



Mitigating Heat Stress

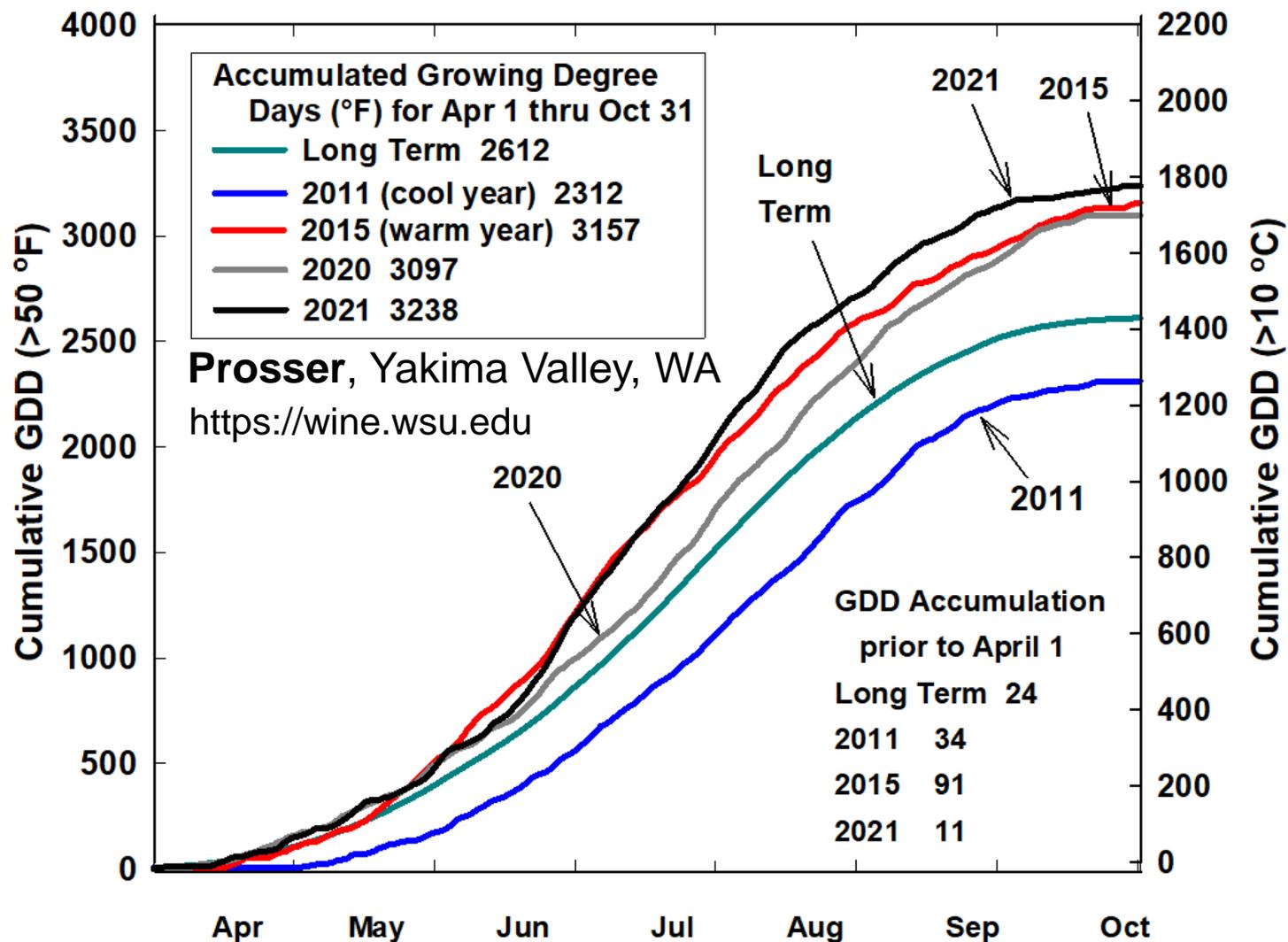
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2021 Growing season: The future is now

