



AGRI-PV: WAS KANN SIE BIETEN? BEISPIELE GARTENBAU

ONNO MULLER (O.MULLER@FZ-JUELICH.DE), MATTHIAS MEIER ET AL.
Institute of Bio-and Geosciences 2: IBG-2 Plant Sciences, Shoot dynamics

Mitglied der Helmholtz-Gemeinschaft

Webinar-Serie:
*Agrarforschung zum
Klimawandel*



EXAMPLES

- Message from IHC- acceptance for horticulture APV (and a little blueberry)
- Fig/Feige (Japan)
- Ginger/Ingwer vanilla/Vanilla (Taiwan)
- Raspberry/Himbeere (Juelich)
- Spinach/Spinat (Juelich & Burgewald)
- And a bit more blueberry/Blaubeere..





WS07 Agrivoltaics as a Dual Land-Use Strategy for Berry and Grape Production: Sustainability and Socio-Economic Impacts

Day 2 · Aug 24 (Mon) · 18:00–19:30 · Room J

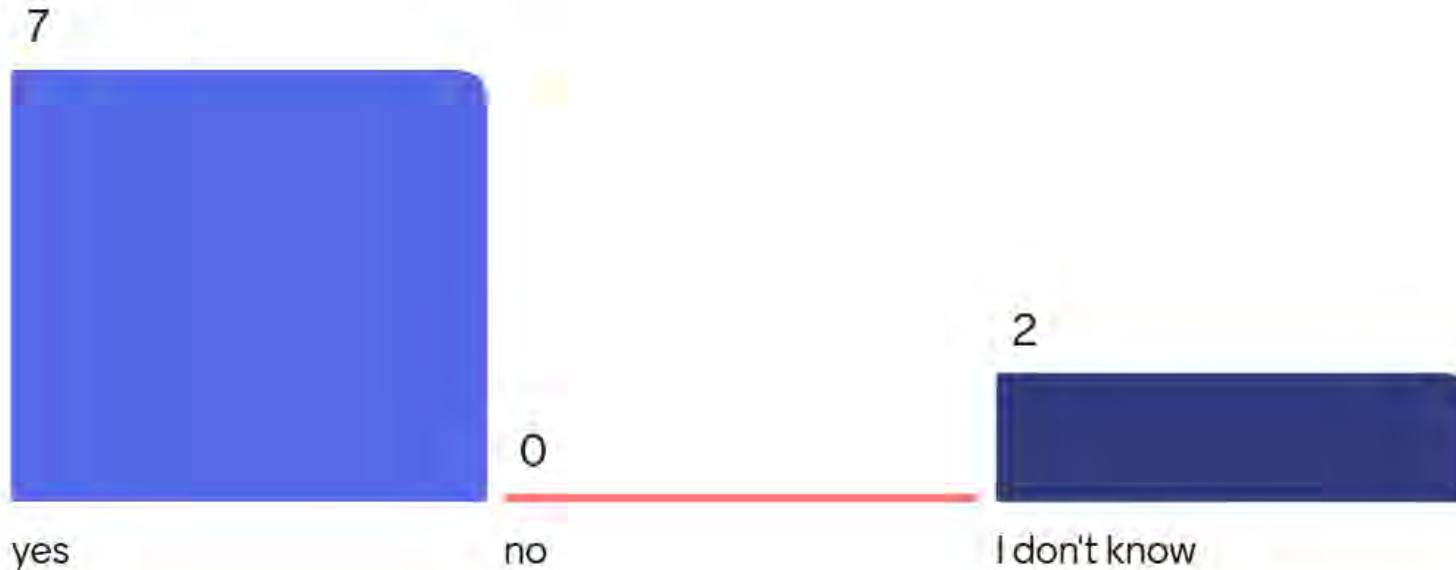
Moderator

Onno Muller

GARTENBAU/HORTICULTURE

Horticulture is the science, art, and practice of growing fruits, vegetables, flowers, and ornamental plants
Often in protected environment such as greenhouse , foil tunnels

“the greenhouse next to your house changes to agrivoltaics” would you like this?



APV VERSUS NORMAL BLUEBERRY : WHAT DO YOU TASTE?



Thank you! to Sagamiko farm
berry garden for APV blueberries

30/~40 persons
guessed that
'normal'
blueberries were
APV grown



menti.com
3600 4424

<https://www.menti.com/alg5o2ia2vge>



JAPAN, GREENHOUSE WITH PV-PANELS

Cultivation in Hachihama



Workshop organization thank you to :Emiliane Kiladze

TAIWAN, GREENHOUSES WITH PV-PANELS



Ginger

Member of the Helmholtz Association



Vanilla

Page 7



AGRIVOLTAICS AS A DUAL LAND-USE STRATEGY FOR THE SUSTAINABLE PRODUCTION OF LONG-CANE RASPBERRY 'LAGORAI' (*RUBUS IDAEUS* L.)

E. KILADZE, C. JEDMOWSKI, O.A. LEAL, A. AGARWAL, A. UMEROVA, N. BRÜGGEMANN, R. BOL, U. RASCHER, M. MEIER-GRÜLL, D.R. BRYLA, and O. MULLER

Date: 24.08.2026 – THE 32ND INTERNATIONAL HORTICULTURAL CONGRESS



Deutscher Akademischer Austauschdienst
German Academic Exchange Service



შოთა რუსთაველის ეროვნული
სამეცნიერო ფონდი
SHOTA RUSTAVELI NATIONAL
SCIENCE FOUNDATION





RESEARCH MATERIALS

Experimental Treatments (roofs)

- 60% shade – semi-transparent solar panels.
- 40% shade – semi-transparent solar panels.
- Polytunnel control system – standard plastic roof used in raspberry production.



Plant Material

- 400 long-cane raspberry plants (*Rubus idaeus* L. 'Lagorai'), 15 rows.

Variety chosen because:

- Produces harvest in the first year (long-cane system).
- Widely used in commercial production and experimental trials.
- Popular cultivar with high market acceptance.

