EFFECTS OF RADIATION MODULATION AND AGRIVOLTAIC SYSTEMS ON PHOTOSYNTHETIC EFFICIENCY, REDOX HOMEOSTASIS, AND METABOLIC QUALITY IN HORTICULTURAL CROPS

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INTRODUCTION

- Climate change increases variability in solar radiation, affecting crop productivity and quality[1]
- Excess light → photoinhibition & oxidative stress; low light → reduced carbon assimilation
- Optimizing light is crucial for balancing physiology and metabolism[2]
- Agrivoltaic systems modulate light intensity and spectrum, improving microclimate stability
- This study evaluates effects of radiation reduction on photosynthesis, redox homeostasis, and nutraceutical metabolism[3,4]

METHODS

Experimental Design
- Micro-Tom tomato under 5 radiation regimes: Growth Chamber | PVC | Nylon | Agrivoltaic (shaded) | Open Field
- PPFD and spectral gradient across treatments
- Sampling stages: *flowering* and *green fruit*

Physiological Analysis
- CAT, POD (antioxidant enzymes)
- Chlorophyll content
- NADPH levels

Gene Expression (qPCR)
- Light signaling: HY5, PIFs
- Secondary metabolism: PAL, CHS, DFR, PSY
- Redox regulation: APX

Metabolic & Phenotypic Traits
- Biomass, fruit size, seed number
- Phenols, flavonoids, sugars
- RFOs, maltose, structural carbohydrates

Microclimate Monitoring
- PPFD | Temperature | Humidity

REFERENCES

[1] L. Taiz and E. Zeiger, Plant Physiology and Development, Sinauer Associates (2015).
[2] C.H. Foyer and G. Noctor, Plant Cell (2011).
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RESULTS

Micro-Tom plants are currently established under five distinct radiation regimes: Growth Chamber, PVC Cover, Nylon Cover, Shaded Agrivoltaic System, and Open Field

- Plant growth and development are being continuously monitored to assess early responses to different light environments
- Light conditions are systematically evaluated:
  – Light intensity (PPFD) and spectral quality measured **twice daily**
  – Temporal variations recorded to capture daily fluctuations across treatments
- Ongoing measurements include:
  – Morphological parameters (plant height, leaf development, early biomass trends)
  – Visual assessment of plant vigor and uniformity
  – Initial physiological indicators related to light adaptation
- Data collection is in progress to establish correlations between radiation regimes, light quality, and plant performance

CONCLUSIONS

- Agrivoltaic systems are expected to improve light management and reduce stress conditions in crops
- Enhanced redox balance is expected to support plant growth and metabolic efficiency
- Light modulation is hypothesized to promote antioxidant and nutraceutical compound accumulation
- Overall, agrivoltaic systems are expected to improve crop quality and resource-use efficiency

Take-home message

→ *The aim is to demonstrate that optimizing light through agrivoltaic systems can enhance plant performance, resilience, and nutritional quality.*

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