NM WRRI Student Water Research Grant Final Report

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2. Project title: Assessing Consumptive Water Use of Pistachio Orchard in the Mesilla Valley, Using Drip Irrigation.

3. Description of research problem and research objectives

Southern New Mexico is experiencing a shortage of surface water due to many years of drought, exacerbated by climate change. The Global Climate Models project a temperature increase of more than 5 °F over the next half-century (Dunbar et al., 2022). This temperature rise is expected to put additional pressure on the water supply required for growing crops such as alfalfa and pecans. This proposed project aims to investigate the potential of pistachio trees as an alternative crop for sustainable agriculture in the Mesilla Valley, NM. The hypothesis is that pistachio trees will use less water as they thrive in warm climate regions, exhibit drought tolerance, and can withstand hot and dry summers with temperatures exceeding 100 °F, as well as cool winters without freezing (Esteban Herrera, 1997). While pistachio orchards have been successful in the San Joaquin Valley, CA, and parts of Arizona and New Mexico, our understanding of the water consumption by pistachio trees in the Mesilla Valley environment is limited. This study is part of an ongoing major research project to assess water use in young pistachio trees, approximately 3 years old, under a drip irrigation system.

4. Description of methodology employed

4.1. Site Description and Instrumentation

The experiment was conducted in 2024 at a 20-acre pistachio farm called RPO. The farm is located near the town of La Mesa in the Mesilla Valley, NM (N 32° 6' 34", W 106° 42' 21"), Figure 1. The young pistachio trees are drip-irrigated using two ¾-inch surface tubing lines that run along both sides of the trees, with holes perforated near the base of the trees. The average height of the trees was 8 ft. The trees were spaced in a row-column matrix of 15 ft by 20 ft.

An eddy covariance system was installed on a 29-foot tower (Figure 2) in the RPO to measure the components of energy fluxes (net radiation, sensible heat, latent heat, and soil heat) above the trees. Additional sensors, including relative humidity, air temperature, global solar radiation, wind speed and direction, barometric pressure, and precipitation, were also installed to measure the weather parameters. The sensor types/models and their siting on the tower are shown

in Figure 2 and they were purchased from Campbell Scientific Inc., Logan, Utah. The net radiation was measured using the Apogee four-way sensor, and the sensible and latent heat were derived using the eddy covariance technique from 10 Hz measurements of 3-dimensional wind speed, air temperature, and vapor using an IRGASON sensor. The soil heat flux was measured using a pair of soil heat flux plates, a soil volumetric moisture sensor, and soil temperature probes.