Management Practices

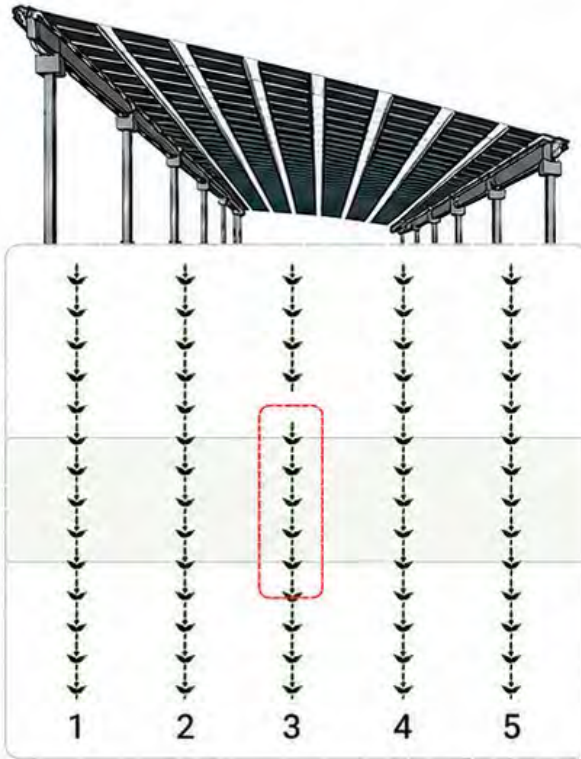
- Fertilization, plant protection, and irrigation were identical across treatments.
- All practices followed standard commercial raspberry production protocols.



EXPERIMENTAL DESIGN

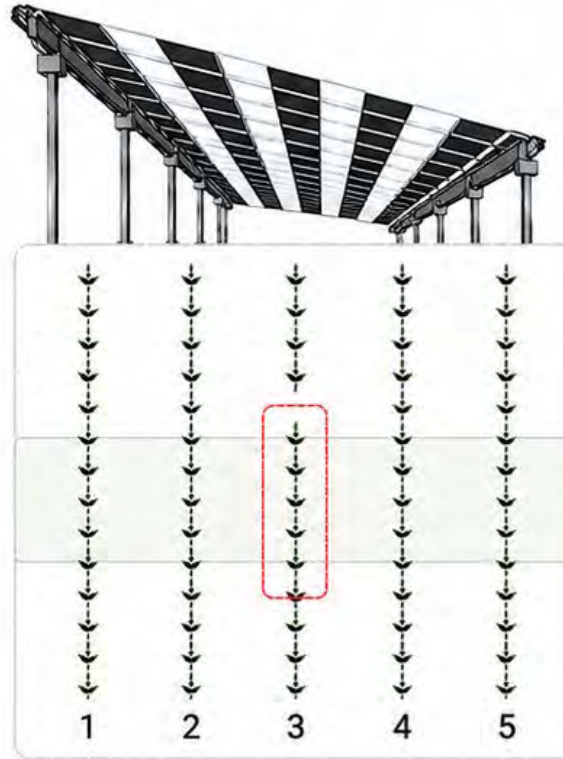
60% SHADE

Semi-transparent solar panels



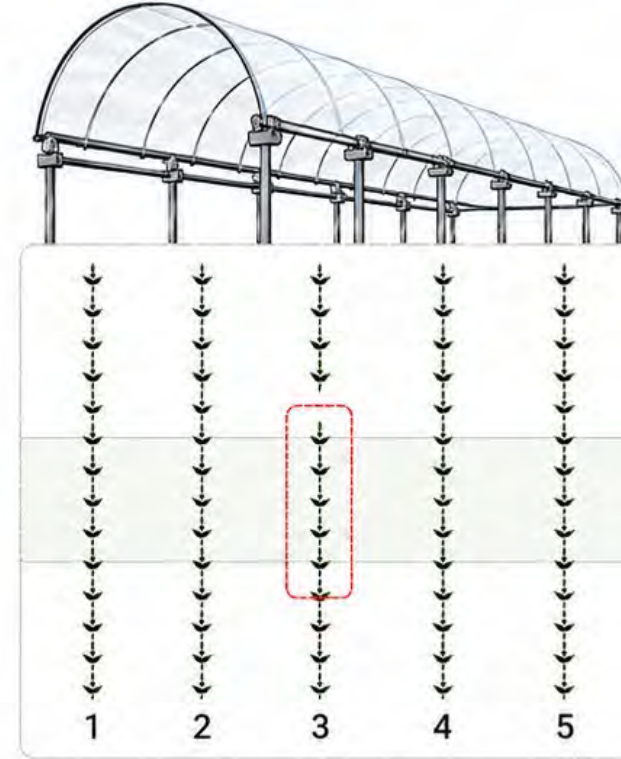
40% SHADE

Semi-transparent solar panels



CONTROL

Polytunnel plastic roof



- 3 treatments.
- 5 rows per treatment (10 m; 27 plants per row).
- Measurements were collected from the central 15 plants of the middle row (Row 3) in each treatment.



RESEARCH GOALS and OBJECTIVES



Research goal:

To evaluate the overall suitability of APV systems for sustainable raspberry production.

Research objectives:

- Monitor key physiological performance indicators.
- Assess plant growth and yield components during the first year.