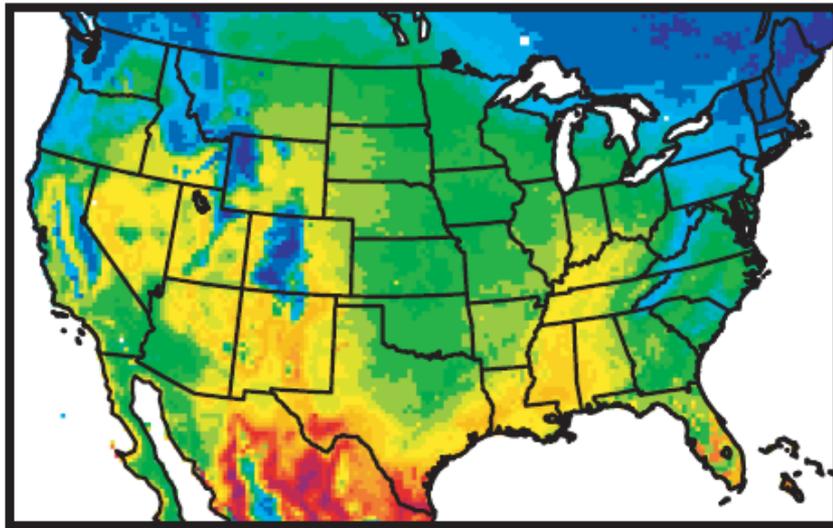


- Eastern WA with new seasonal GDD record in 2021
- Heatwaves: Prosser with peak at 112°F, 29 days with $T_{\max} > 95^{\circ}\text{F}$