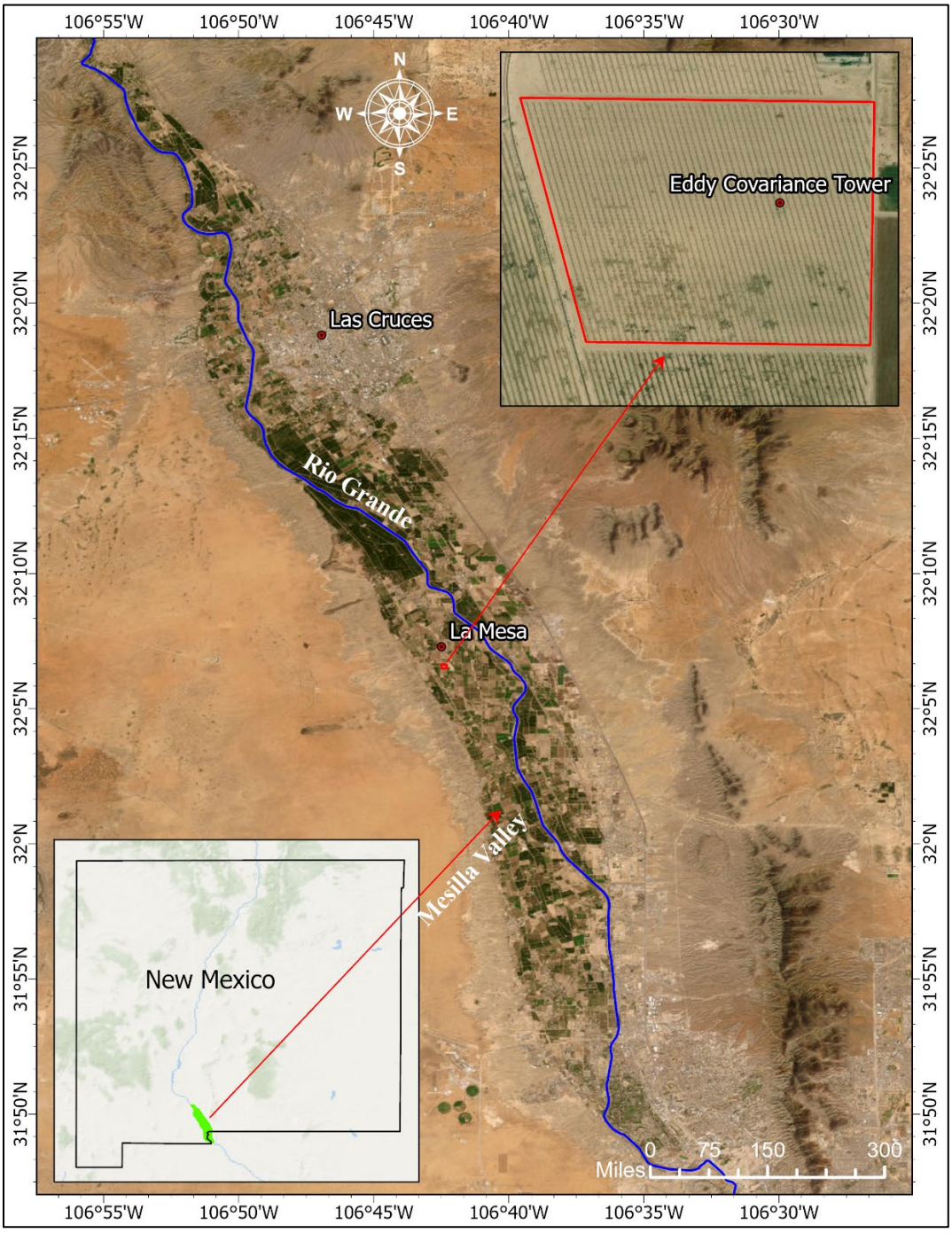


Figure 1. The geographic location of the pistachio orchard (RPO) and the eddy covariance flux tower for measuring components of the energy budget in the Mesilla Valley, NM.

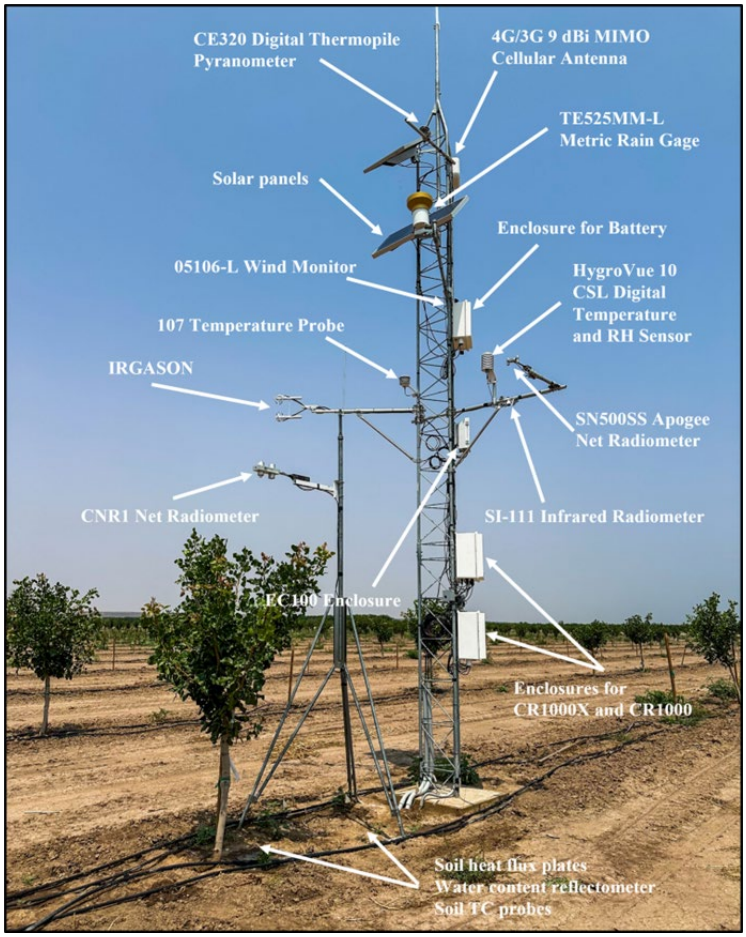


Figure 2. The eddy covariance flux station tower and installed sensors at the pistachio orchard (RPO), Mesilla Valley, NM.