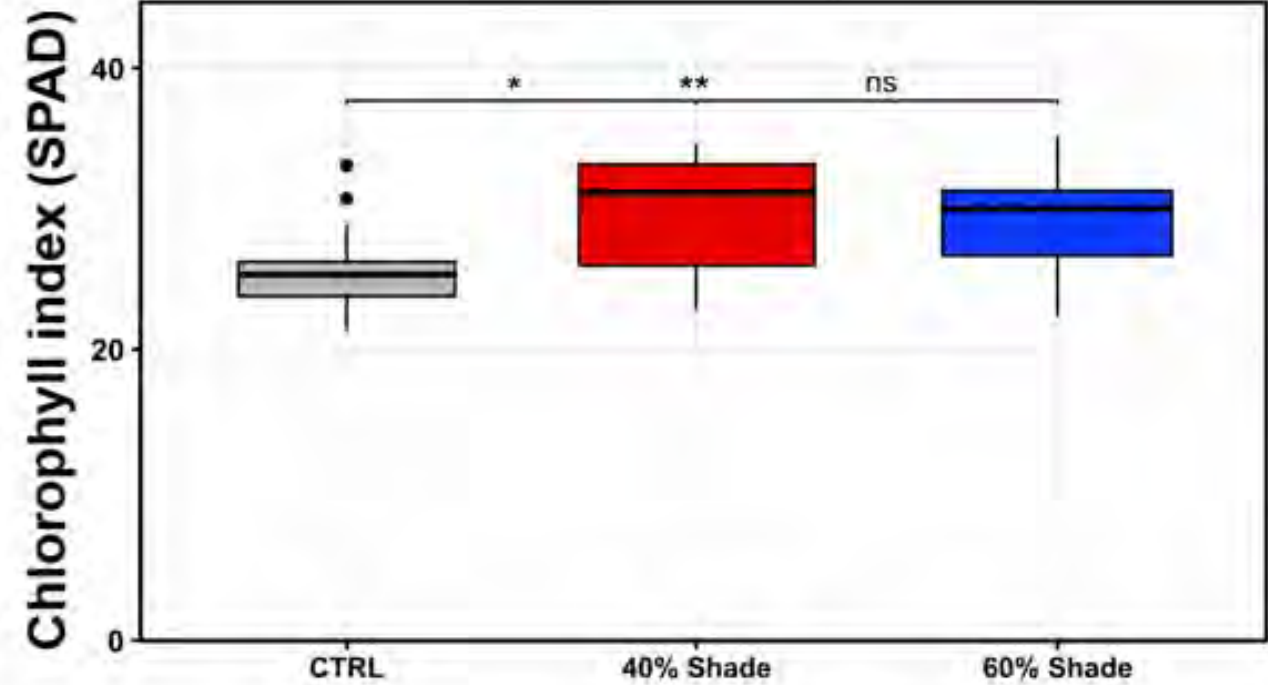
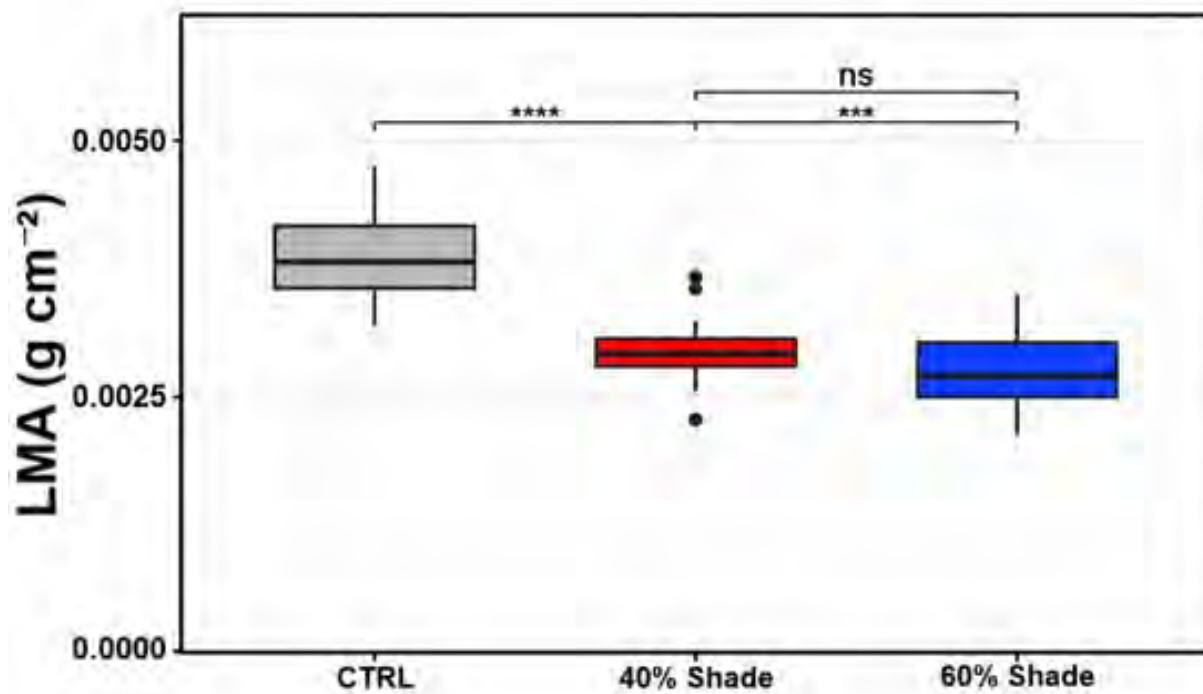
Outcome:

First-year results provide a baseline for understanding raspberry performance under APV conditions.





