IECAG 2024 Conference
The 4th International Electronic Conference on Agronomy
02–05 December 2024 | Online
MDPI

The effect of hydrochar from aloe vera residues on cherry tomato growth and soil microbial activities

Concepción García-Gómez[1*], Dimitrios Kalderis[2], María Dolores Fernández[1]

1. Dep. of Environment and Agronomy, Inst. Nal. de Investigación y Tecnología Agraria y Alimentaria (INIA,CSIC), 28040 Madrid, Spain. * cgarcia@inia.csic.es; mdfdez@inia.csic.es
2. Department of Electronic Engineering, Hellenic Mediterranean University, 73100 Chania, Greece. kalderis@hmu.gr

1. INTRODUCTION & AIM

Aloe vera residues are increasing due to the growing demand for the gel, driven by the expanding range of applications. These residues were converted into hydrochar through a hydrothermal carbonization (HTC) process, with the dual objectives of contributing to the circular bioeconomy and serving as a secure organic amendment to enhance soil quality.

Intensive agricultural practices such as monocultures, excessive tillage, use of pesticides and fertilizers, have adversely affected soil quality, leading to the depletion of organic matter (OM), reduced crop yields, and a loss of biodiversity.

Aim: To evaluate the effects of applying an unwashed hydrochar derived from aloe vera residues, as a soil amendment, on both plant and soil microorganisms.

Raw materials
- Aloe vera based-hydrochar obtaining: HTC process (220 ºC, 4 h) [1]
- Seeds of cherry tomato (*L. esculentum* var*. cerasiforme*)
- Agricultural soil (Madrid, Spain): Sandy loam texture, pHw (1:2.5) 7.4, OM 3.6%, ECw (1:5) 250 µS/cm

2. EXPERIMENTAL DESIGN & METHODS

Experimental timeline

Hydrochar:soil mixtures (w:w dry weight, triplicate): 0% (control), 0,5%, 1% and 3% hydrochar

1 day equilibrium

TRIAL 1 (from day 1 to day 36)

Sowing 8 tomato seeds per pot

Harvesting (day 36)

Aging of blends (5 months)

TRIAL 2 (from day 145 to day 180)

Sowing (day 145)

Harvesting (day 180)

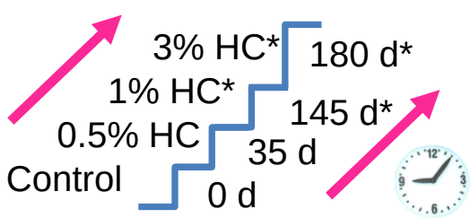
Determinations (at 35, 145 and 180 days)
- Germination of seeds
- Plant growth

In leaves [2]:
- Photosynthetic pigments and protein contents
- Biomarkers (ROS, GPOD, CAT, MDA)

In hydrochar:soil mixtures [3]:
- Dehydrogenase (DH)
- Phosphatase (PH)
- Urease (UR)
- Ammonium oxidase (AO)

3. RESULTS & DISCUSSION

Electrical Conductivity



HC: Hydrochar

ACTIVATION ↑
INHIBITION ↓

Germination
Trial 1 ↓ 3%
Trial 2 No effect

Plant growth
Trial 1&2
No effect

Chlorophyll (CHL)
Trial 1&2 ↓
1 %, 3%

Oxidative stress biomarkers

Protein and malondialdehyde (MDA)
Trial 1 ↓ 3% Trial 2 No effect

Reactive oxygen species (ROS)
Trial 1&2 No effect

Guaiacol peroxidase (GPOD)
Trial 1&2 STRONG ↑ 3%

Catalase (CAT)
Trial 1 STRONG ↑ 3%
Trial 2 SLIGHT ↓ 1%, 3%

Soil enzymatic activities

Dehydrogenase (DH)
Trial 1 STRONG ↑ all rates
Trial 2 SLIGHT ↑ all rates

Phosphatase (PH)
Trial 1&2 ↓ 3%

Ammonium oxidase (AO)
Trial 1 ↓ 3% Trial 2 No effect

Urease (UR)
Trial 1&2 No effect

- Effects seemed to be associated to harmful organic substances of fresh hydrochar.
- Antioxidant system (GPOD and CAT enzymes) counteracted the oxidative effect of toxics.
- Aging eliminates the toxic effects on seed germination, protein and MDA levels in tomato leaves, and on AO in soil showed at the highest level of hydrochar in the blends.

CONCLUSIONS

- Hydrochar may contribute to the circular bioeconomy after the HTC process of aloe vera wastes.
- Hydrochar may be proposed as a soil amendment after a maturing period.

FUTURE WORK / REFERENCES

- Study of additional crops and soil targets, including soil invertebrates.
- Assessment of hydrochar in different types of soils.
- Post-treatment of hydrochar such as washing, leaching, or co-composting.

[1] Kalderis et al. (2024) SCENV 5:100057
[2] García-Gómez et al. (2018) Sci Total Environ 644:770-780 and references cited herein.
[3] García-Gómez et al. (2023) Agronomy 13:2004 and references cited herein.

Funding: METASOIL PID2023-149788OB.C22