Localized, Geospatial Sensing of Canopy and Fruit Microclimate for Real-time Management of Sunburn in Apple

PIs: Lav R. Khot, R. Troy Peters, Bernardita Sallato, Washington State University

Project Personnel: Rakesh Ranjan, Amogi Basavaraj, Washington State University

Washington State (WA) contributes to >64% of total apple production in the Unites States

Apple sunburn: Excessive heat and high intensity sunlight during summer months

Up to 40% of annual crop yield losses & reduced fruit quality (marketability)

Fig. 1. Apple sunburn disorders [a,b) necrosis, c) browning and d) photo-oxidative sunburn]

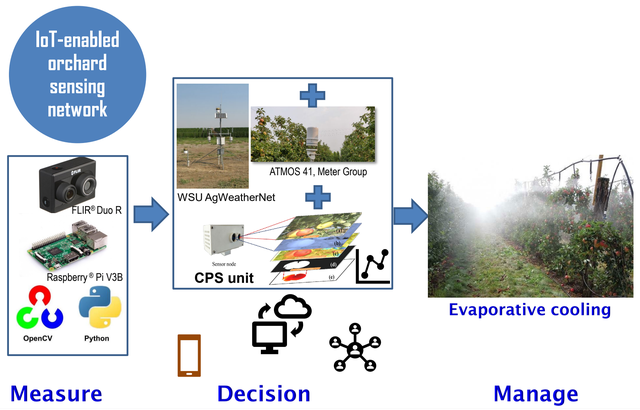
Challenges

- Lack of accurate sunburn monitoring tools and integrated crop protection technologies
- Existing techniques are unsupervised and often inefficient
- Evaporative cooling technique, commonly used, can lead to high energy and water demands, increases food safety risks

Objectives

1. Develop a crop physiology sensing system (CPSS) for in-field real time monitoring of fruit surface temperature (FST)
2. Automation and integration of a retrofitted overhead cooling system for effective sunburn management

Approach



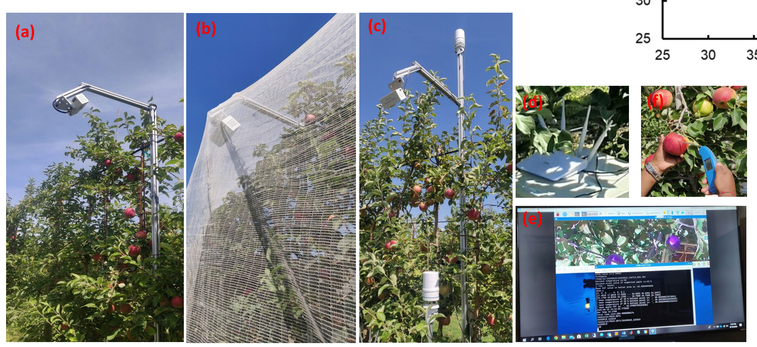


Fig. 2. CPS2.0 node deployed in (a) wet zone of modified evaporative cooling, (b) shade net, and (c) untreated control with two all-in-one weather sensors within and above the canopy to monitor imagery and weather-based fruit surface temperature and (d) in-field cellular router to create a local WiFi grid to add connectivity and (e) remote data access; (f) FST ground truthing

CPSS development and field validation

- Prototype development, testing, and revision (CPS2.0)
- Field validation (*cv* Honeycrisp, and Cosmic Crisp in 2019-20)
- Evaporative cooling system modification

Results

- Thermal-RGB imagery based FST was highly correlated
- Improved fruit quality compared grower control

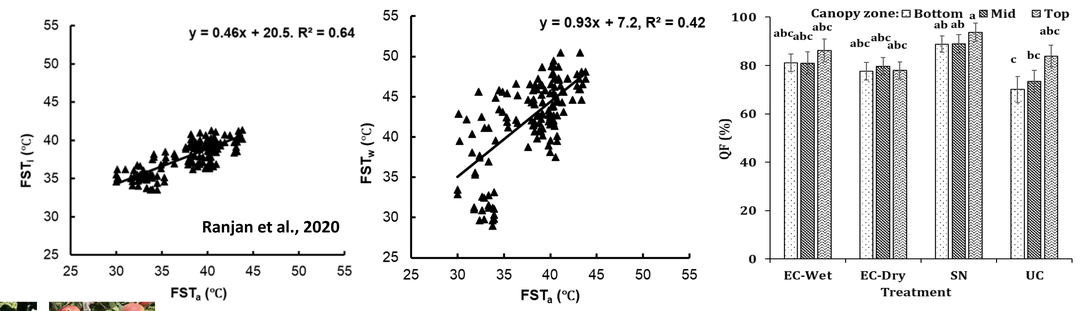


Fig. 3. Relationship between actual fruit surface temperature (FST_a) and imagery (FST_I) and weather based FST (FST_w) and fruit quality factor (QF) for wet (EC-Wet) and dry (EC-Dry) zone of evaporative cooling, shade net (SN) and untreated control (UC) treatments

2021 season work plan

- CPSS integration with modified EC
- Integrated system validation in commercial orchards

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