30 Years of Irrigation Research: What’s Next?

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The early days

Pre-1990 (Age of the IAREC Bobs)
- Drip irrigation becoming standard for wine grapes
- Typically no cover crop (tilling between rows is common)
- 1983: First WSU-IAREC irrigation research vineyard planted
- 1987: WSU-PAWS starts providing ET₀ data
- Field trial 1985 – 1990 (Cabernet S., Riesling, Chenin blanc)
- Goals: - Harden off vines for winter survival
  - Develop crop coefficients for ETᵥ = Kᵥ × ET₀
  - Deficit irrigation (50% ETᵥ) only during ripening period, and soil water replenished after harvest (near leaf fall)

"The ability of growers to properly implement irrigation scheduling water management in late summer is critical to the sustained, long-term production of V. vinifera vineyards in central Washington." - Evans, Spayd, Wample et al. (AWM, 1993)

The middle ages

1990 – 2000 (Advent of RDI)
- Increasing use of cover crops (seasonal or permanent)
- 1992: Start of WSU/SMWE irrigation research collaboration
- Field trial 1992 – 1996 (Sauvignon blanc)
- Goals: - Control canopy development (shoot vigor)
  - Improve fruit quality while maintaining yield
- Adoption of regulated deficit irrigation ("crude" RDI)
- Water deficit before or after fruit set: High (near field capacity) vs. low (near permanent wilting point) → HH, HL, LH, LL

"Effective irrigation management results in better control of plant growth and more efficient and economical crop production." - Wample & Smithyman (FAO, 2000)

Walter J. Clore
- Father of Washington’s wine industry
- Not the father of irrigation research

"Irrigation was by the furrow method. Two or three irrigations each season have been sufficient for these varieties." - Clore et al. (AJEV, 1972)

1. Vines use little water before bloom (<10% of season) → Low Kᵥ
2. Water use peaks near veraison → High Kᵥ
3. Post-veraison decline due to deficit irrigation (50% ETᵥ)
The new millennium

Post-2000 (Refining RDI)
- AgWeatherNet provides \( \text{ET}_d \) for irrigation scheduling
- Industry RDI "standard": 70% \( \text{ET}_c \) from fruit set to harvest

**Goals:**
- Optimize timing and extent of water deficit
- Test interactions with crop load
- Manipulate wine style in the vineyard
- Severe water deficit before or after veraison (25 – 35% \( \text{ET}_c \))

"Quantitative information could be used to fine-tune RDI strategies in order to produce fruit to winery specifications (e.g., for blending options) while maintaining vine capacity and cold hardiness."
Keller, Smithyman & Mills (AJEV, 2008)

The value of fundamental research

- **Myth:** Late-season irrigation dilutes wine quality
- Old-world laws and new-world winemakers prohibit or restrict pre-harvest irrigation
- **2004:** Start fundamental grape physiology experiments
- **Goals:**
  - Investigate grapevine and berry water relations
  - Test hydraulic isolation theory (dogma)
  - Provide evidence for or against dilution myth
- Use displacement sensors, root pressure chamber, dye, microscopy, growth model calculations

"There is little scientific evidence that late-season water uptake by the roots and transport to the fruit is detrimental to grape quality." Keller, Smithyman & Bondada (JXB, 2006)

Water deficit increases fruit sun exposure
- Sun-exposed berries are hot berries
- Too little water too late (25% \( \text{ET}_c \)) is detrimental to vines and wine

Pre-veraison irrigation can be cut to 25% \( \text{ET}_c \)
- Pre-veraison water deficit more important than post-veraison deficit
- Both crop load and water determine berry size
**Trouble with \( K_c \)**

- Washington (Yakima Valley) \( K_c \) too low for ripening period
- Most vineyard expansion in warmer AVAs
- Climate change is altering the GDD–\( K_c \) coupling
  → Hot growing seasons and/or warm sites: \( K_c \) drops to zero before harvest

**Updating \( K_c \)**

- \( K_c = \) Function of canopy surface area (site-specific)
- Test use of UAVs (drones) to determine and map \( K_c \)
- Precision irrigation to cost-effective scale
- Apply \( K_c \) to both hand-pruned and mechanized vineyards

**Tailoring deficit irrigation**

- Wine styles differ between varieties (red, white...)
- Response to water stress varies among varieties
- Pessimist (isoohydric) versus optimist (anisohydric) categorization too simplistic
- Match irrigation frequency and extent of water deficit to varietal physiology and desired end use of the grapes
- Optimize RDI for red varieties
  - Avoid late-season water stress
  - Prevent berry shrinkage during hang-time
- Adopt PRD for some white varieties
  - Avoid excessive fruit sun-exposure
- More fruit with less water (WUE)
  - Subsurface irrigation?

**PRD: Coming to a vineyard near you?**

- Partial Rootzone Drying (fruit set through harvest)
- Easy to manage (irrigate dry side) and water-conserving
- 2015: Wine Science Center opens at WSU Tri-Cities
- Field trial 2014 – 2016 (Chardonnay, Riesling)

**Goals:**
- Maintain berry size and yield
- Reduce bitterness, astringency in wine

**Back to the future: What’s next?**

- Washington \( K_c \) needs updating
- Bringing new technology to bear on irrigation
- Tailoring irrigation to variety and wine style
Heat waves and drought

- Heat waves and droughts are becoming more frequent
- **2010**: New WSU-IAREC wine grape research vineyard planted
- **2015**: Four growth chambers installed at WSU-IAREC
- Field trials supported by growth chamber experiments
- **Goals**: - Test interactions between heat and water stress
  - Generate knowledge and recommendations that will empower growers to cope with drought and heat
- Hydrocooling during temperature peaks

Funding sources

- WSU Agricultural Research Center
- WA State Grape and Wine Research Program
  - Washington State Wine Commission
  - WSU (Legislative Appropriation)
  - Washington Wine Tax
- USDA Northwest Center for Small Fruits Research
- USDA (WSDA) Specialty Crop Block Grant Program
- Ste. Michelle Wine Estates
  - Distinguished Professorship
  - In-kind Contributions (Field Trials)

Thank you!