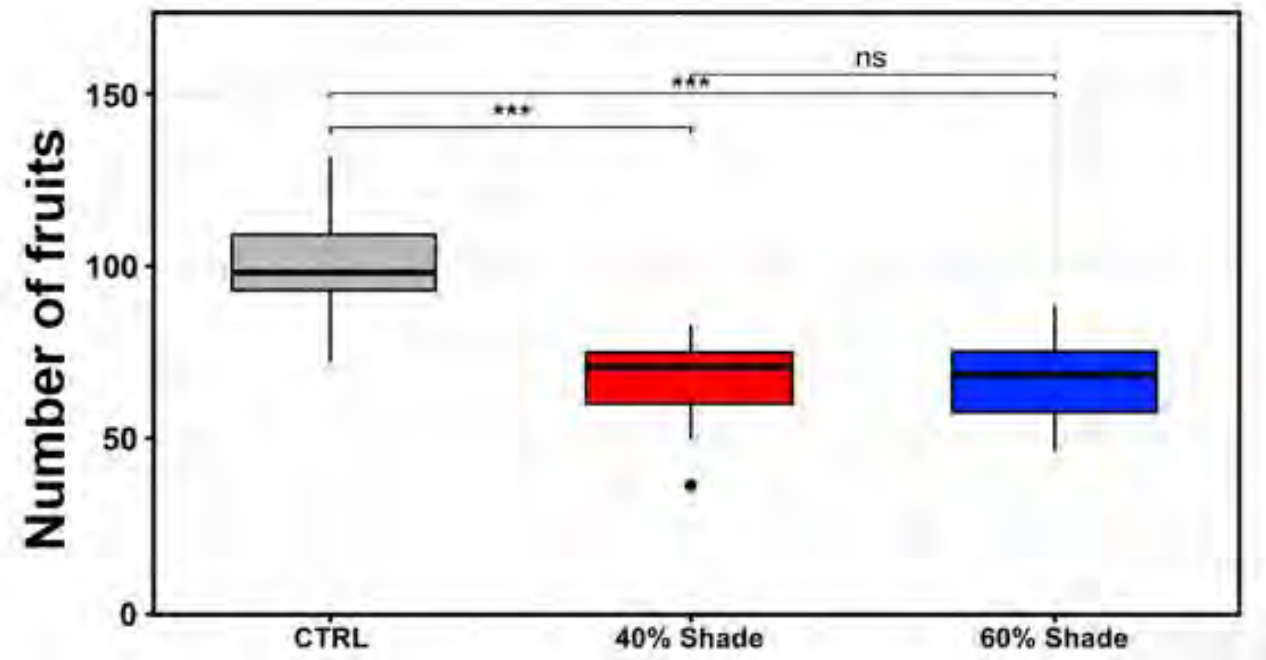
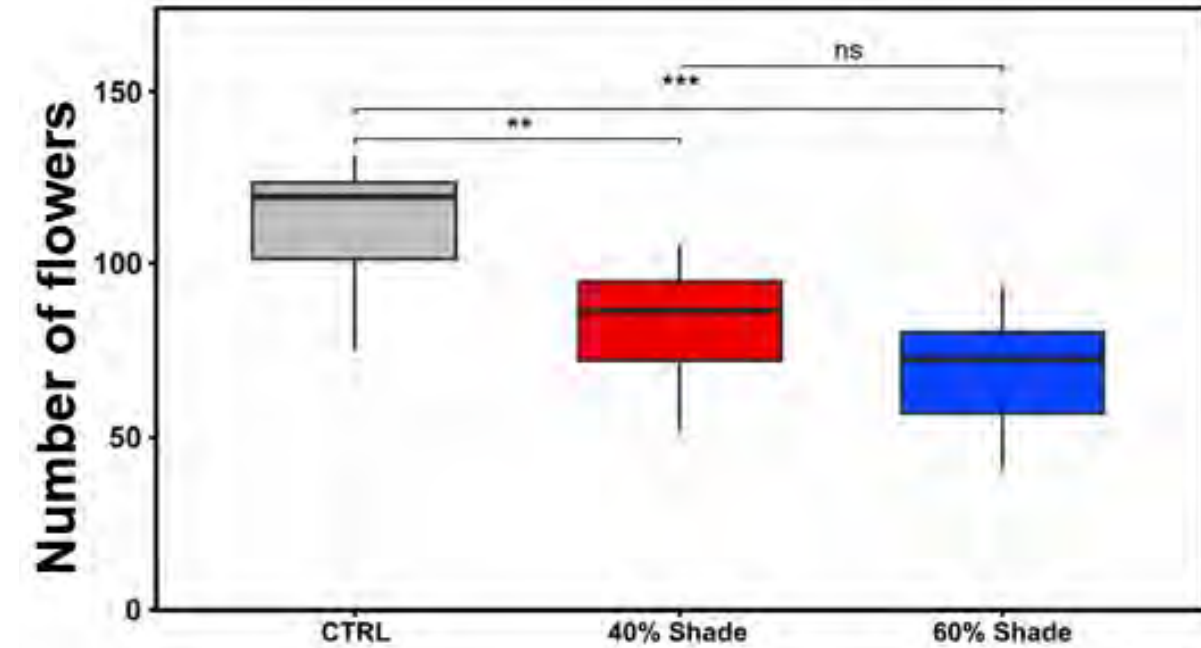
RESULTS: LEAF TRAITS 2025



- Leaf Mass per Area (LMA): Significantly lower under shading, indicating thinner leaves.
- Chlorophyll index (SPAD): Higher under shading, indicating increased leaf chlorophyll.



