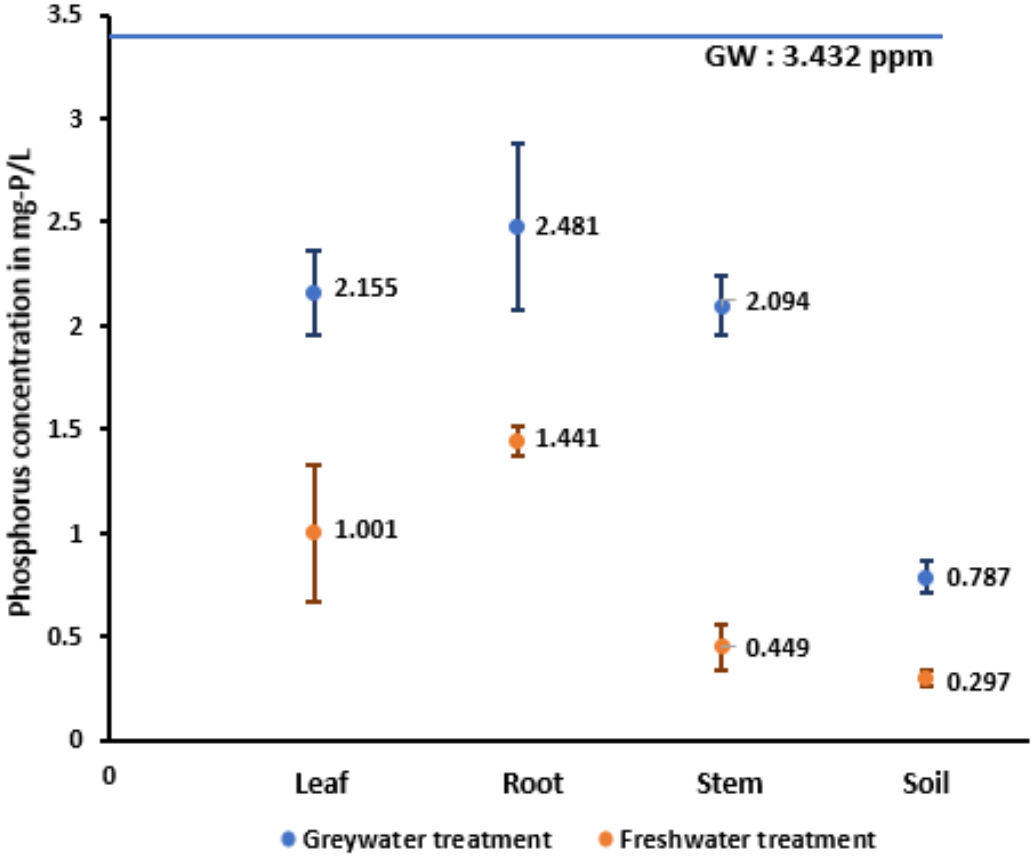


- **GW biomass > FW biomass by 43%**
- **Leaf biomass > stem biomass > root biomass**

