Project 1_2 Optimisation of Environmental Parameters to Enhance the Quality and Yield of Bioactive Compounds in Medicinal Plants

PC Hub Theme (see list here)
Theme 1: Plant Health – Nutrition, Physiology and Biosecurity
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The research project is designed to utilise the advantages of protected cropping (PC) environments to **enhance medicinal plant production traits and resource efficiency**, specifically through the precise control of light, nutrient, and temperature regimes.

The primary aim of the project is to:

- Determine the **optimal nutrient formulations and delivery regimes** for different medicinal crop varieties at various growth stages. This process aims to tailor nutrient and watering regimes to enhance the yield and quality of plant bioactives.
- Optimise **light intensity and quality, as well as temperature and substrate requirements** in each crop to support daily and developmental physiological processes, **increase biomass, influence morphology** and stimulate secondary metabolite production throughout the growth cycle.
- **Resource Efficiency:** Identifying optimal growth conditions to **reduce production (energy and resource) costs** and enhance traits that increase

market value. This includes matching the timing of environmental inputs to optimal plant use to improve the cost-effectiveness of PC.

A major knowledge gap stems from the current lack of precise, dynamic control over environmental inputs, despite the capability of controlled environments:

- **Precision Control:** While controlled environments allow for more precise control of inputs and outputs than traditional cropping, many current systems rely on supplemental nutrient applications. There is a gap in establishing **optimal water, nutrient, and biostimulant formulations and their delivery regimes** tailored specifically for different varieties of the same crop at different growth stages.
- **Precision Stress and Adaptation Management:** Exposure to mild stress enhances plant resilience, underscoring its role as a driver of adaptive responses. For many medicinal plants, however, the potential of **controlled stress regimes to improve yield and quality of secondary metabolites remains largely unexplored**. Advancing this research requires optimising stress conditions and elucidating the molecular mechanisms that drive productivity, while minimising growth penalties.
- **Real-Time Adaptation:** There is a need to move beyond static recipes toward dynamic systems where inputs are constantly adjusted. Developing management models that connect cultivation inputs, genetics, and 'omics measurements to plant health and desirable traits requires extracting **new information from large plant-imaging, transcriptomic, and metabolomic datasets**.

The project will use techniques such as:

- **Nutrient Assays and Delivery:** Utilising **controlled irrigation and fertigation systems** for precise input control and establishing **high-throughput assays for nutrient uptake and mobilisation**. These assays will be benchmarked against existing **off-the-shelf sensor technologies**.
- **Metabolite Analyses:** Untargeted and targeted metabolomic analyses will be conducted to characterise the spatial and quantitative dynamics of secondary metabolites. This will employ state-of-the-art matrix-assisted laser desorption ionisation mass spectrometry imaging (MALDI-MSI) and high-resolution accurate-mass (HRAM) instrumentation to enable precise detection, localisation, and quantification of key compounds.
- **Omics Analyses:** Other omics approaches, such as transcriptomic analyses, will be used to profile global and tissue-specific gene expression patterns in response to stress and environmental stimuli. This will enable the identification

of regulatory networks and pathways linked to secondary metabolite biosynthesis and adaptive responses.

- **Data Capture and Analysis:** Capture data and create data frames for downstream analyses. Work with PhD students within PC-HUB Theme 4 (Digital Agriculture and Machine Learning) on **big data (analytics, machine learning, AI)** to extract new information and develop models to optimise specific yield and quality outputs.
- **Sensing and Real-Time Control:** Developing **innovative sensing and feedback systems** to monitor photosynthetic productivity, growth, and stress. These systems, integrated with Digital Agriculture, will be used to adapt light, temperature, and water inputs **in real-time**.

Suitable candidates will have a background in:

Candidates suited for this interdisciplinary research should possess expertise in areas that connect plant biology with digital technology and data analysis, interacting across multiple scientific themes. Relevant backgrounds may include:

- **Plant Physiology and Nutrition**
- **Controlled Environment Agriculture/Horticulture**
- **Natural Product Chemistry/Phytochemistry**
- **Molecular and 'Omics Sciences** (transcriptomics, genomics, metabolomics, proteomics).
- **Data Capture**, **Analysis & Statistics, & Machine Learning** (ML/AI)

How to apply

The PC Hub offers a limited number of competitive scholarships.
To apply, please email the following documents to pchub@latrobe.edu.au by **15 February 2026:**

- Application form completed.
- Up-to-date CV
- University transcripts

Only shortlisted applicants will be contacted.