RESULTS: FLOWERING and FRUIT TRAITS 2025

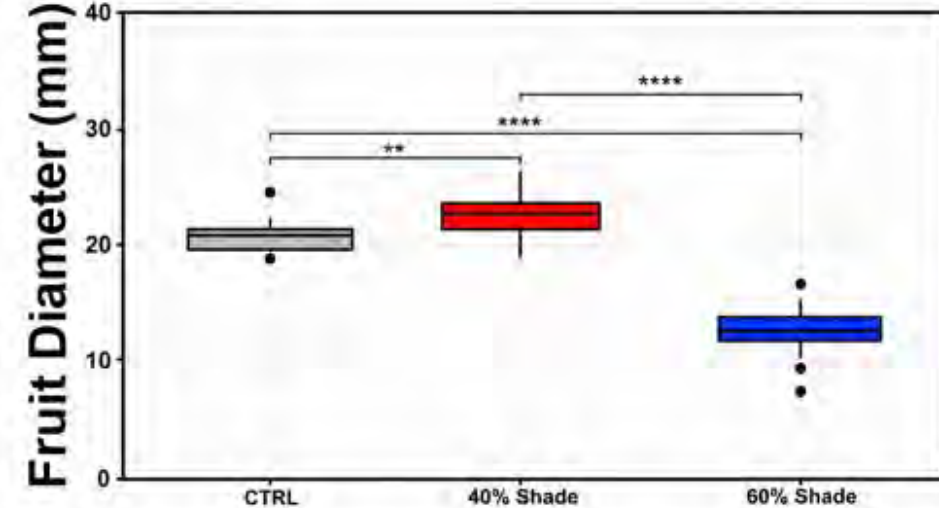
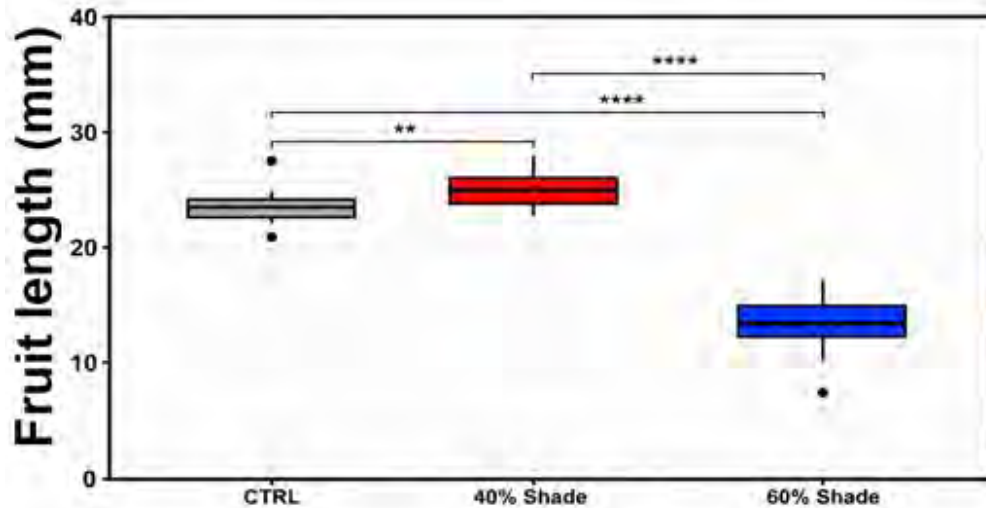
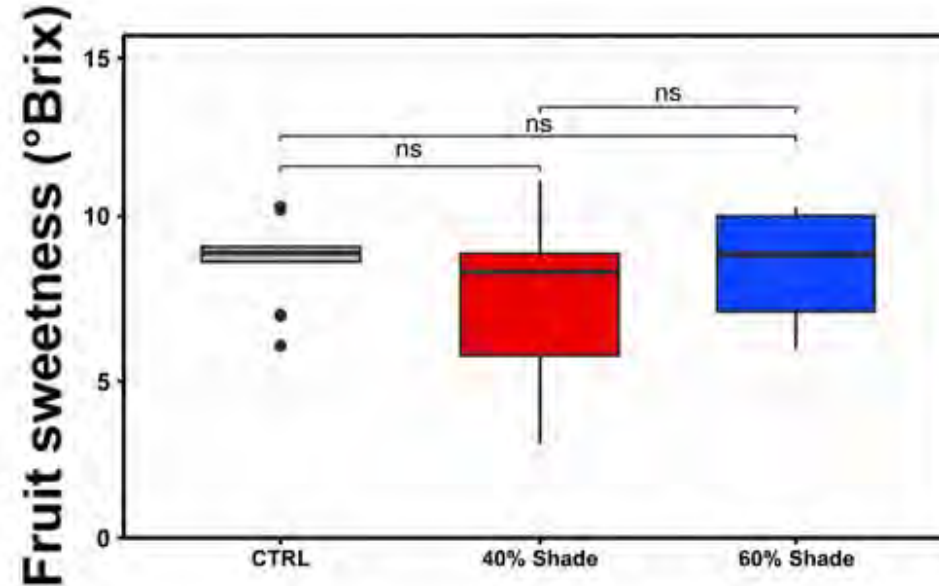
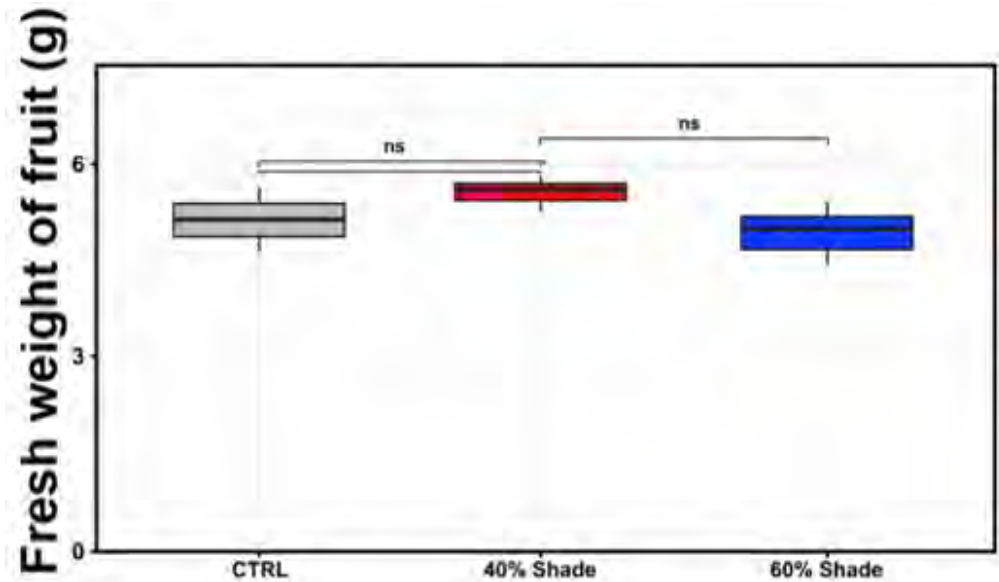


- Flowers: Highest in control; both shading levels significantly reduced flower number.
- Fruit number: Similar trend; slight difference between 40% and 60% (Not all flowers developed into fruits, likely due to low temperatures).