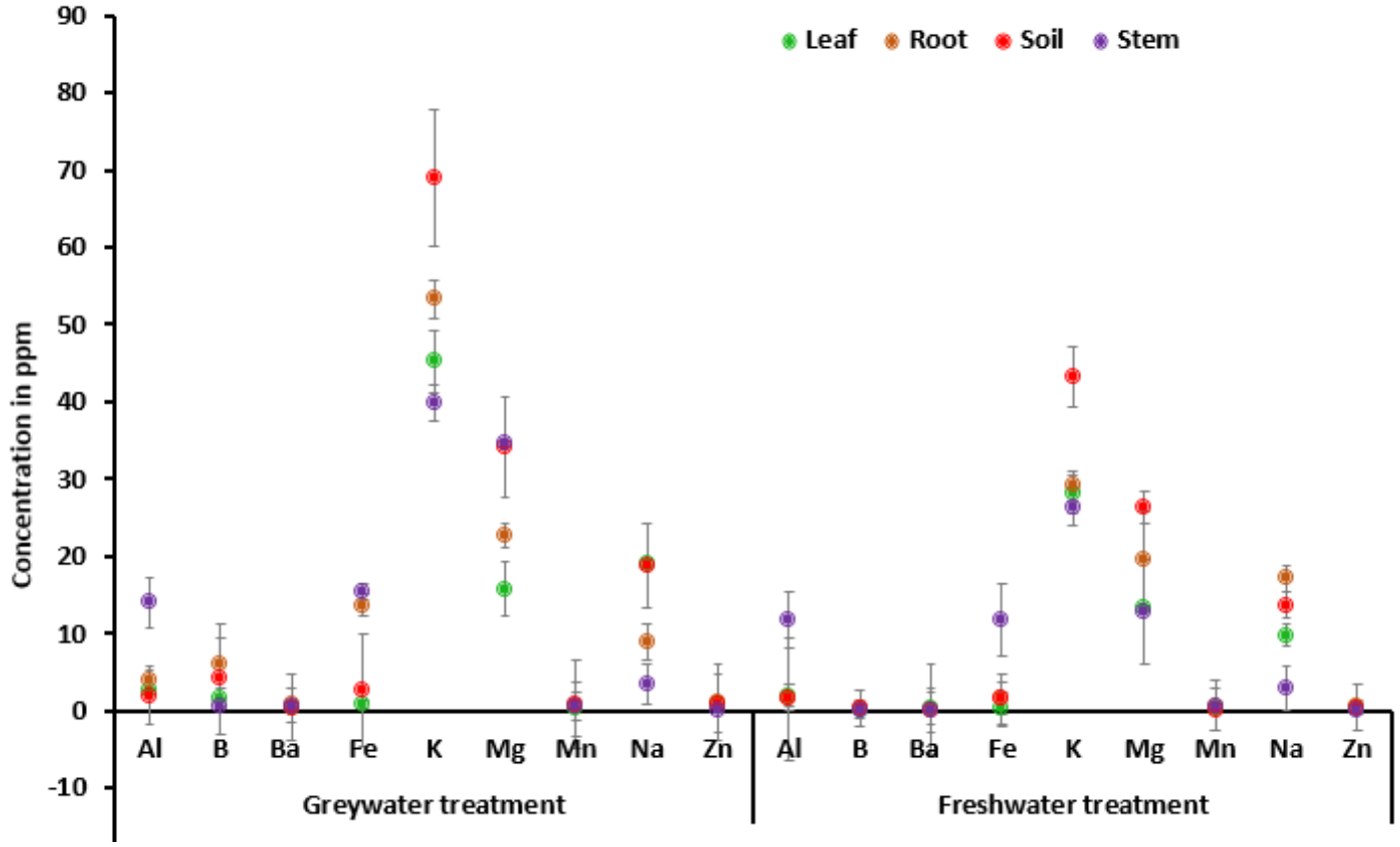
GW: Greywater; FW: Fresh water

Results: Nutrients and minerals in plant biomass and soil

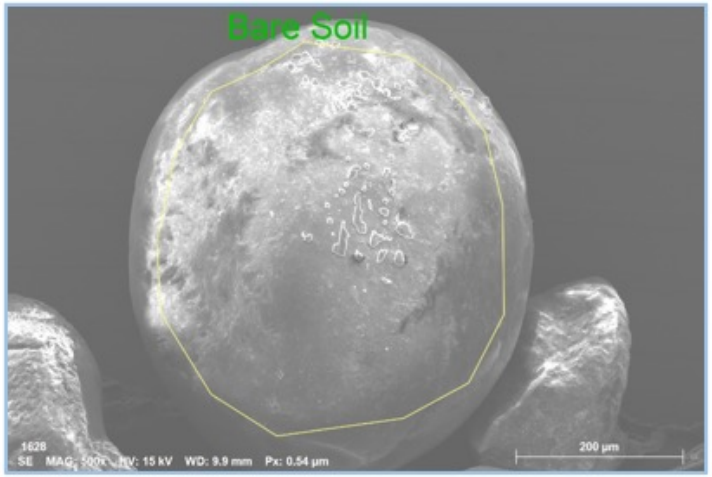
Phosphorus content