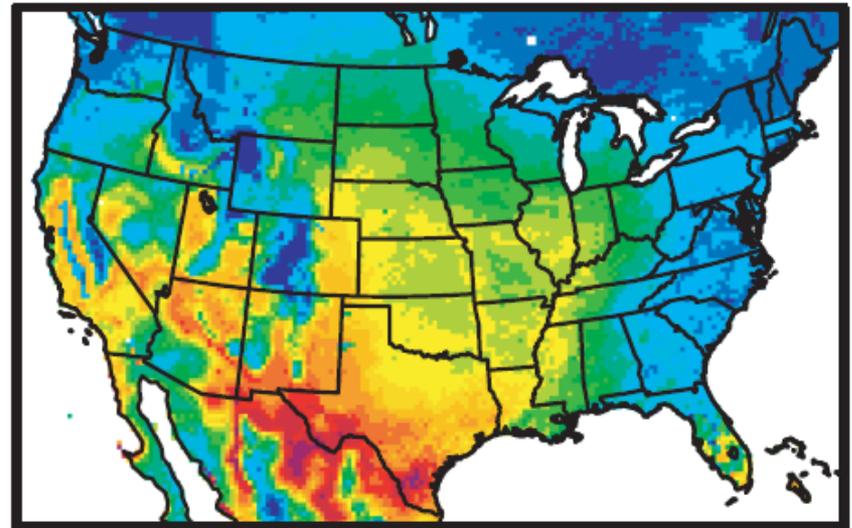
The future: More heat ahead

Projected changes in number of hot days in late 21st century

Growing season



Ripening period



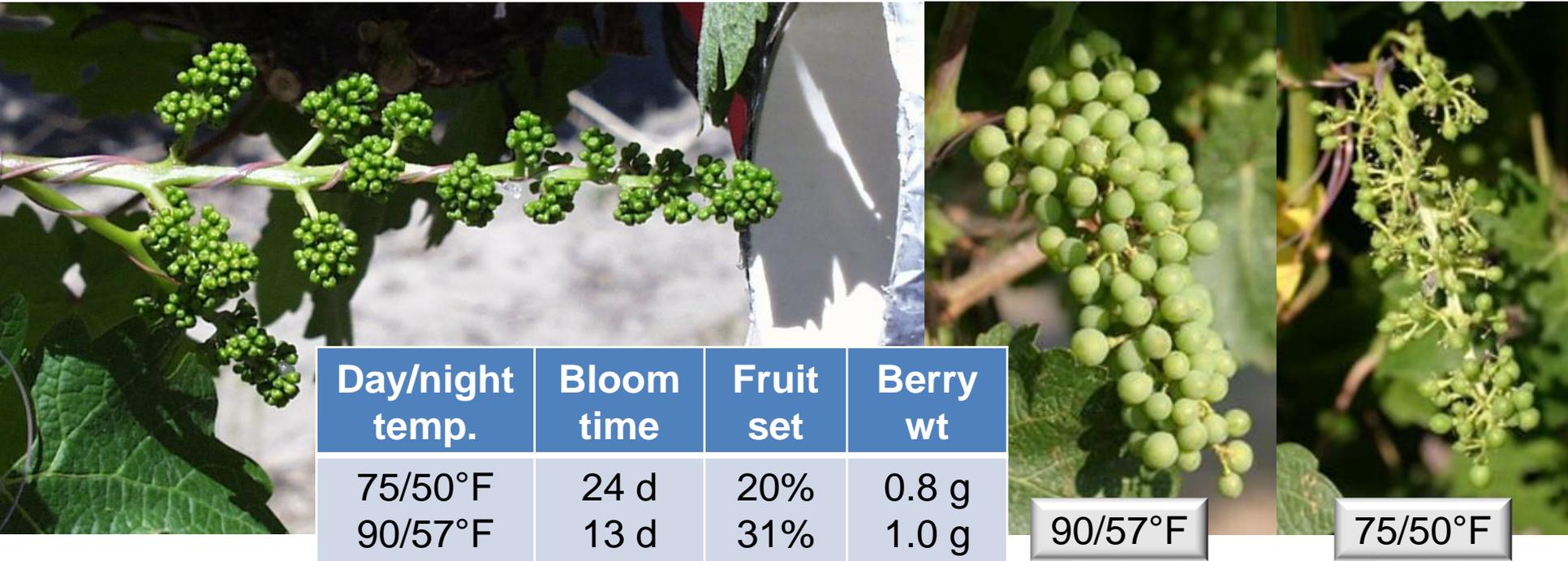
0 20 40 60 80 days/yr



0 8 16 24 28

- Model prediction: More hot days ($T_{\max} > 95^{\circ}\text{F}$) across US
- 2021 was like predictions for late 21st century:
29 hot days during growing season (5 during ripening period)

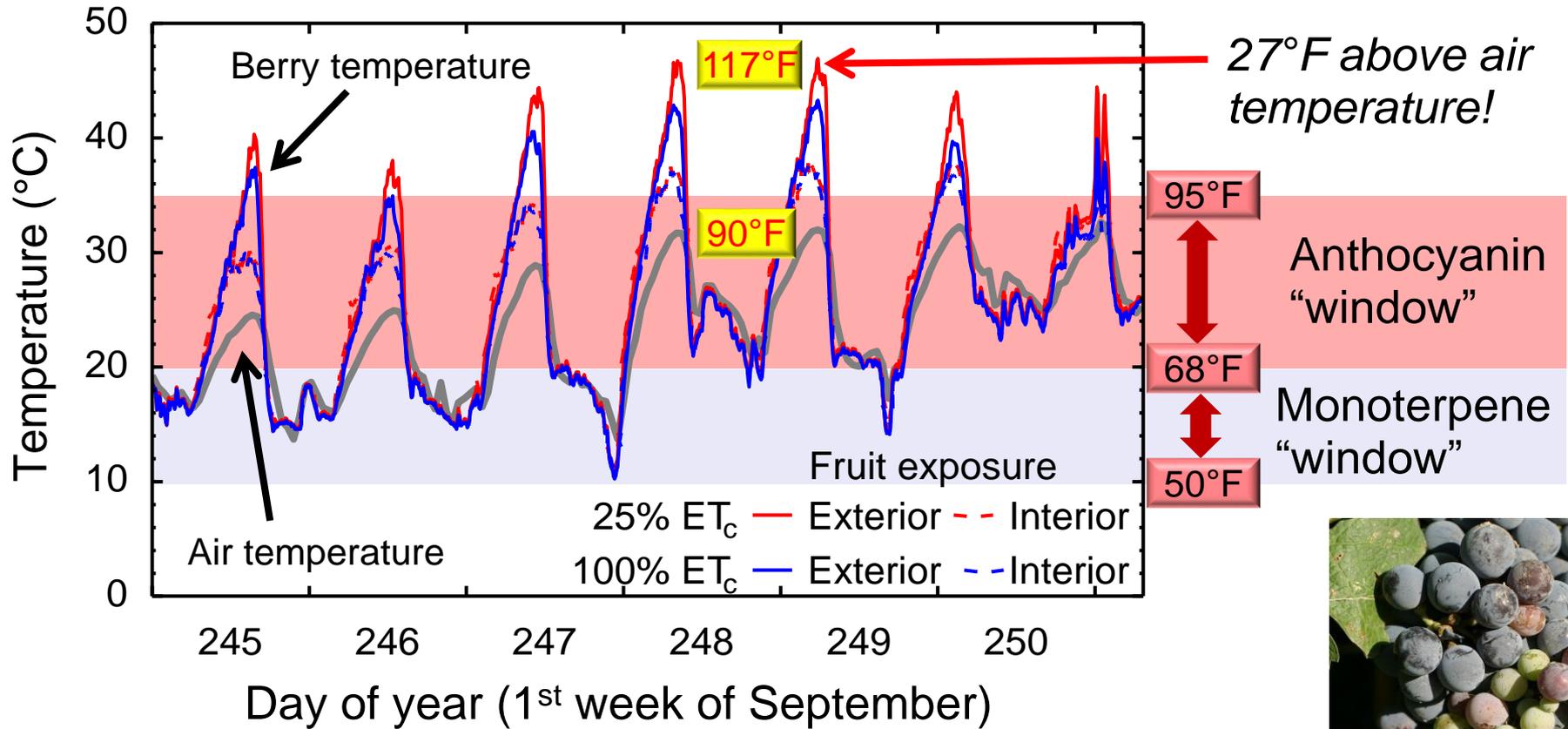
Heat stress compromises yield



Temperature from 50 to 90°F → Fertilization, fruit set increase, but temperatures above 95°F...

