

# Dose- and species-dependent effects of wood vinegar as a biostimulant in soilless cultivation systems

D. Gaudio<sup>1</sup>, C. Pastacaldi<sup>1</sup>, C. Beltrami<sup>1</sup>, L. Boatto<sup>1</sup>, L. Giorgi<sup>1</sup>, S. Tegli<sup>1</sup>

<sup>1</sup> Laboratorio di Patologia Vegetale Molecolare, Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Università degli Studi di Firenze, 50019 Florence, Italy;  
Email: [dario.gaudio@unifi.it](mailto:dario.gaudio@unifi.it)

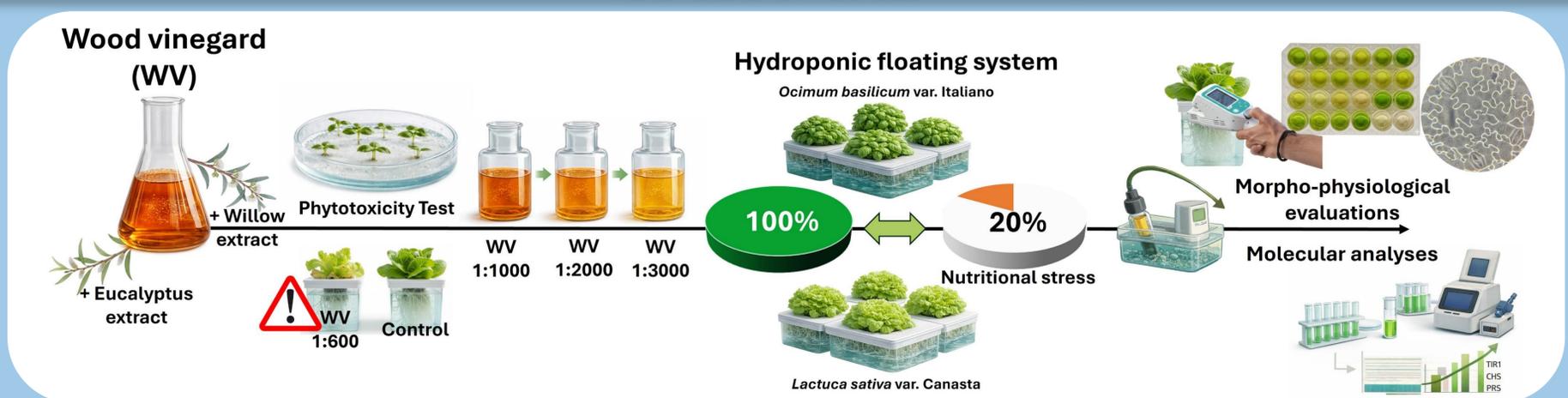
## Introduction

Natural biostimulants are emerging as sustainable alternatives to synthetic agrochemicals for enhancing plant growth and stress tolerance, particularly in soilless cultivation systems.

## Aim

This study investigated the effects of a plant-derived biostimulant - wood vinegar (WV) - applied at different concentrations in a hydroponic floating system cultivating *Lactuca sativa* var. Canasta and *Ocimum basilicum* var. Italiano under optimal (100%) and nutrient-stress (20%) conditions.

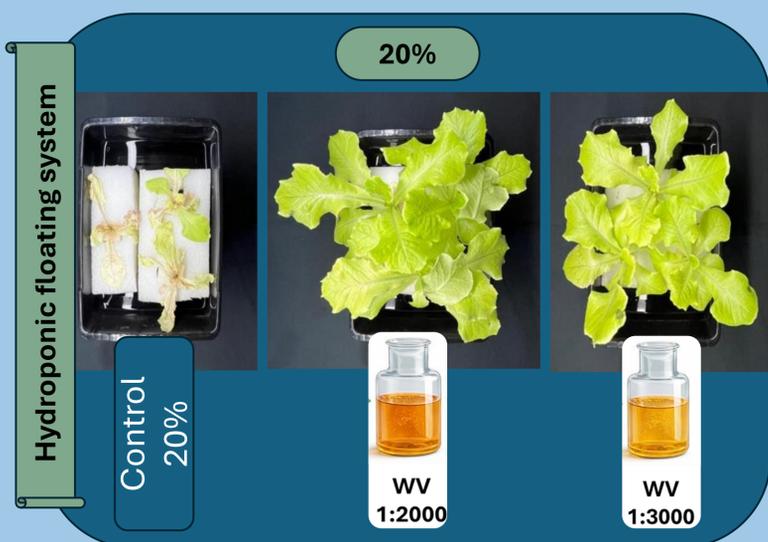
## Materials and methods



## Results and discussion

Preliminary trials at a 1:600 dilution caused severe phytotoxicity in both species, with marked reductions in shoot and root biomass. Subsequent experiments therefore focused on WV, the only commercial formulation tested, applied at higher dilutions (1:1,000, 1:2,000, and 1:3,000). Plant responses were dose- and species-dependent.