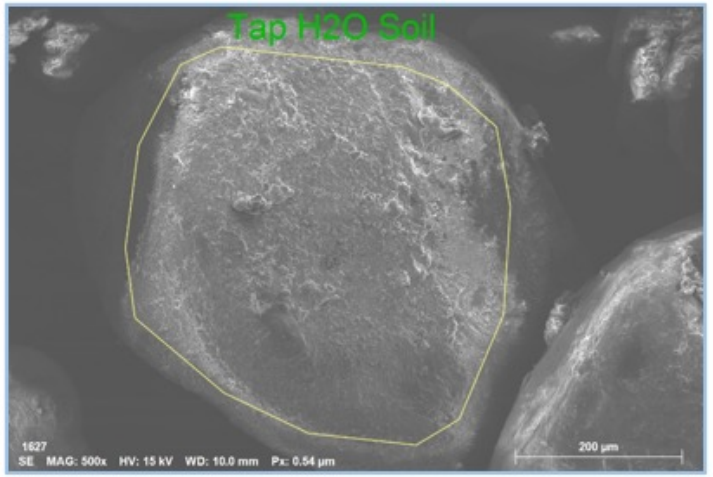


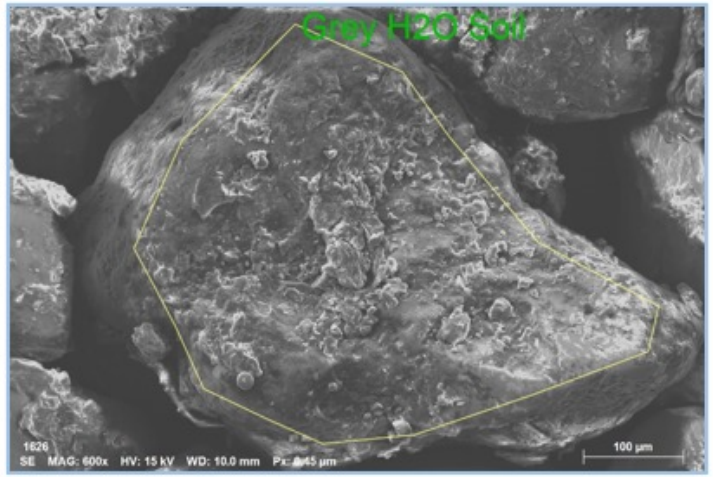
Mineral content

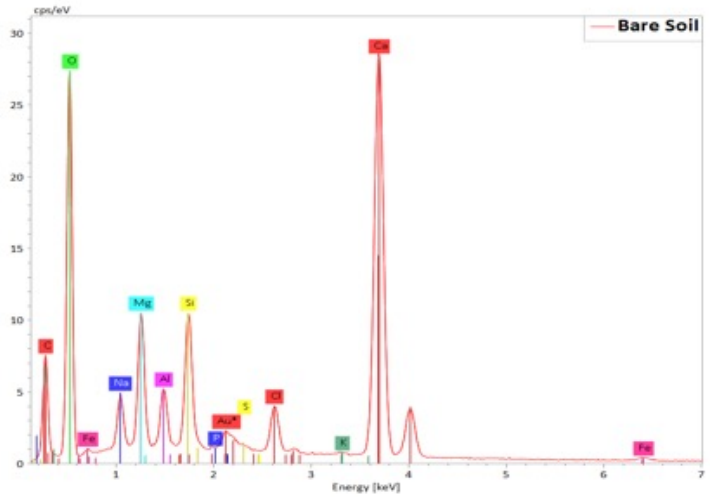


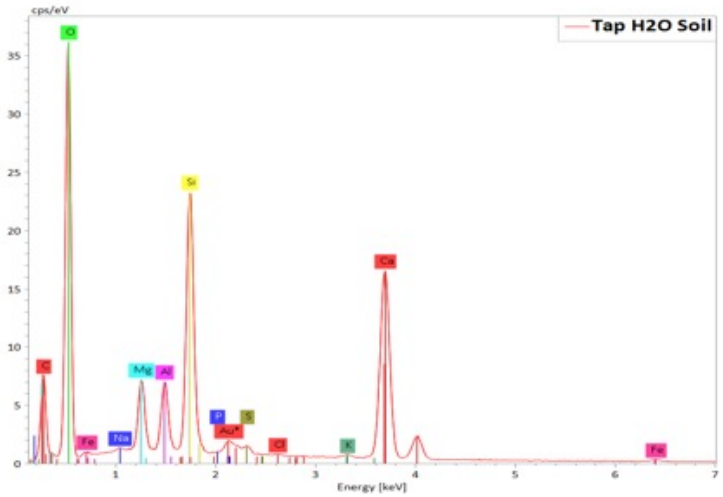
EDS Analysis of media before & after treatment