- Inhibit pollen germination → Poor fruit set, shot “berries”
- Reduce cell division (maximum at 70–80°F) → Small berries
- Reduce cluster formation in buds → Low bud fruitfulness for next year’s crop

VSP and water deficit: Risky combination



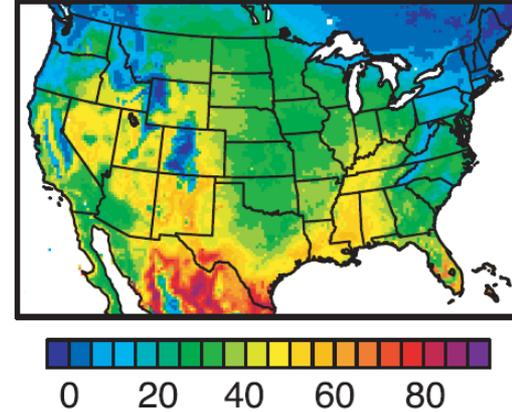
- Water deficit → Small berries, low shoot vigor
 - Open canopy: Exposed clusters are warm clusters
 - High light: More flavonols, flavan-3-ols (bitter, astringent)
 - High temperature: Less anthocyanins (color) above 95°F
- Sunburn on exposed berries above 108°F



Keller et al. (2016)

Mitigating heat stress: Options

- Conflict of interest: Deficit irrigation conserves water and enhances fruit quality, but stomata close
 - Canopy heats up
 - Should we irrigate more before heatwaves?



- Heat stress mitigation → Consequences?
 - **Shade netting**: Expensive (~\$12,000/acre), less light → Lower photosynthesis → Yield, quality?
 - **Overhead sprinklers**: More water → May compromise deficit irrigation goals → Higher vigor, berry splitting, bunch rot
 - **Heat-tolerant varieties**: Requires field grafting, replanting, breeding
 - **Vineyard relocation**: Requires vineyard removal and redevelopment
- We need:
 - Better knowledge of varietal diversity (responses to heat/drought stress)
 - Variety-specific, cost-effective irrigation and heat mitigation strategies

Mitigating heat stress: Irrigation

- Common recommendation: Provide extra irrigation water before heatwaves
- Reality: Vine water status (Ψ) maxes out at irrigation at $\sim 75\%$ ET, no gain even if irrigation is increased to 150% ET

- Real-life tests in 2021:

- **Dry-down trial, 30 varieties**:

Irrigation to fill soil profile at fruit set, then no irrigation through veraison

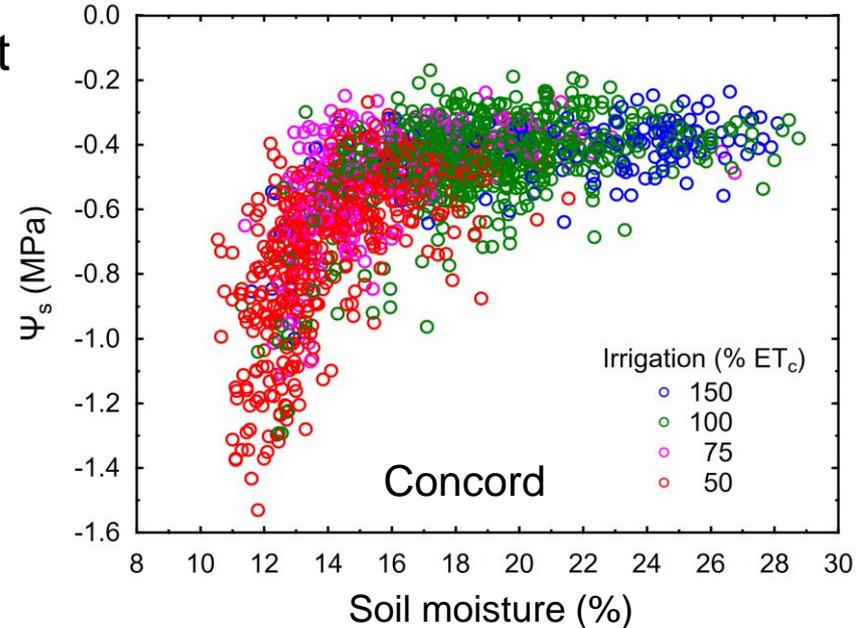
- **Irrigation trial, Riesling**: Full irrigation (100% ET replacement), RDI, and PRD (partial rootzone drying)

- **Irrigation/canopy trial, Riesling, Chardonnay**: Full and half irrigation, leaf removal after fruit set, shading at veraison