RESULTS: FRUIT TRAITS 2025

- Fruit weight & sweetness:
No significant differences.
- Fruit size:
40% shade increased length and diameter; 60% shade reduced both.



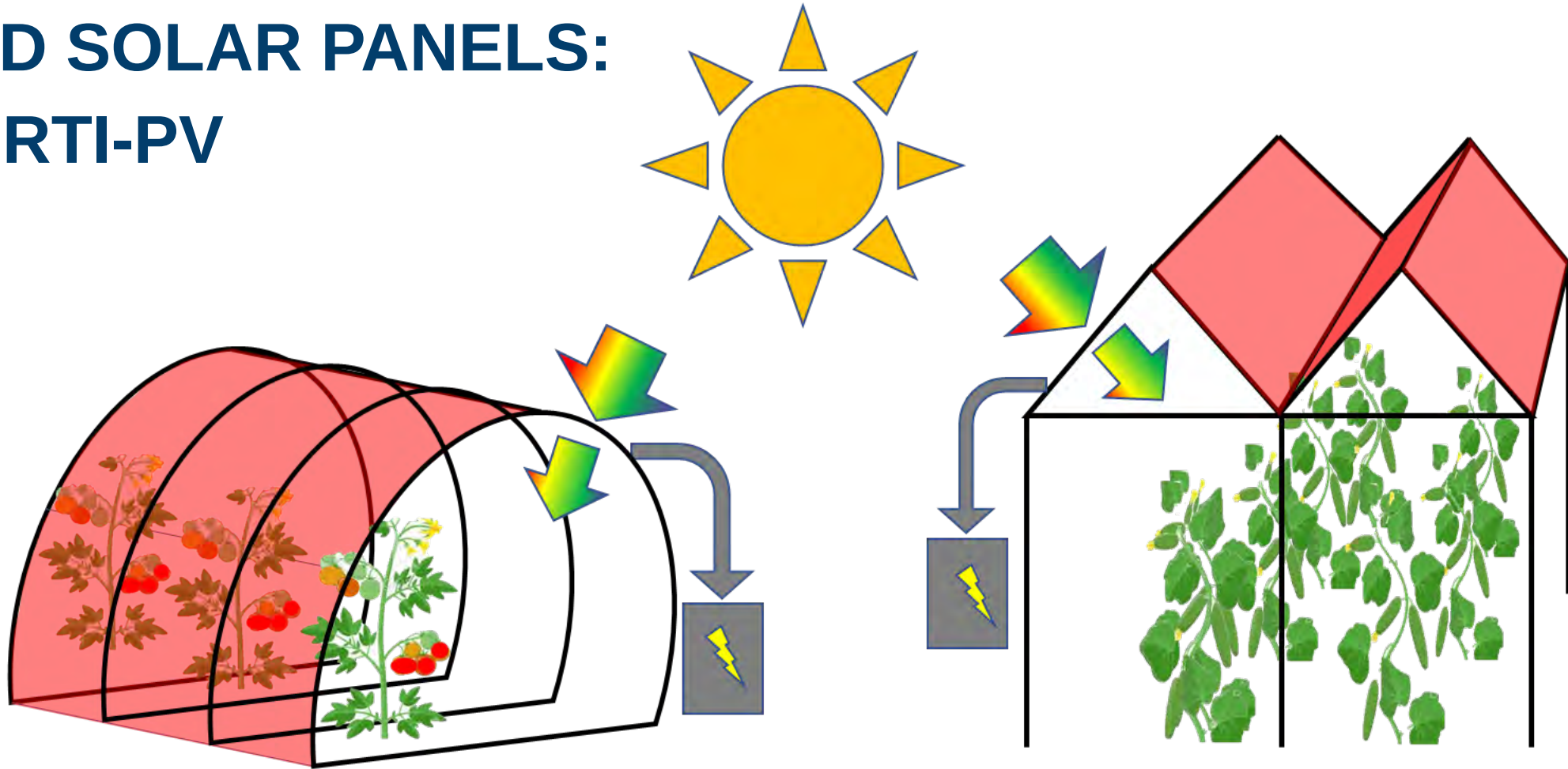
RASPBERRY AGRIVOLTAICS (HortiPV): RESEARCH RESULTS FROM GERMANY

2025	40% APV	Crop Yield = 79% of control	Late planting, harvest fall
	60% APV	Crop Yield = 69% of control	

2026	40% APV	Crop Yield = 85% of control	Hot summer
	60% APV	Crop Yield = 83% of control	