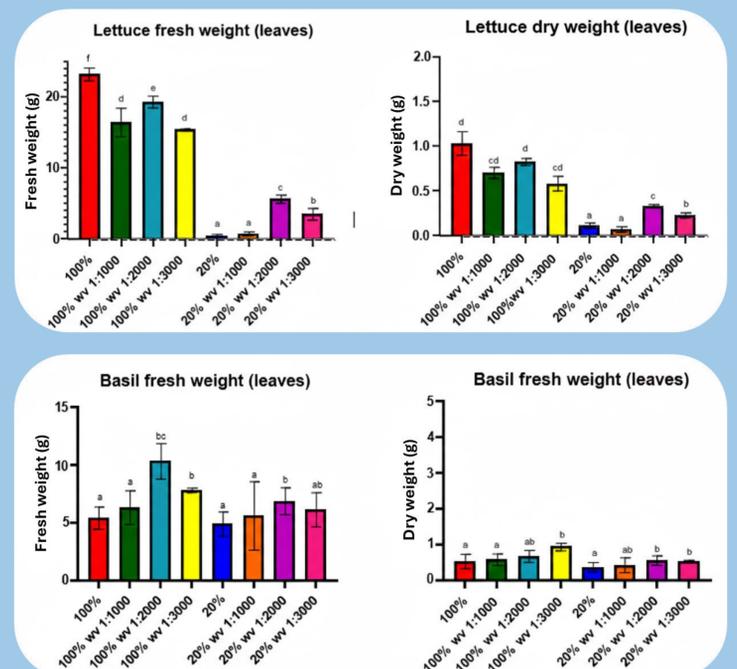
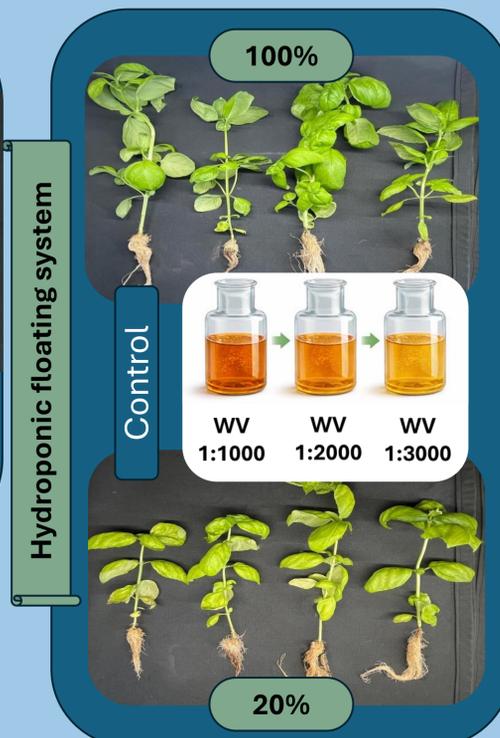
### Lettuce



In lettuce, 1:2,000 and 1:3,000 WV dilutions significantly increased shoot and root fresh and dry biomass under nutrient stress compared with the 20% control. These improvements were associated with enhanced photosynthetic performance, including higher PSII efficiency and increased chlorophyll a and b contents.

Basil showed a stronger response, with significant increases in biomass, plant height, internode number, and photosynthetic efficiency, particularly at the 1:2,000 dilution under both optimal and stress conditions. Gene expression analyses indicated that WV modulated key growth- and stress-related pathways. Upregulation of *TIR1* in leaves and roots suggests enhanced auxin signaling, while increased expression of *CHS* and *PR5* in roots points to activation of phenylpropanoid metabolism and defense responses, especially under nutrient limitation.

### Basil



## Conclusions

Overall, these results demonstrate that properly diluted wood vinegar acts as an effective biostimulant in hydroponic systems, promoting growth and physiological performance while modulating defense-related mechanisms. However, its effectiveness is highly species- and dose-specific, highlighting the importance of tailored application strategies.