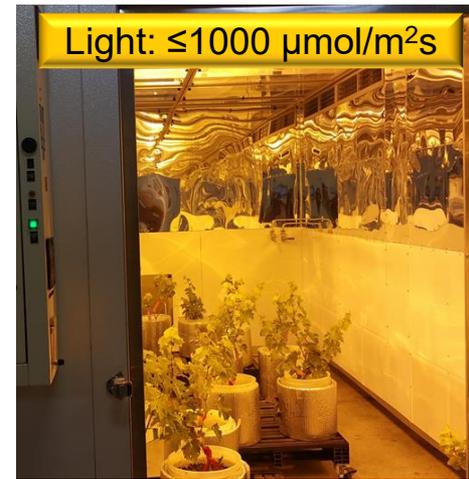
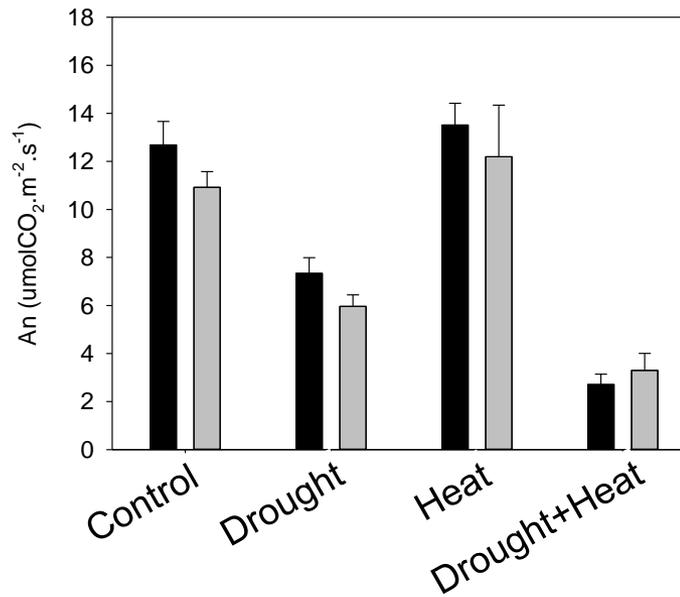
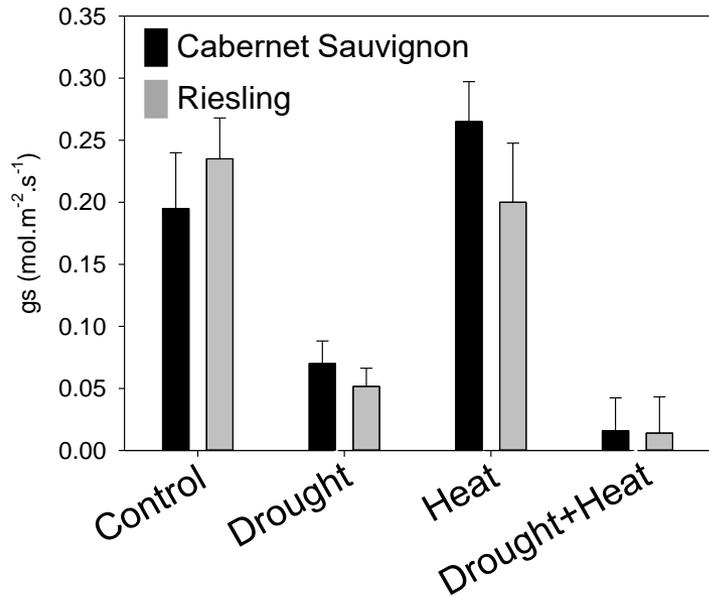
- Brief leaf wilting in few varieties (Tempranillo)