SPECIALCATEGORY, AGRICULTURE IN GREENHOUSE AND SOLAR PANELS: HORTI-PV



HORTI- PV INTEGRATING ORGANIC PV IN FOIL TUNNES

Foiltunnels in Jülich



Member of the Helmholtz Association



Special thanks to : H.-J. Egelhaaf

Page 17



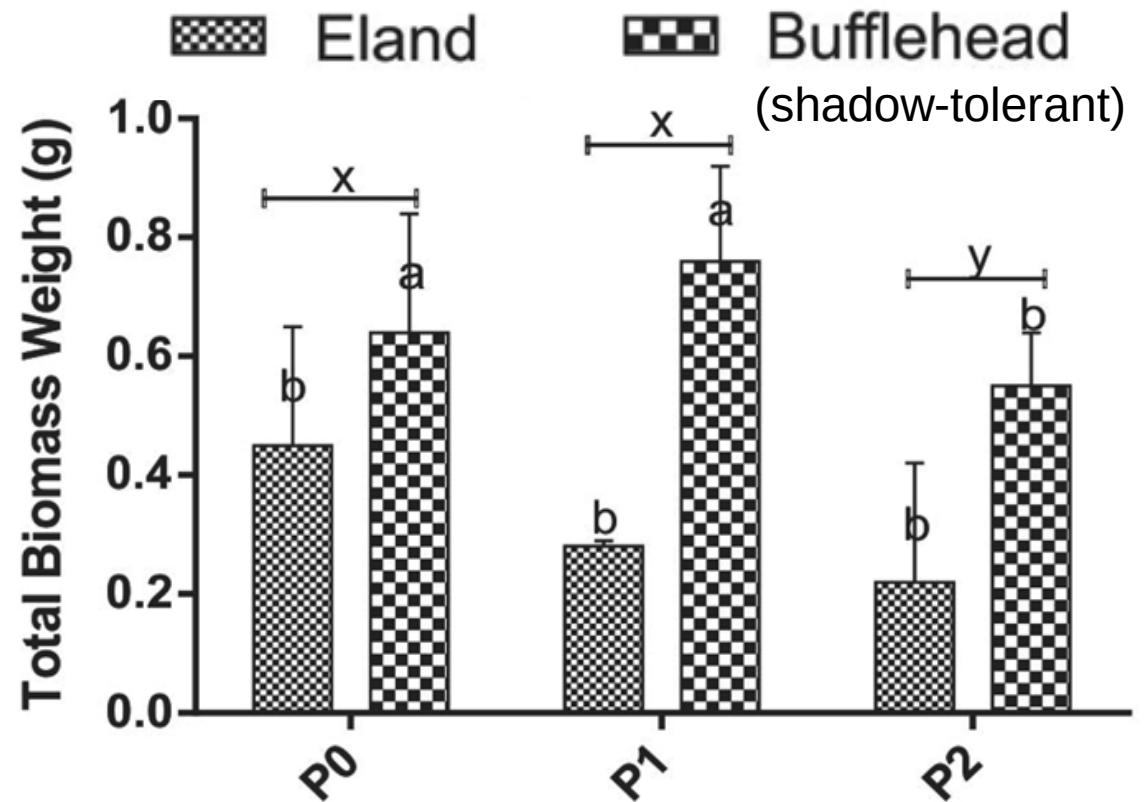
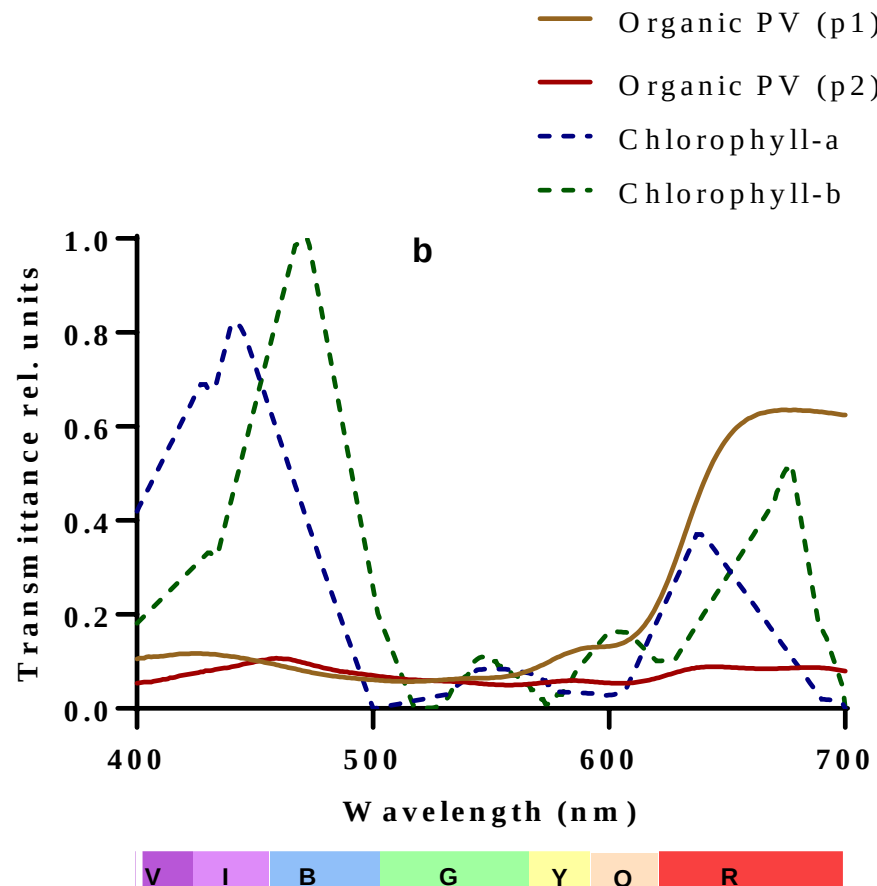
ORGANIC PV TEST IN GREENHOUSE AND FIELD IN JÜLICH



U.N. Ukwu et al. Effect of Organic Photovoltaic and Red-Foil Transmittance on Yield, Growth, SPAD Value and Photosynthesis of Two Spinach Genotypes under Field and Greenhouse Conditions. Photosynthesis research 2022