4.2. Methodology Implemented

The latent heat flux of the pistachio orchard was calculated as a residual in the energy balance (Equation 1). The latent heat flux (LE) is then converted to the equivalent depth of water, also known as evapotranspiration (ETa), in millimeters using Equation 2.

$$LE = R_n - H - G \quad (1)$$

where LE is the latent heat flux (W m^{-2}), Rn is the net radiation (W m^{-2}), H is the sensible heat flux (W m^{-2}), and G is the soil heat flux density (W m^{-2}) or the energy conducted into or out of the soil.

$$ET_a = \frac{LE}{\lambda\rho} \times 1000 \quad (2)$$

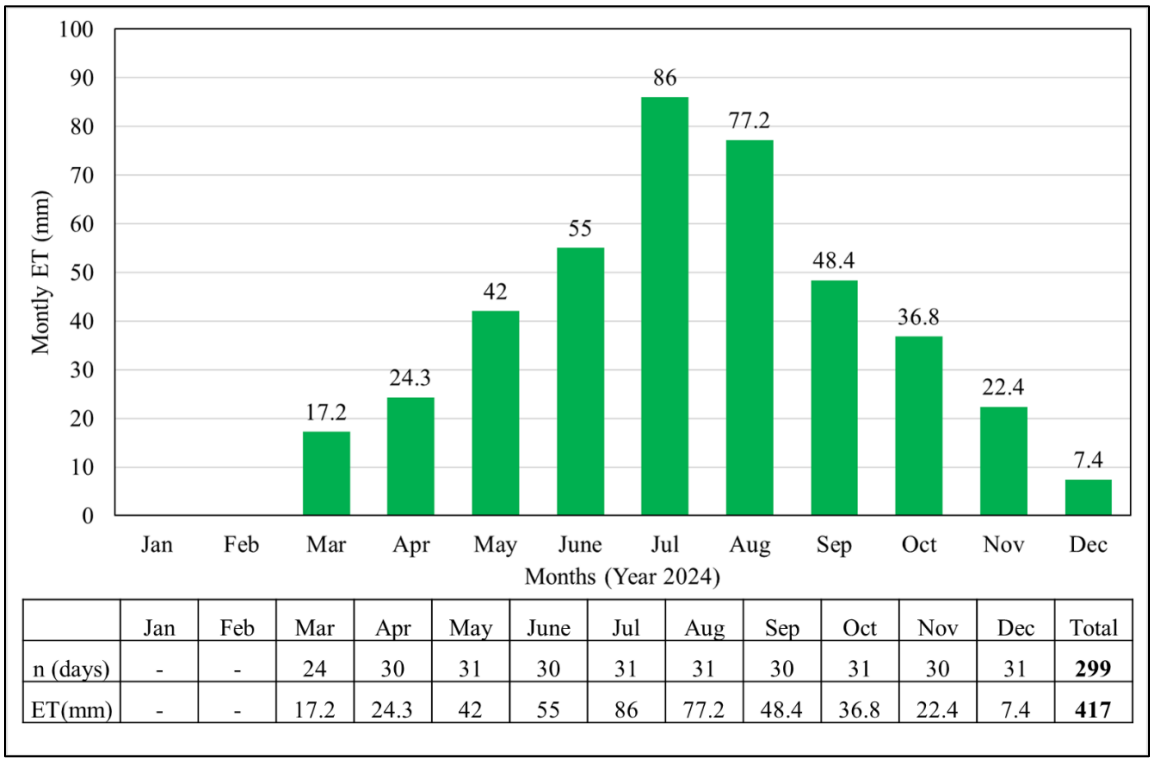
where λ is the latent heat of vaporization of water (2.45 MJ kg^{-1}), ρ is the density of water (1000 kg m^{-3}), and 1000 is the conversion from meters to millimeters.

5. Description of results: including findings, conclusions, and recommendations for further research

5.1. Evapotranspiration (ETa)

Monthly ETa values measured in the pistachio orchard at the RPO farm are shown in Figure 5. This study is still ongoing, and the ETa values presented in this report are preliminary. Additional data analyses are ongoing, such as CO_2, stem water potential, and soil moisture, which need to be considered in ET estimation. Measurement of ETa did not start for this study until April, after the instrumentation was installed. In April, the leaves started to emerge from winter dormancy, and by July and August, they had reached the peak. By the end of October, they had entered senescence and fallen from the trees.