- Little sunburn, minor differences in fruit composition

- Posters: Charles Obiero, Geraldine Diverres, Evan Fritzke



Water for growth, temperature for ripening

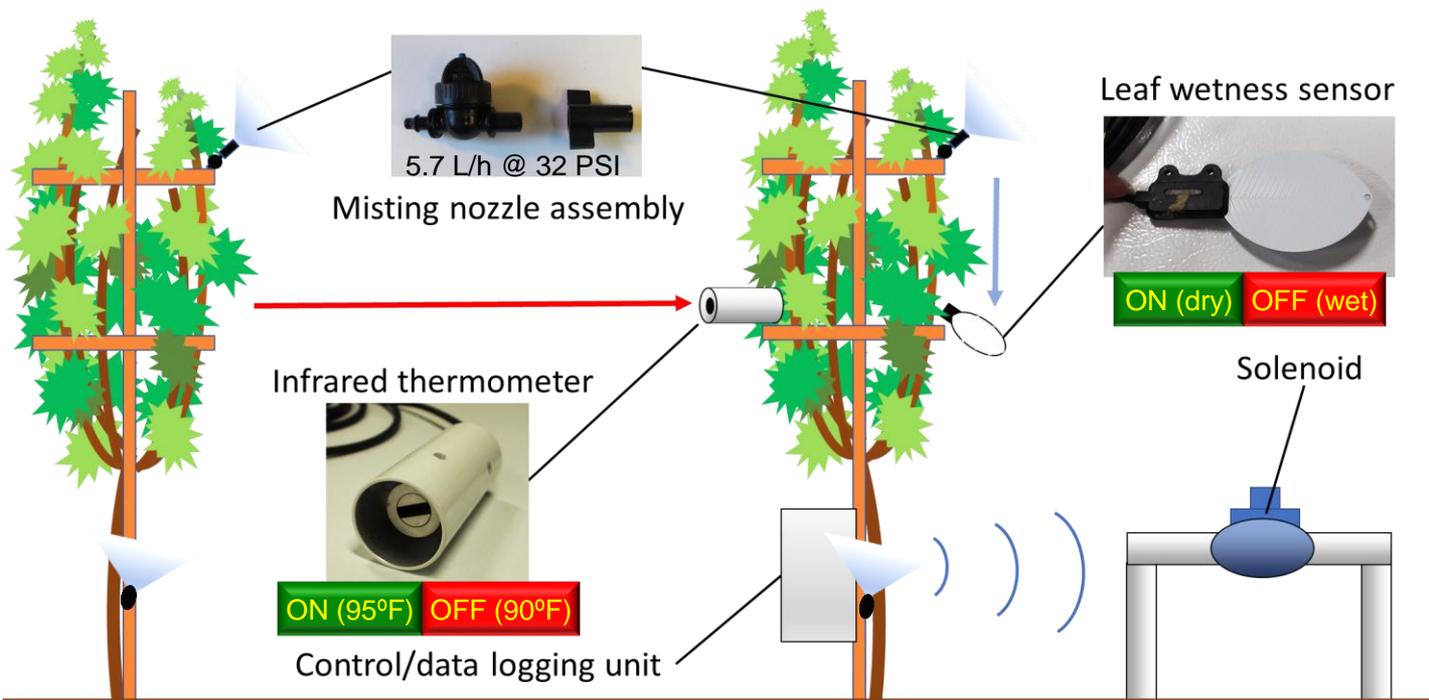


ET = Evapotranspiration

- **Growth chambers:** Control: 10-yr average max/min temperatures ($86/57^\circ\text{F}$), irrigation at 100% ET; Heat: $104/75^\circ\text{F}$; Drought: 50% ET
- **Leaf physiology:** Dominated by water availability but modulated by temperature, depends on phenology, leaf age; recovery in 2–4 d
- **Shoot growth:** Dominated by water availability
 - ✓ Drought → Less growth
- **Fruit composition:** Dominated by temperature
 - ✓ Heat → $+1^\circ\text{Brix}$, $+0.25 \text{ pH}$, -2 g/L TA



Mitigating heat stress: Canopy cooling



→ Poster: Ben-Min Chang

- Novel mist-type evaporative cooling system
- Misting nozzles on drip tube attached to foliage wire (west) or irrigation wire
- Feedback control maintains temperature, avoids leaf wetness, water runoff
- 90% reduction in water use compared with overhead sprinklers
- Canopy temperature maintained around 90–95°F during heatwaves
- No effect on disease incidence, yield, TSS, TA, but lower pH

