

Modeling of stochastic temperature and heat stress directly underneath agrivoltaic conditions with orthosiphon stamineus crop cultivation

ABSTRACT

This paper presents the field measured data of the ambient temperature profile and the heat stress occurrences directly underneath ground-mounted solar photovoltaic (PV) arrays (monocrystalline-based), focusing on different temperature levels. A previous study has shown that a 1 °C increase in PV cell temperature results in a reduction of 0.5% in energy conversion efficiency; thus, the temperature factor is critical, especially to solar farm operators. The transpiration process also plays an important role in the cooling of green plants where, on average, it could dissipate a significant amount of the total solar energy absorbed by the leaves, making it a good natural cooling mechanism. It was found from this work that the PV system's bottom surface temperature was the main source of dissipated heat, as shown in the thermal images recorded at 5-min intervals at three sampling times. A statistical analysis further showed that the thermal correlation for the transpiration process and heat stress occurrences between the PV system's bottom surface and plant height will be an important factor for large scale plant cultivation in agrivoltaic farms.

Keyword: Transpiration; PV heat conversion; Plant heat stress; Agrivoltaic system; Sustainable integration; Thermal analysis