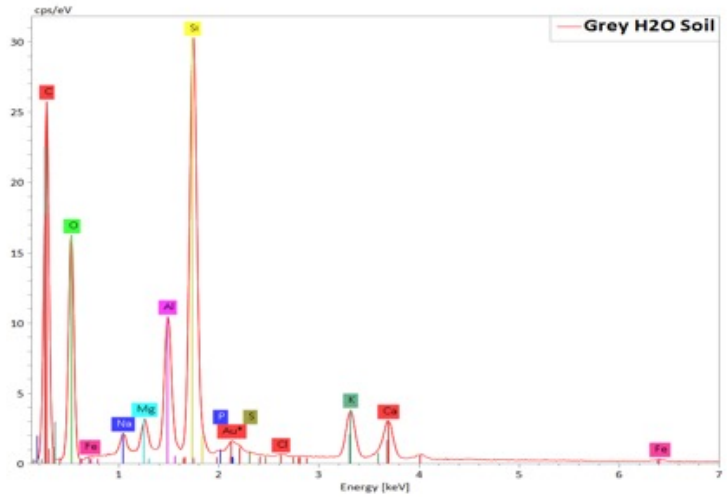












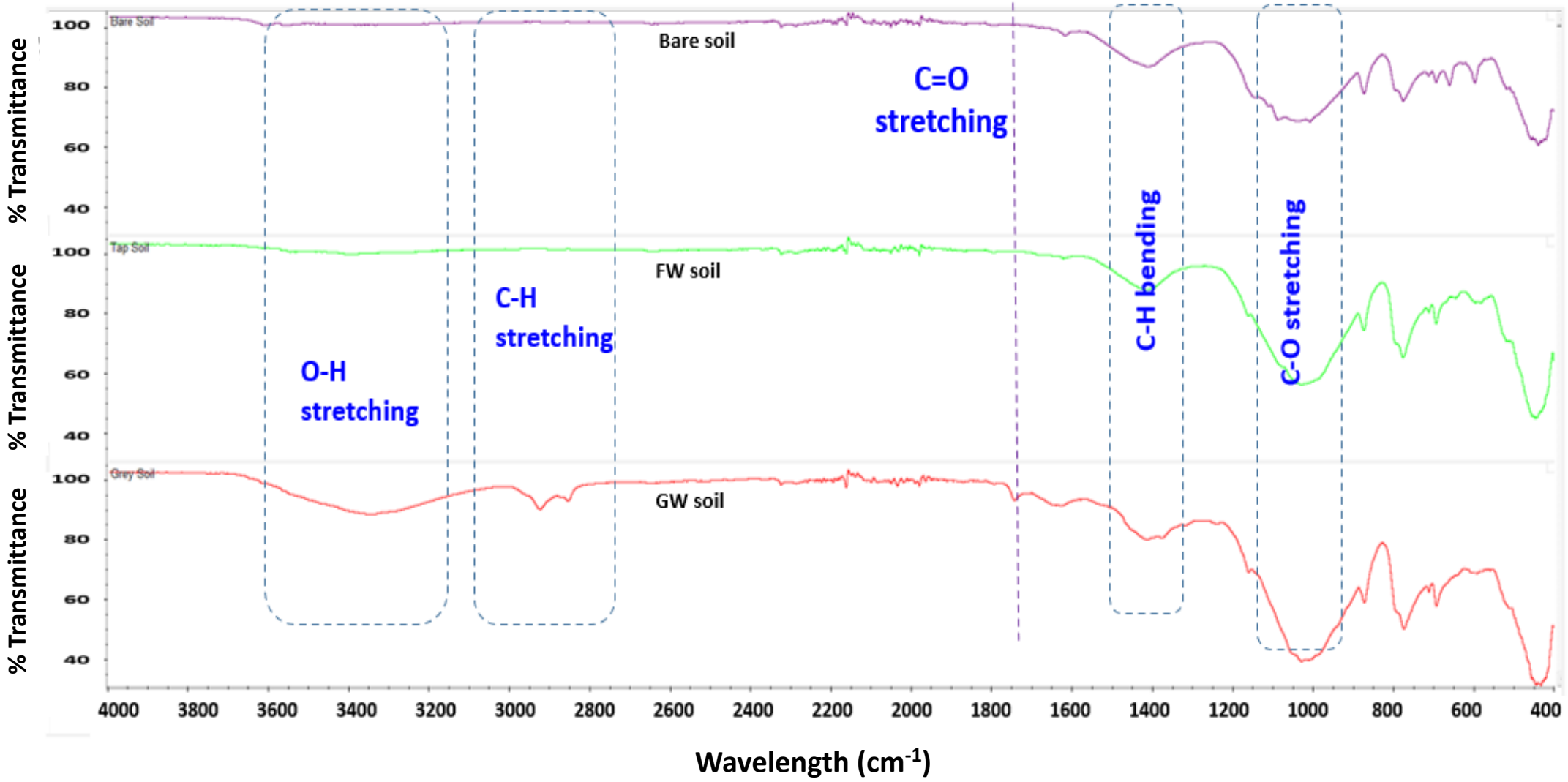
Bare soil

Freshwater applied soil

Greywater applied soil

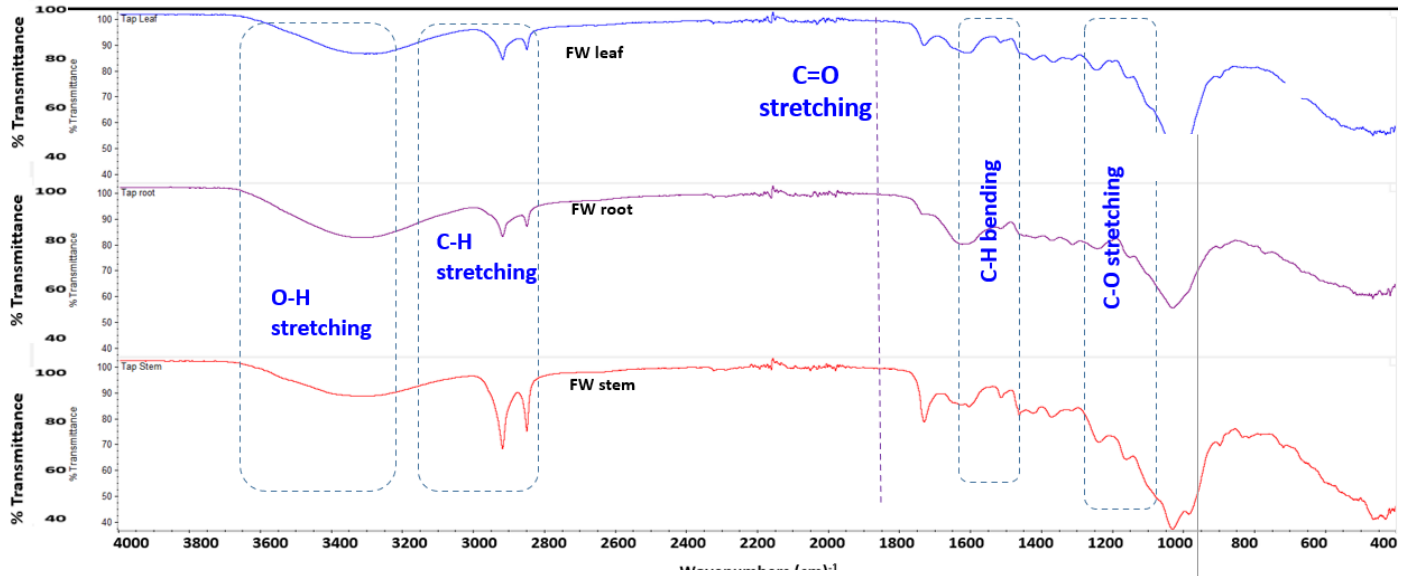
Results: FT-IR characterization

Media before and after treatment

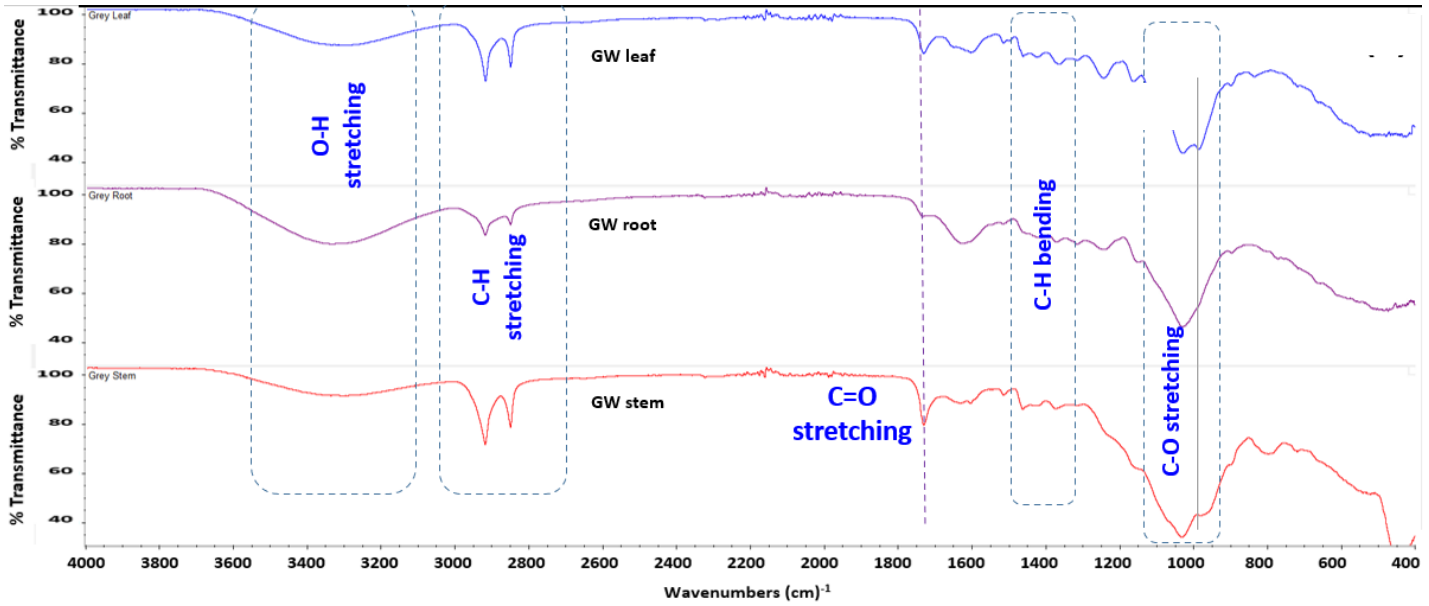


Results: FT-IR characterization

Freshwater treated biomass



Greywater treated biomass



Conclusion

- Greywater is a suitable alternative to freshwater irrigation as it did not negatively affect the growth of plant and supply nutrients to soil.
- Minerals and nutrients were found to increase in the GW irrigated soil resulted in 15% higher plant growth
- Future studies should be focus on the long-term monitoring of soil minerals
- *Ruellia tuberosa* is a promising plant candidate under greywater irrigation
- Future study is needed to determine long-term resilience and contribution to treatment through nutrient and organic uptake.
- These systems could also be used as urban production centers for biomass for energy production
- Future studies should be focus on alternative plants for the greywater treatment

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