Increasing Food Production in Drylands Using Agrivoltaics

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INTRODUCTION

- **We are investigating a novel ecosystems approach of collocating an "over story" of solar photovoltaic (PV) panels with an "understory" of food plants** to take advantage of cooler temperatures and reduced evaporation under PV panels to maximize food production, water savings, and energy generation.
- We knew from previous studies that this ecosystems approach, called agrivoltaics, is beneficial for some plants, but not beneficial for others .
- This study looked at which plants the Agrivoltaics setting is most and least beneficial for.

DRIVING QUESTIONS

Given the tradeoffs of reduced light to drive photosynthesis versus the potential for reduced heat and moisture stress when growing plants under PV panels, we ask:

1. **How does growing in an agrivoltaics installation influence instantaneous photosynthetic rates of various crop species?**
2. **Which plants experience greater carbon uptake when grown in a conventional (open) garden and which experience greater carbon uptake in an agrivoltaics (under PV) installation?**
3. **Which plants have a higher water use efficiency (plant production per unit water input) when grown under PV panels, and which have a higher water use efficiency when grown in an open garden?**

METHODS

Agrivoltaic (under PV) and Control (open) areas:

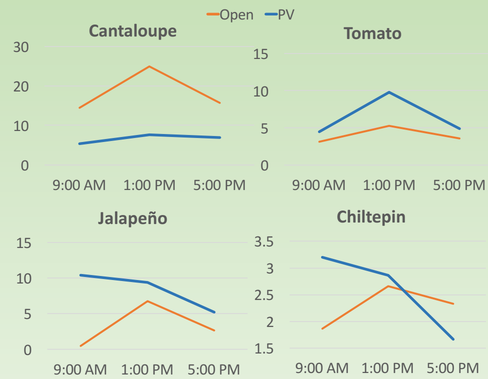
- There were mature cantaloupe, jalapeño, tomato, and chiltepin plants.
- Both sites received equal amounts of irrigation.

Net Photosynthetic (CO_2 uptake) and Transpiration (H_2O loss) Rates

We used a portable photosynthesis system (LI-6400) to:

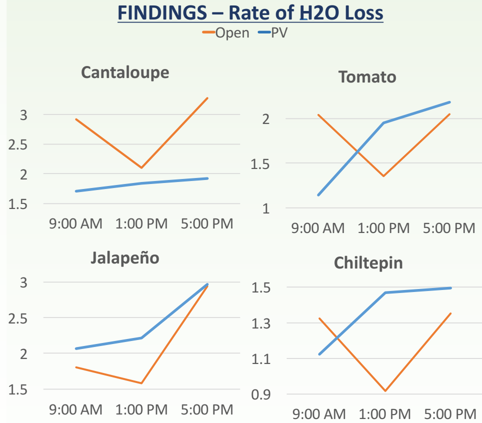
- Match ambient conditions within the agrivoltaics (under PV) and Control (open) areas in terms of light and temperature at each hour throughout the day.
- Measure instantaneous net photosynthesis and transpiration and then estimate **water use efficiency (WUE)** = photosynthesis / transpiration

FINDINGS – Rates of CO2 Uptake



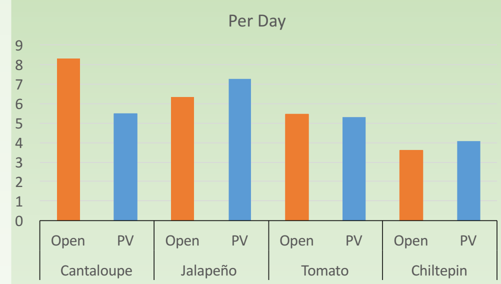
- In cantaloupe, photosynthetic rates were higher in the open garden throughout the day.
- In jalapeño, photosynthetic rates were higher in the Agrivoltaics setting throughout the day.
- In tomato, photosynthetic rates were higher in the Agrivoltaics setting throughout the day.
- In chiltepin, photosynthetic rates were higher in the Agrivoltaics setting in the morning and early afternoon, but were higher in the open garden in the late afternoon.

FINDINGS – Rate of H2O Loss



- In cantaloupe, transpiration rates were lower in the Agrivoltaics setting throughout the day.
- In jalapeño, transpiration rates were lower in the open garden throughout the day.
- In tomato, transpiration rates were lower in the Agrivoltaics setting in the morning, but lower in the open garden the rest of the day.
- In chiltepin, transpiration rates were lower in the Agrivoltaics setting in the morning, but lower in the open garden the rest of the day.

FINDINGS – Water Use Efficiency (WUE = CO2 Uptake/H2O Loss)



- In cantaloupe, WUE was 51% higher in the open garden, suggesting a limitation in the Agrivoltaics setting
- In jalapeño, WUE was 14% higher in the Agrivoltaics setting
- In tomato, WUE was 3% higher in the open garden equal between treatments
- In chiltepin, WUE was 14% higher in the Agrivoltaics setting.

CONCLUSIONS

Plants growing in an agrivoltaics setting (under PV) receive less light, but this comes with positive tradeoffs in terms of reduced evaporative loss of soil moisture and limited exposure to periods of excessive heat or light stress. Some plants thrive better in this setting than in a conventional garden setting. We found:

1. **While cantaloupe had a lower photosynthetic rate in the Agrivoltaics setting, in also had a lower transpiration rate in this setting.**
2. **Jalapeño, tomato, and chiltepin all had a mostly higher photosynthetic rate in the Agrivoltaics setting, but also a mostly higher transpiration rate in this setting.**
3. **Jalapeño and chiltepin had a higher WUE rate in the Agrivoltaics setting, while tomato was about equal cantaloupe had a much higher WUE in the open garden.**

Additional species should continue to be explored to capture a wider understanding of what plant functional types are most appropriate for this new type of food production.

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