Washington State Grape and Wine Research Program

FINAL REPORT

PROJECT TITLE: Optimizing Irrigation Efficiency with Soil Water Sensor-based Systems

WRAC Project Number: 2022.3-C.JP2
DURATION: FY 22 – FY 23 (July 2021 – June 2023)

PRINCIPAL INVESTIGATOR

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COOPERATORS

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OBJECTIVES of RESEARCH PROJECT

The original proposal as presented contained 5 objectives to be addressed over 3 years. WRAC funded the first year of the project at $20,000 with no other funding being requested by the PI owing to a project being funded by the Northwest Center for Small Fruit Research (NCSFR) to automate irrigation scheduling in the Ducleaux Cellars Vineyards near Milton-Freewater, OR. Observations, data collection, and assessment has continued at Kiona via funding provided from other grants awarded through WA Department of Agriculture, and an additional project (WRAC 2023.1-CP.JP1). The objectives for the original proposal were reduced accordingly to include mainly data collection and interpretations from continuously recording soil sensors in the Kiona Block 2 Vineyard consisting of the following:

A. Determine the best placement of soil water sensors (depth in the soil profile and proximity to the vine) for establishing irrigation scheduling (frequency and quantity of water applied) to impose a desired level of water stress upon the vine.
B. Determine whether the above placement should be different for water applied via surface drip versus subsurface drip.
C. Assessment of water dynamics within the upper 65 inches of the soil profile under 4 rates of irrigated applied as surface drip and subsurface drip.

SUMMARY OF ACCOMPLISHMENTS

Data from soil water sensors at Kiona Vineyards during the 2021 and 2022 growing seasons have determined that the best placement of sensors is beneath the emitter or very near the point of water delivery into the soil. Water movement within the soil via capillary action was shown to be in all direction from the point of water release into the soil. In the case of subsurface drip, water movement from the point of release from a delivery tube at 24 inches below the soil surface was observed to enhance soil water content deeper into the soil profile as well as upwards to within 6-7 inches from the surface. Data from these continuously recording sensors also allow a visual assessment of water use by depths of sensor placement throughout the soil profile that occur between irrigation events. By correlation of soil water content and leaf water potential and other measurements of vine activity, irrigation scheduling can become more precise for maintaining vine water stress within desired levels needed for meeting fruit quality goals.

For additional information, please access the WAVEx podcast (50 minutes) which includes a specific section on these results: Jacoby, P.W. 2023. Deep Root Zone Irrigation. WA Wine WAVEx webinar. 50 minutes. **https://www.washingtonwine.org/wave/**

OUTREACH AND EDUCATIONAL PRODUCTS supported from this project and others include the following:

Jacoby, P.W. 2023. Optimising subsurface drip irrigation for effective drought defence. Adjacent Digital Politics Lt., Crewe, Cheshire, UK https://www.openaccessgovernment.org/optimising-subsurface-drip-irrigation-for-effective-drought-defence/162119/

Jacoby, P.W. 2023. The importance of irrigation systems in enhancing winegrape vineyards resilience. Adjacent Digital Politics Ltd., Crewe, Cheshire, UK https://www.openaccessgovernment.org/irrigation-systems-enhancing-winegrape-vineyards-reslience/157257/

Jacoby, P.W. 2022. *Optimizing water use for Winegrapes with Sensor-controlled subsurface irrigation*. Abstract. *In:* NW Ctr. Small Fruits Res. Ann. Meet, Conf. Proc. p. 37. Kennewick, WA

Jacoby, P.W., L.R. Khot. 2021. *Advancements of sensor-based water management to maximize crop water use efficiency in conjunction with direct root zone (DRZ) subsurface drip irrigation.* ASABE/AI 6th Decennial Irrigation Symposium, San Diego, CA, Dec. 5-6. DOI: https://doi.org/10.13031/irrig.2020-045 Paper Number: 20-045

Jacoby, P.W., M. Brain. 2021. *Sub-surface micro-irrigation in vineyards.* Podcast #101: Sustainable Winegrowing with Vineyard Team, Atascadero, CA. https://www.vineyardteam.org/podcast/?id=877

Khot, L.R., A. Chandel, R.T. Peters, C.O. Stockle, and P.W. Jacoby. 2021. *Drone-based grapevine water use mapping.* WSU Vit/Enology Extension News. Spring Issue pp. 6-8.

