**Experimental fertilizers from food waste: a sustainable way to improve vegetative and productive performances of tomato plants**

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In order to make the agricultural activity more sustainable, reducing its environmental footprint, this Ph.D. research project aims to valorise agri-food residues as soil fertilizers, evaluating their effect on vegetative and productive performances of tomato (Solanum lycopersicum L.). To reach these objectives, different strategies will be adopted, such as the addition of biochar and other fertilizers, obtained from agri-food waste, in different agricultural systems and in vitro tissue culture media.

**Fertilizzanti sperimentali da rifiuti alimentari: un modo sostenibile per migliorare le prestazioni vegeto-produttive delle piante di pomodoro**

Al fine di rendere l'attività agricola più sostenibile ridurne l’impronta ambientale, questo progetto di ricerca Ph.D. mira a valorizzare i residui agroalimentari per creare fertilizzanti del suolo, valutandone l'effetto sulle prestazioni vegetative e produttive di pomodoro *(Solanum lycopersicum* L.). Per raggiungere questi obiettivi saranno adottate diverse strategie, come l'aggiunta di biochar e altri fertilizzanti, ottenuti da rifiuti agroalimentari, in diversi sistemi agricoli e substrati di crescita per la coltura *in vitro*.

# **State-of-the-Art**

In recent years, the modern agricultural system is facing the challenge of achieving food security goals, because of the growth of the world's population and the increasing demand for sustainable processes. Therefore, there are currently many studies in which agricultural residues are evaluated as biofertilizers or biostimulants and soil amendments, to exploit them as a resource and to reduce waste from primary production (Nattassha *et al.*, 2020).

A plant biostimulant is any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance or crop quality traits; lately, they are generating increasing interest and are gradually starting to replace synthetic fertilizers (Jardin *et al.*, 2015). Biochar is a soil amendment, obtained from pyrolysis, under anaerobic conditions, of agricultural by-products and organic wastes, widely used to improve soil’s water-holding capacity and nutrient availability as well as different crops yield (Guo *et* *al*. 2021). A promising product is also the wood distillate (WD), a by-product of pyrolysis process for energy production, rich in different molecules such as esters, alcohols, acids, sugars, and phenols (Berahim *et*. *al*, 2011) which makes it able to act as a biostimulant for crops to increase biomass and fruit production.

Tomato (*S. lycopersicum* L.) is one of the most important crops in the world and even more in the Mediterranean area; for this reason, it is worth to evaluate alternative substrate compositions, both to improve plant vegeto-productive performances and to reduce the use of resource non-renewable and whose exploitation has a high environmental impact, such as peat (Gonnella *et* *al*., 2021).

Effects of the application of biochar and biofertilizers have been evaluated in numerous greenhouse and field studies, while few are the research exploring its influence on *in vitro* grown plants (Di Lonardo *et al.*; 2013; Wiszniewska *et al.*; 2023). Evaluating the effect of biochar added to the culture medium could open new perspectives for tomato micropropagation, improving *in vitro* plant response, reducing the high costsof tissue culture techniques and valorizing agricultural wastes.

Finally, WD has been used as biostimulant and to counteract fungi and bacteria, even at very low concentrations (Fedeli *et al.*, 2022) in several agricultural systems, but never as ingredient of culture media; instead, its use could be a way to replace synthetic additives, given its hormone like properties and its wealth in secondary metabolites (Gayathri *et* *al*., 2015).

# **2. PhD Thesis Objectives and Milestone**

The main objectives of this PhD thesis project are listed below and outlined in the Gantt diagram given in Table 1:

A1) **Evaluation of the response of tomato plants at different types and concentrations of biochar added in the substrate, in soilless agriculture:** Morphological and physiological characterization of plants and fruits (A1.1), Physico-chemical analysis of plants and fruits (A1.2), Physico-chemical analysis of the substrate (A1.3).

A2) **Evaluation of the response of tomato plants at different concentrations of wood distillate added in the substrate, in soilless agriculture:** Morphological and physiological characterization of plants and fruits (A2.1), Physico-chemical analysis of plants and fruits (A2.2), Physico-chemical analysis of the substrate (A2.3).

A3) **Evaluation of the response of tomato plants at different types and concentrations of biostimulants added in the substrate, in soilless agriculture:** Morphological and physiological characterization of plants and fruits (A3.1), Physico-chemical analysis of plants and fruits (A3.2), Physico-chemical analysis of the substrate (A3.3).

A4) **Evaluation of biochar and biostimulants effect in tomato tissue culture:** Morphological characterization of *in vitro* grown plants (A4.1).

A5) **Bibliographic research, Paper and Thesis Preparation:** oral and/or poster communications, scientific papers and PhD thesis.

***Table 1***Gantt diagram for this PhD thesis project.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity Months | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| A1) | ***Evaluation of the response of tomato plants at different types and concentrations of biochar added in the substrate, in soilless agriculture*** |   |   |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
| A2) | ***Evaluation of the response of tomato plants at different concentrations of wood distillate added in the substrate, in soilless agriculture*** |   |   |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
| A3) | ***Evaluation of the response of tomato plants at different types and concentrations of biostimulants added in the substrate, in soilless agriculture*** |   |  |   |   |   |   |  |   |   |   |   |   |  |   |  |  |  |  |   |   |   |   |   |  |
| A4) | ***Evaluation of biochar and biostimulants effect in tomato tissue culture*** |   |  |   |  |  |   |   |   |   |  |  |   |   |   |  |  |  |  |   |   |  |  |   |   |
| A5) | ***Thesis and Paper Preparation*** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |   |   |   |   |   |   |   |

# **3. Selected References**

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