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Research Paper

Microclimate and crop performance in a tunnel greenhouse shaded by organic photovoltaic modules – Comparison with conventional shaded and unshaded tunnels

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Highlights

- Flexible semi-transparent organic photovoltaic (OPV) modules were used for greenhouse shading.
- 23% shading by OPV resulted in a lower canopy temperature and lower nonhomogeneous radiation.
- Shading in the hot summer season improved the growth of tomato plants, yield, and quality.
- OPV can be used for shading and electricity generation however it is expensive and degrades rapidly.
- Additional studies are required to improve OPV efficiency and determine optimal shading percentage.

The use of flexible and semi-transparent organic photovoltaic (OPV) modules as shading elements in a greenhouse tunnel with a tomato crop is presented. Experiments were performed in two similar greenhouse tunnels, covered by diffuse polyethylene sheet, during two summer growing seasons. In 2018, one tunnel was shaded using OPV modules (covering 37% of the roof area and resulting in 23% shading) and the second tunnel served as a control. In 2019, a 25% black shading screen was added to the control tunnel. The microclimate, yield, and physiological parameters were examined in the two tunnels. Results show that at noon (11:00 to 13:00), there was no significant difference in the mean seasonal (June–September 2018, May–August 2019) air temperature and humidity between the tunnels. In 2018, the tunnels differed in terms of the spatial radiation transmittance and leaf temperature. The average radiation level along the OPV tunnel centreline was much lower, and the radiation distribution was less homogeneous than in the control. In 2019, with similar shading percentages in the tunnels, similar average radiation levels were observed. The leaf temperature in the OPV was lower than in the control in 2018 and varied from higher to lower in 2019. The leaf area index (LAI), cumulative yield, and average fruit mass were higher in the

OPV than in the control in 2018, and similar in 2019. The average value of the maximum power output of three OPV modules increased roughly linearly with irradiance.

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Keywords

Organic photovoltaic; Greenhouse; Shading; Radiation; Tomato

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