OPV IMPACT ON SPINACH GROWTH IN GREENHOUSE

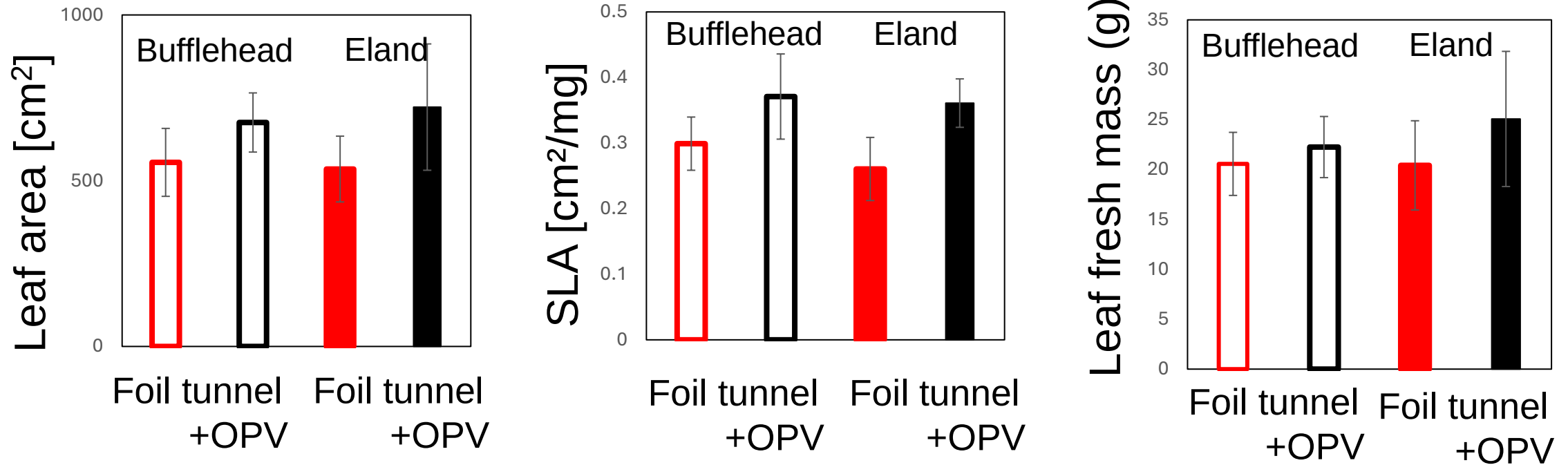


U.N. Ukwu et al. Effect of Organic Photovoltaic and Red-Foil Transmittance on Yield, Growth, SPAD Value and Photosynthesis of Two Spinach Genotypes under Field and Greenhouse Conditions. Photosynthesis Research, May 2023, doi.org/10.1007/s11120-023-01028-8

OPV IMPACT ON SPINACH GROWTH IN FOILTUNNEL



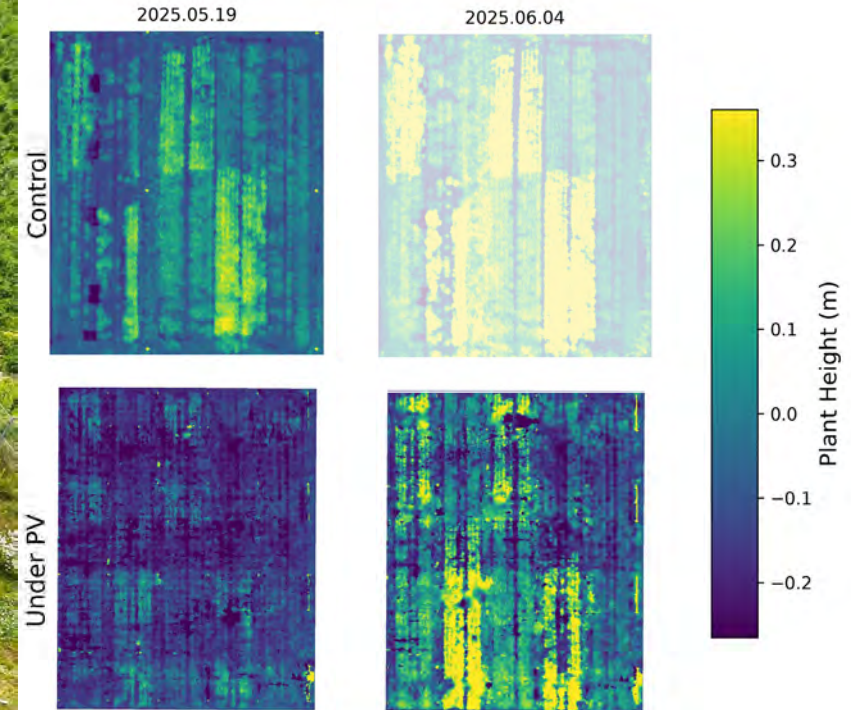
SPINACH GROWTH IN FOIL TUNNEL WITH OPV



Source: Matthias Meier, Leon Merker, Simon Strempe

SPINACH GROWTH UNDER APV

UAV images allows to 'remove' PV panels in 3D to quantify plant growth under APV

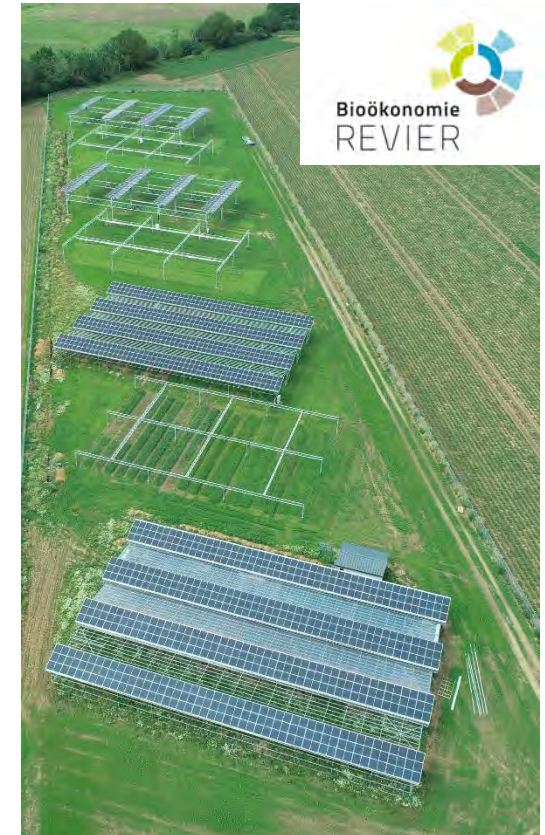


Erekle Chakhvashvili *et al.*

BLUEBERRIES UNDER APV IN BURGEWALD ?



- Next year 😊, more info:



AgriFEE



AGRI-PV: WAS KANN SIE BIETEN? BEISPIELE GARTENBAU

ONNO MULLER (O.MULLER@FZ-JUELICH.DE)

Institute of Bio-and Geosciences 2: IBG-2 Plant Sciences, Shoot dynamics

Mitglied der Helmholtz-Gemeinschaft

Webinar-Serie:
*Agrarforschung zum
Klimawandel*