The ETa of pistachio increased as the trees grew and the leaves reached maturity, and then declined as the season progressed. The highest monthly total ETa of 86 mm was measured in July, when the plants reached full growth. The total ETa measured during the year was 417 mm (n = 299 days), and during the growing season, it was 370 mm (n = 214 days). Total precipitation measured in 2024 was 85 mm. The ET of this young drip-irrigated pistachio orchard (about 3 years old) is much less when compared to the ET of mature flood-irrigated pecan, which is about 1100 mm. It should be noted that the pistachio orchard is still young and has not yet begun producing nuts.



	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Total
n (days)	-	-	24	30	31	30	31	31	30	31	30	31	**299**
ET(mm)	-	-	17.2	24.3	42	55	86	77.2	48.4	36.8	22.4	7.4	**417**

Figure 3. Monthly total actual ET measured using the eddy covariance technique.

5.2. Conclusion

The ET of a young drip-irrigated pistachio orchard located in the Mesilla Valley near La Mesa, NM, was measured using the energy budget residual method and eddy covariance technique in 2024. The ET measured during the growing season, from April to October, was 370 mm (n = 214 days), which is significantly less than the ET of a mature flood-irrigated pecan orchard, at 1100 mm (April - October). The ET values of pistachio presented in this report are for one growing season and are preliminary, as this research is continuing and further data are being collected.

6. Provide a paragraph on who will benefit from your research results. Include any water agency that could use your results.

This research will benefit farmers, irrigation specialists, and regional water managers who are working to improve agricultural water use efficiency in arid environments, such as the Mesilla Valley and other parts of southern New Mexico. By providing accurate estimates of consumptive water use in young pistachio orchards using drip irrigation, the findings can support more informed irrigation scheduling, optimize water allocation, and help sustain long-term agricultural productivity. The results can also aid other researchers and extension services in developing region-specific guidelines for water management under changing climate and resource conditions.

7. Describe how you have spent your grant funds. Also, provide your budget balance and how you will use any remaining funds. If you anticipate any funds remaining after August 30, 2024, please contact Carolina Mijares immediately. (575-646-7991; mijares@nmsu.edu)

I. Total grant funded: **$ 7,498**

II. Expenditures:

- **a.** Travel expenses for the 69th Annual New Mexico Water Conference - $675.89
- **b.** Graduate student salary from 05/16/2025 to 08/15/2025 - $ 6,312.60
- **c.** Purchases for data acquisition and storage – $ 283.99
- **d.** Poster printing charges – $61.68
- **e.** Travel expenses for field work – $141.96
- **f.** Fringe benefits – $40.41
- **g.** Total money spent – **$ 7516.53**

III. Remaining funds: $ 0.00

8. List of presentations you have made related to the project.

- Oral Presentation at the 2025 ASHS Annual Conference on July 28 to August 1, 2025, at Hyatt Regency New Orleans, Louisiana.
- Poster presentation at the ***Graduate Research & Arts Symposium (GRAS) 2025*** on April 24, 2025, at Corbett Center, New Mexico State University, Las Cruces, New Mexico.
- Poster presentation at the ***69th Annual New Mexico Water Conference*** hosted by WRRI on November 4-6, 2024, at Buffalo Thunder Resort, Santa Fe, New Mexico.

9. List publications or reports, if any, that you are preparing. For all publications/reports and posters resulting from this award, please attribute the funding to NM WRRI and the New Mexico State Legislature by including the account number: NMWRRI-SG-FALL2023.

None at this point

10. List any other students or faculty members who have assisted you with your project.

Graduate Students: Thanushan Kirupairaja, Chris Chavez, and Boxiao Li assisted with field data collection and instrumentation maintenance.

Faculty: Dr. Salim Bawazir and Dr. Richard Heerema

11. Provide special recognition awards or notable achievements as a result of the research including any publicity such as newspaper articles, or similar.

None

12. Provide information on degree completion and future career plans. Funding for student grants comes from the New Mexico Legislature, and legislators are interested in whether recipients of these grants go on to complete academic degrees and work in a water-related field in New Mexico or elsewhere.

I am currently pursuing my PhD in Civil Engineering, with a specialization in Water Resources Engineering.