Grower panel

Lacey Lybeck

Vineyard Manager

Allan Brothers Fruit – Sagemoor Vineyards

Leif Olsen

Owner/Managing Partner

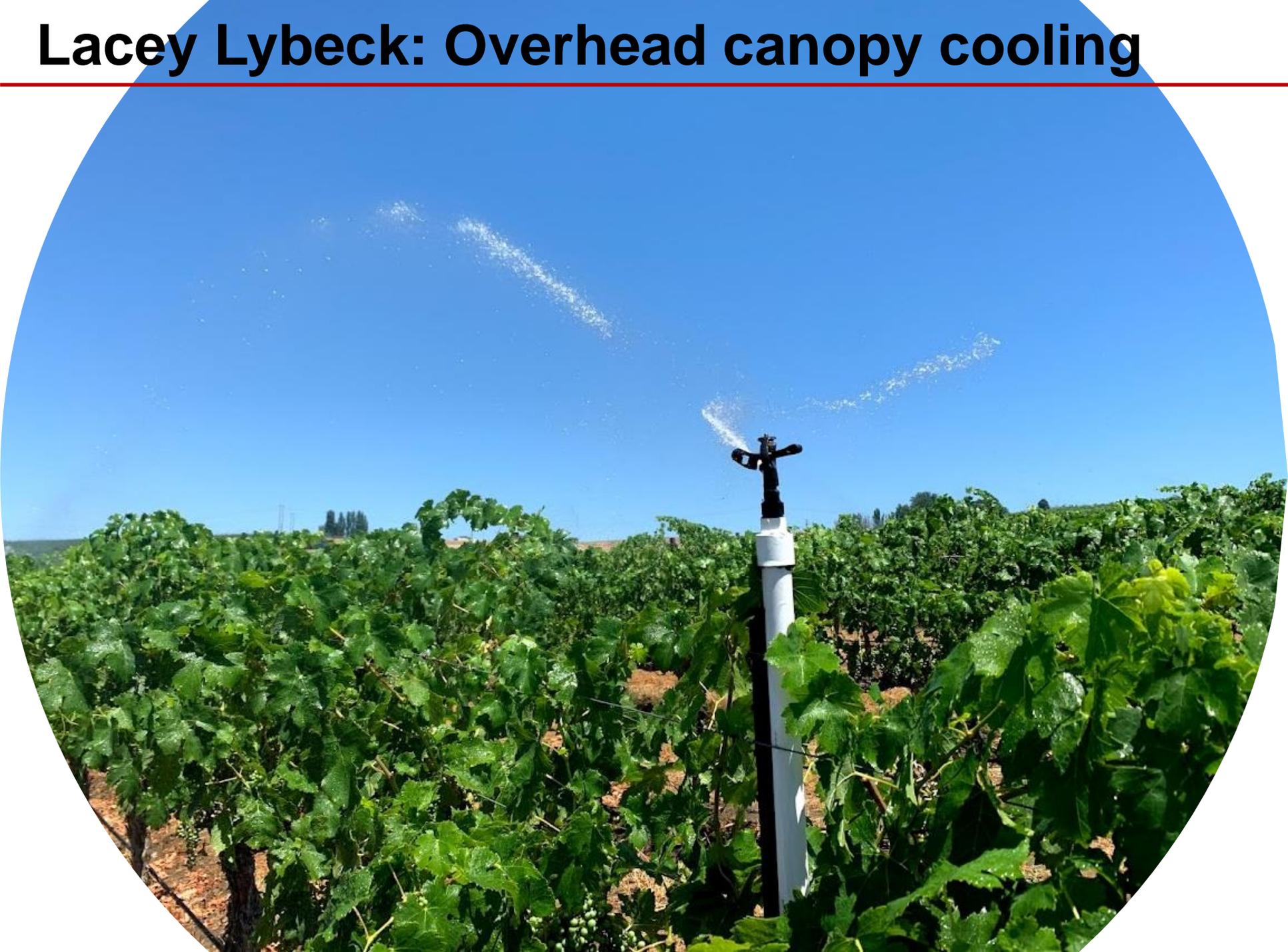
Olsen Brothers Ranches

Yun Zhang

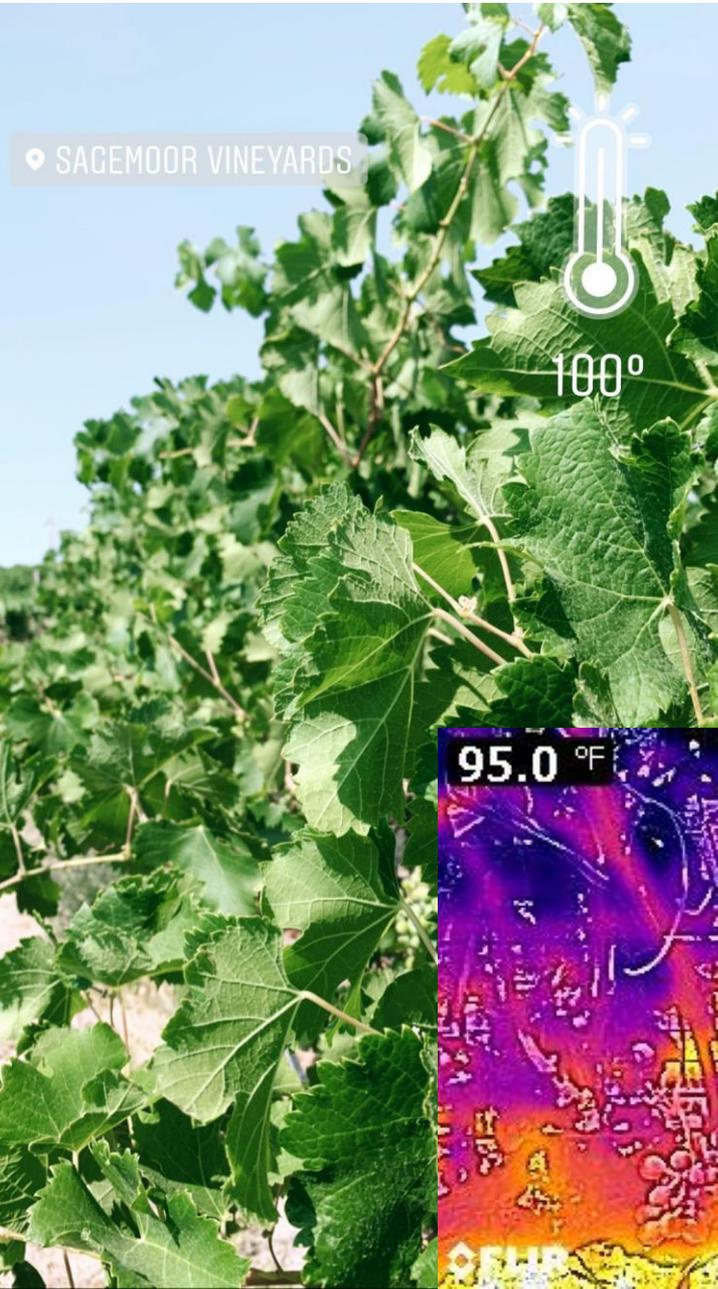
Viticulturist

Ste. Michelle Wine Estates

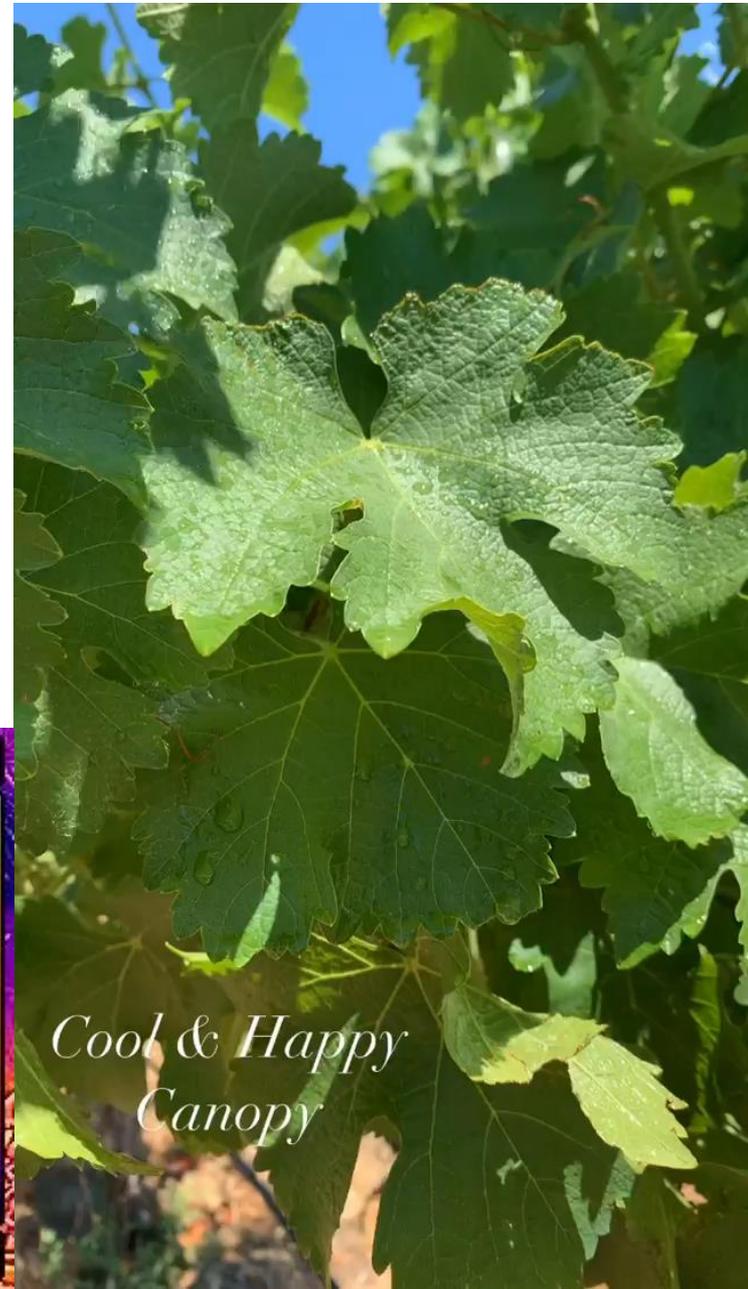
Lacey Lybeck: Overhead canopy cooling



Lacey Lybeck: Overhead canopy cooling



FLIR thermal camera visualizes berry and canopy temperature



Cool & Happy Canopy

Leif Olsen: Shade panels to prevent sunburn



Yun Zhang: Water to prevent leaf injury





Questions?

Comments?

Ideas?

Thank you!