Soil, Water, and Plant Relations in Green Roof Management

Wyatt Gillman[1], Rory Jenkins[2], Jimmy Owen[3], Jett Schmidt[4]

[1]Department of Environmental Science, [2]Department of Biological and Agricultural Engineering, [3]Department of Geology, [4]Department of Horticulture and Natural Resources

Green roofs are forms of green infrastructure that are a growing solution to stormwater runoff and other problems caused by urbanization

Figure 1 (Left): Green roofs on Regnier Hall at Kansas State.

Figure 2 (Below): Aerial view of experimental green roof layout with sensor and plot location compositions.

Figure 3 (Above): Ekdahl Weather Station (Kansas Mesonet)

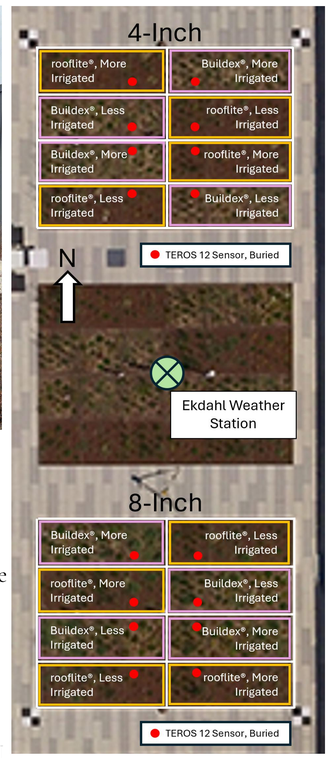
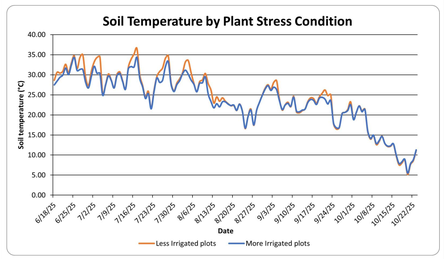


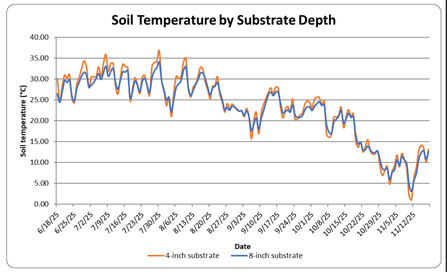
Figure 4 (Bottom Right): TEROS 12 Advanced Soil Moisture Sensor + Temperature and EC (METER Group)

Figure 5 (Below): Plant mixes included in experimental plots.

Mix A: Sedums	Mix B: Sedums + Natives	Mix C: Native grasses and forbs
		

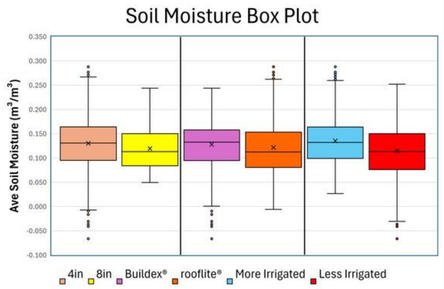
Results:

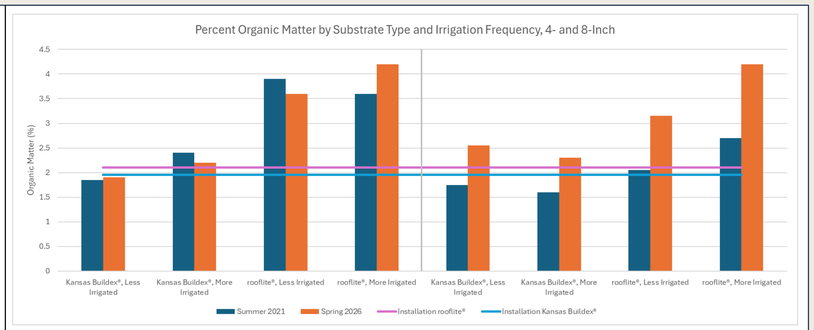


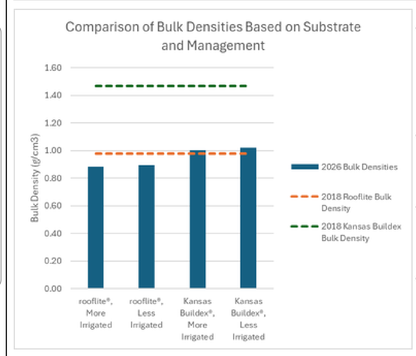


Lower Soil Temperatures and More Stable Soil Moisture:

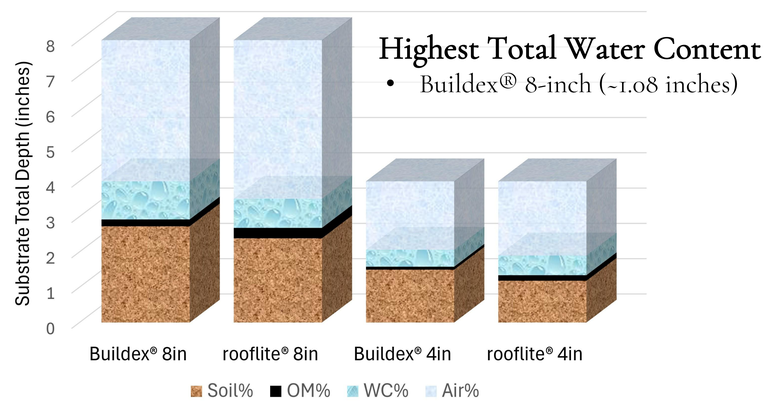
- 8-inch Depth
- Buildex®
- More Frequently Irrigated





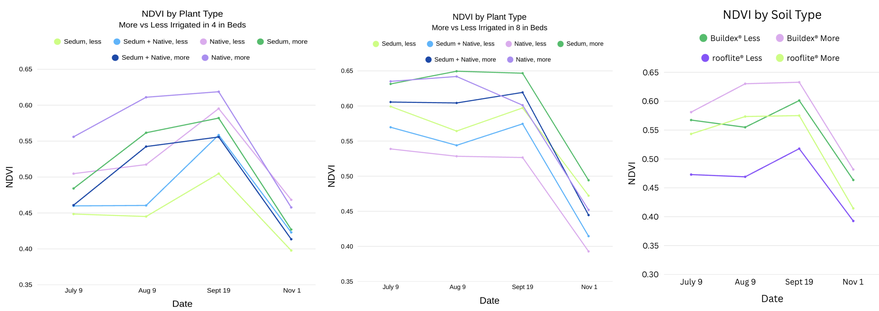


- Soil organic matter and bulk density depend primarily on substrate type
- Effects of irrigation frequency and substrate depth are limited
- rooflite® had a higher percent OM and a lower bulk density
- Bulk density of Buildex® will not impede plant growth



NDVI values (greenness) depends on soil type, soil depth, and irrigation levels:

- Higher NDVI with 8-inch substrate
- Higher NDVI with Buildex® substrate
- Difference in NDVIs by plant type



Methods:

- Study Period: 1 Jul – 5 Nov 2025
- NDVI categorized by analyzing drone pictures from 2025 season
- Daily mean values for soil temperature and moisture
- Random sampling for soil properties
  - Loss on ignition for organic matter analysis
  - Dry weight divided by volume for bulk density calculation

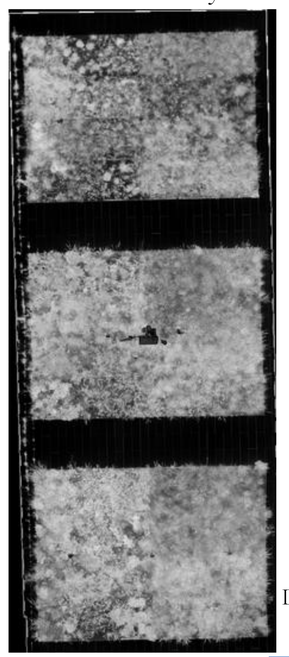


Figure 6 (Above): Soil samples being taken at random for organic matter and bulk density analysis.

Figure 7 (Left): Drone picture displaying NDVI for Aug 9th, 2025

Figure 8 (Right): Manual soil moisture and temperature reading being taken with a TEROS 12 sensor.

Recommendations:

From our research, less managed green roofs in the Great Plains can be achieved by:

- 8-inch substrate depth
- Buildex® substrate mix
- Native plant mix

References:

About Green Infrastructure. (2015, September 30). US Environmental Protection Agency. https://www.epa.gov/green-infrastructure/about-green-infrastructure

Alam, M. M. L. (2022). Climate Change Mitigation Potential of Green Roofs: Exploring Urban Heat Island Indicators and a Green Roof's Capacity to Sequester Carbon in the Flint Hills Ecoregion [Ph.D., Kansas State University]. https://www.proquest.com/docview/2771607967/abstract/EA27BFB0E73847DFPQ/1

Decker, A. B. (2021). *An experimental design to assess soil-plant-water relations on a Kansas green roof*. https://hdl.handle.net/2097/41683

Google. (2025). [Aerial view of the APDesign green roof at Kansas State University] [Map]. Google Earth. google.com

Kansas State University. (2025, October 14). KSU Architecture, Planning, and Design Experimental Green Roof. Green Roofs. https://www.k-state.edu/greenroofs/apdesign.html

Lundholm, J.T. (2015), Green roof plant species diversity improves ecosystem multifunctionality. J Appl Ecol, 52: 726-734. https://doi.org/10.1111/1365-2664.12425

Special thanks to: Dr. Isis Scott, Dr. Lee Skabelund, Muhaiminul Islam, & Kaden Spencer "Drone Guy"