Sandia National Laboratories

WATER SAFETY, SECURITY AND SUSTAINABILITY

Southeastern New Mexico Farmer's Irrigation Water Management Program

A Sandia National Laboratories Small Business Assistance Project

Introduction

In many parts of New Mexico, as well as the arid western U.S., it is becoming apparent that water conservation measures are needed to offset water loss due to drought and the increased demand of population growth. Water conservation programs are being implemented in domestic, industrial, and agricultural arenas to increase overall irrigation efficiencies by monitoring soil moisture infiltration, storage and depletion. In doing so, numerous complex interactions between: 1) surface, vadose, and ground water, 2) climate, 3) soil characteristics and textures, 4) plant physiology, and 5) intrinsic economic constraints can be positively correlated and better understood.

Image of a center-pivot irrigation system delivering water efficiently to only partial sections of this field.

Monitoring soil moisture in a surficially desiccated sandy loam supporting New Mexico green chile.

Need

Monitoring soil moisture accumulation and migration is an extremely important irrigation procedure used to determine the optimal irrigation application schedule for individual soil textures and crop varieties, as well as the proper volumes of delivered water needed to maintain field capacity saturation levels within the crops' root zones (a function of growth season and crop maturity). Newly implemented irrigation techniques and practices will increase forage yields and ultimately save precious water. Optimizing crop production by understanding relationships that exist between water consumption, nutrient uptake, and lengths of seasonal growth to maturation, among others, is an ongoing economic concern to irrigators in southeastern New Mexico.

Objectives

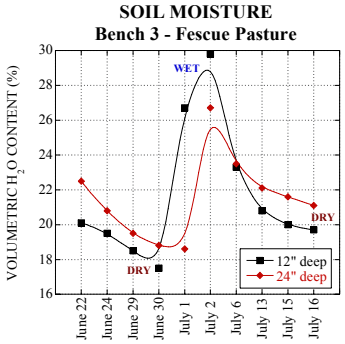
Irrigators require a tool or a method that will allow them to optimize irrigation efficiency and crop yield, while at the same time minimizing water consumption. Sandia National Laboratories, in conjunction with the New Mexico State University's Agricultural Science Center (NMSU-ASC), is providing assistance to irrigators here in southeastern New Mexico by accurately tracking and correlating the evolution of soil moisture properties, hydrodynamic processes, plant physiologies, water quality and availability issues, as well as daily meteorologic conditions. This work will aid in developing and correlating the complex relationships between: 1) textural and constitutive pedogenic properties, 2) soil moisture infiltration, percolation, and depletion rates, 3) plant physiology and evapotranspiration rates, 4) daily climatic and meteorologic conditions, 5) hydrodynamic processes, and 6) water availability, quality, storage, and usage concerns.

Image of an evapotranspiration gage, two soil moisture probes and a soil moisture data logger field box located at the head of the Bench 3 fescue pasture, NMSU-ASC.

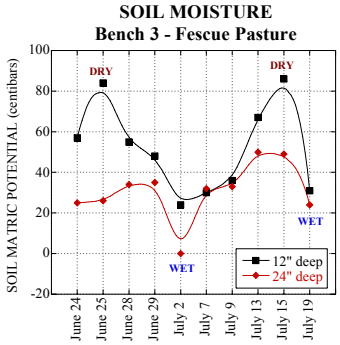
Image of the weather station at NMSU-ASC monitoring daily meteorological conditions including evaporation rate, relative humidity, solar radiation and temperature.

Existing Research

Sandia and the NMSU-ASC have installed soil moisture probes, soil matric potential probes, divining probes, data loggers, relative humidity sensors, evapotranspiration gages and rain gages to a variety of agricultural fields supporting annual yield crops including: 1) alfalfa, 2) gramagrass, 3) fescue, 4) tall wheatgrass, 5) green chile, 6) pima cotton, 7) acala cotton, 8) field corn, 9) giant sunflowers, 10) sorghum, and 11) milo. Together we are working to positively correlate the complex interrelationships between surface and ground water quality and availability, meteorological conditions, soil characteristics and textures, plant physiologies and various site-specific economic constraints to maximize the efficiency of agricultural irrigation methods in southeastern New Mexico. The technologies developed by this study will not only have a positive impact on the western states of the U.S., but also in arid climates worldwide.



(A)



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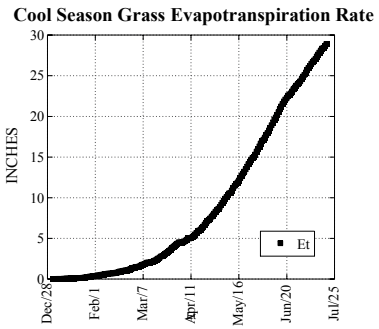

(C)

Plots showing: (A) the volumetric water content (measured using Decagon Devices ECH$_2$O dielectric moisture probes), and (B) the soil matric potential (measured using Watermark soil matric potential probes) of the sandy loam supporting the Bench 3 fescue pasture. Side-roll irrigation of Bench 3 occurred on June 30, as seen in the peak of plot (A) and within the trough of plot (B). Plot (C) shows the cumulative measured evapotranspiration rate of Bench 3 fescue collected between the months of December 2003 and July 2004.

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