Amogi, B.R., A.K. Chandel, L.R. Khot, and P.W. Jacoby. 2020. *A mobile thermal-RGB imaging tool for mapping crop water stress of grapevines.* 2020 IEEE Int'l Workshop on Metrology for Agric./Forestry. Trento, ITALY, Nov. 4-6. Virtual Conf. info@metroagrifor.org DOI: 10.1109/MetroAgriFor50201.2020.9277545

RESEARCH PUBLICATIONS

Jacoby, P.W. 2023. Use of Deficit Irrigation to Enhance Winegrape Production Efficiency. *In*: Zhang, Q.(ed.). **Encyclopedia of Smart Agriculture Technologies**. Springer, Cham. https://doi.org/10.1007/978-3-030-89123-7_179-1

Ma, X.C., J. Wu, F. Han, Y. Ma, P.W. Jacoby. 2023. Optimizing crop water productivity and altering root distribution of Chardonnay grapevine (*Vitis vinifera* L.) in a silt loam soil through direct root-zone deficit irrigation. *Agricultural Water Management* https://doi.org/10.1016/j.agwat.2022.108072

Ma, X.C., P.W. Jacoby, K.A. Sanguinet. 2022. Improving net photosynthetic rate and rooting depth grapevines through a novel irrigation strategy in a semi-arid climate, pp. 61-72. *In*: Pastore, C.; Winefield, C.; Pas Diego, M. (Eds.) **Resilience of Grapevine in Climate Change: From Plant Physiology to Adaptation Strategies.** *Frontiers in Plant Sci*. https://doi.org/10.3389/978-2-83250-009-5

Tolomelli G, G.S. Kothawade, A.K. Chandel, L. Manfrini, P.W. Jacoby and L.R. Khot. 2022. Aerial-RGB imagery-based 3D canopy reconstruction and mapping of grapevines for precision management. *2022 IEEE Workshop on Metrology for Agriculture and Forestry (MetroAgriFor)*, pp. 203-207. https://doi.org/10.1109/MetroAgriFor55389.2022.9965062

Chandel, A.K., L.R. Khot *, B. Molaei, R.T. Peters, C.O. Stöckle, P.W. Jacoby. 2021. High-resolution spatiotemporal water use mapping of surface and direct-root-zone drip irrigated grapevines using UAS-based thermal and multispectral remote sensing. *Remote Sens.* 13, 954. https://doi.org/10.3390/rs13050954

RESEARCH SUCCESS STATEMENTS

The most critical outcome of this research to date has been the knowledge gained for successful employment of automated irrigation scheduling. There are a number of methods being used for determining the most optimal timing and duration of irrigation events over the growing season. Generally, these methods involve either on-plant or in-soil sensors. Our focus has been on the in-soil sensors for using both soil water content and soil water availability to serve as the sentinel determiner of irrigation timing and duration. This research has also been informative in defining differences in the use of these sensors for both surface drip and subsurface drip delivery. The time gap between in-soil and on-plant determination of vine water stress may favor use of the in-soil sensors to prevent physiological damage to the vine or fruit.

In the use of subsurface drip irrigation, the DRZ (direct root-zone) delivery system has been modified continuously to be more efficiently employed and resistant to root and soil clogging, as well as compatible to mechanical methods used for vineyard surface maintenance and weed control. Single tube placement in close proximity to the vine base is now being employed and evaluated for watering efficiency. Our research has confirmed the ability to save up to 35 percent of water needed to maintain yields when using DRZ versus surface drip.

We have also confirmed that DRZ contributes to deeper root development which could create more vine resilience to drought impacts by providing vine the means to access water from the full soil profile.

FUNDS STATUS – All funds allocated to this project (**$20,000**) have been exhausted within the categories presented below.

Personnel
Salaries, wages and benefits for student interns and graduate student fees……… 9,937.06

Supplies and Expenses …………………………………………………………… 9,032.13

Travel (in-state) ………………………………………………………………….. 237.92

TOTAL ………………………………………………………………………… $20,130.86

NOTE: $130.86 over-run paid from gift funds