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Study finds solar panels more than doubled shoot growth in a Puglia vineyard

The agrivoltaic trial suggests partial shading eased heat stress, increased bunch weight and slowed sugar buildup in grapes.

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Researchers in southern Italy have found that solar panels placed above vineyard rows can help grapevines grow in hot, dry conditions, while also changing fruit chemistry and increasing plant diversity on the ground below, according to a study that points to both opportunities and tradeoffs for Mediterranean wine regions facing more frequent heat stress.

The work was carried out at an agrivoltaic vineyard in the Laterza area of Puglia and was recently published in Scientia Horticulturae. The researchers examined how shading from photovoltaic modules affected vine growth, yield, berry composition, biodiversity and the vineyard microclimate. They compared vines grown under different levels of shading with vines exposed to full sun.

Their results suggest that, in a hot and water-limited setting, partial shading can reduce stress on the plants. Giuseppe Ferrara, a professor in the Department of Soil, Plant and Food Sciences at the University of Bari and one of the researchers involved, said the strongest potential benefits appear in places where crops face high summer temperatures, low rainfall and limited water availability.

The differences measured in the Puglia vineyard were large. Average shoot length reached 115.8 centimeters in full sun, compared with 268 centimeters to 274 centimeters under low and high shading. The study also found heavier grape bunches under the panels. Average bunch weight was 164.9 grams under the higher-shading treatment, versus 65.4 grams in full sun.

Ferrara said the vines under the modules appeared to face less environmental stress and were able to maintain more efficient photosynthesis because temperatures were lower. That mattered in this vineyard because it relied on rainfall, with only limited emergency irrigation. In that context, reducing heat exposure can be important during the peak of summer.

The study found that the panels also altered the local climate around the vines. Air temperature under the agrivoltaic system was about 0.5 C to 1.0 C lower, and relative humidity rose by 2% to 14%. Those shifts may look modest, but they can have practical effects when heat becomes intense. At very high temperatures, grapevines can close their stomata, which restricts photosynthesis. Plants may also increase transpiration in an effort to cool their leaves, which can worsen water stress in dry conditions.

The researchers also measured changes in the fruit itself. Berry sugar concentration fell from 25.8 °Bx in full sun to 22.9 °Bx under the highest shading level, while acidity changed less. Ferrara said shading can delay sugar accumulation, while cooler conditions slow the breakdown of organic acids. He also noted that berries under the panels contained more water, which contributed to a dilution effect on sugar concentration.

That shift could matter beyond the vineyard because grape sugar levels help shape harvest timing, fermentation and potential alcohol in wine. In very hot regions, slower sugar buildup may help some producers avoid the rapid ripening that can push grapes

out of balance. At the same time, lower sugar can change the style of the finished wine, which means the technology could become a practical but delicate choice for growers and wineries trying to protect yields without losing control over fruit quality.

The findings add to a broader debate in viticulture about how to respond to rising temperatures. In some wine regions, extreme heat can speed ripening, reduce acidity and increase the risk of sunburn or drought stress. Agrivoltaic systems may offer one way to protect vines while generating electricity on the same land. But the new study also underlines that results are not universal.

Ferrara said the Puglia findings should not be automatically applied to cooler or wetter areas, or to other crops, without careful local testing. He pointed to earlier experimental work in Valpolicella, in northern Italy, where production was higher outside the area covered by solar panels. In climates with lower solar radiation or milder temperatures, extra shading can reduce productivity rather than improve it.

That warning is central to the study. The agronomic effect of solar panels depends on the interaction between plant physiology and local climate and soil conditions. A system that protects vines from extreme summer heat in southern Italy may perform very differently in a region where clouds, rain or lower temperatures already limit light.

The researchers also reported a statistically significant rise in spontaneous plant species richness beneath the modules. Species observed included clover, common sowthistle, plantain, tassel hyacinth and several forms of alfalfa. More diverse vegetation can have wider ecological effects by supporting pollinators and beneficial insects, including predators that help control pests. Ground cover may also reduce erosion, improve soil structure and add organic matter.

The team has not yet completed a direct assessment of soil biodiversity, such as bacterial communities or soil fauna, but Ferrara said those areas are expected to be examined in future work. That could become important as growers and policymakers look beyond energy generation and crop yield to assess how agrivoltaic systems affect farmland over time.

The study comes as interest in dual-use agricultural land is growing across Europe, where farmers are under pressure from higher temperatures, water shortages and energy costs. In vineyards, the issue is especially sensitive because the value of the crop depends not only on how many grapes are harvested but also on how the fruit matures. The Italian results suggest that in hot Mediterranean climates, solar shading may improve vegetative growth and bunch development while reshaping the path to ripeness.

For growers, that means agrivoltaics may become less a simple energy project than a tool that can alter farming decisions. The placement of panels, the amount of shade and the needs of a specific grape variety all appear to matter. In wine regions where summer heat now threatens both vine health and the style of the final product, those details could shape whether solar structures are seen as protection, a production risk or both.