

Irrigation Scheduling with Soil Moisture Sensors

(Ranjan) R. Sri Ranjan, Ph.D., P.Eng.

Department of Biosystems Engineering
University of Manitoba, Winnipeg, MB R3T 5V6
Canada

Contact: ranjan@cc.umanitoba.ca

1

Today's presentation

- How much water to apply?
- How can sensors be effectively used in irrigation scheduling?
- Principles of operation of different sensors
- The good, bad, and the ugly!

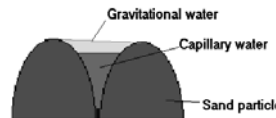
2

Irrigation scheduling

- Atmospherically based data
 - < Evapotranspiration
- Plant-based data
 - < Leaf water potential
 - < Leaf colour and angle
- Soil-based data
 - < "Feel and texture" method
 - < Water content
 - < Capillary pressure

3

Readily Available Moisture (RAM)



- The gravitational water will drain freely.
- Capillary water near field capacity is the best source for crops.
- Water in smaller pores exert a larger capillary pressure

4

When to irrigate?

- Water content between "Field Capacity" and "mid-way" to "Wilting Point" is readily available to plants
- Ideally, irrigation should commence when the water content reaches this "mid-way" point

5

Depth of one irrigation or Irrigation Capacity

- The difference between Field Capacity (FC) and "current water content" (CWC) represents the "Irrigation Capacity (IC)"
 $IC = (FC - CWC) * \text{rooting depth}$
- Applying this amount will minimize deep percolation losses

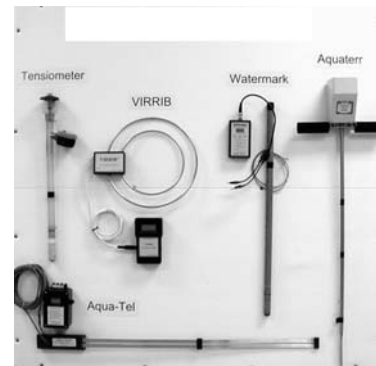
6

Principles of Operation

- Gravimetric method
- Tensiometer
- Resistance sensors (Watermark)
- Capacitance methods (Aqua-Tel 94, Aquaterr)
- Propagation of electromagnetic waves (VIRRIB)

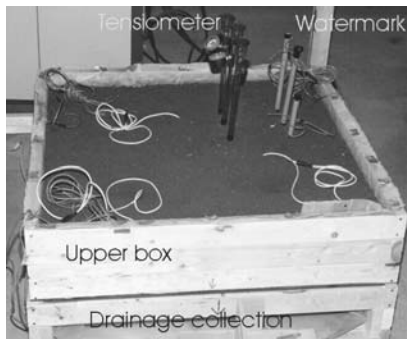
7

Types of sensors



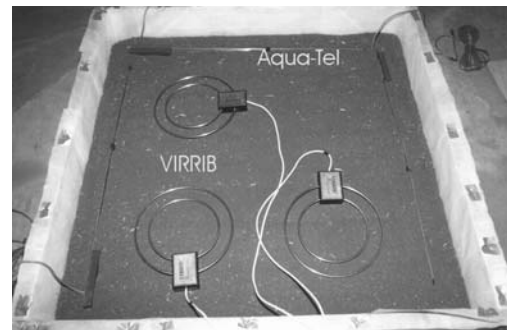
8

Lysimeter



9

Layout of the sensors



10

Test conditions

- Lysimeter setup:
 - < Range of moisture contents: 17% - 34% by volume
 - < Soil type: loam
 - < Sensors position/orientation
- Bulk density 1.2 Mg m^{-3}
- Soil depth 0.2 m

11

Soil moisture sensors

- 3 Tensiometers
- 3 Watermark sensors
- 3 Aqua-tel 94 probes
- 3 VIRRIB sensors
- 1 Aquaterr

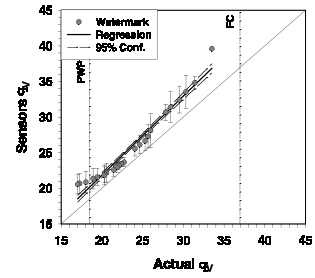
12

What do the graphs show?

- Gravimetric method was used as the standard to compare the readings from the instruments
- Weight basis water content was converted to volumetric basis and is shown on the X-axis
- Sensor readings are shown on the Y-axis
- Sensor readings in capillary pressure units were converted to volumetric water content data using the soil moisture characteristic curves

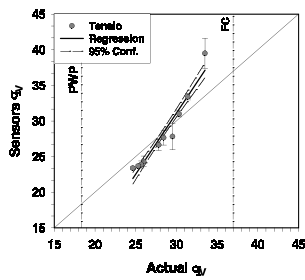
13

Performance of Watermark Sensors
Ramada Series - Lysimeter Study



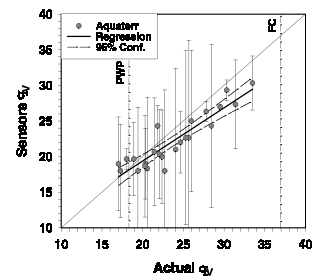
14

Performance of Tensiometers
Ramada Series - Lysimeter Study



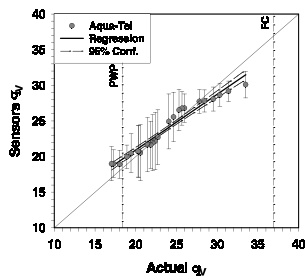
15

Performance of the Aquaterr Probs
Ramada Series - Lysimeter Study



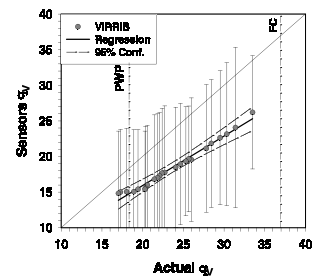
16

Performance of Aqua-Tel Sensors
Ramada Series - Lysimeter Study



17

Performance of VIRRIB Sensors
Ramada Series - Lysimeter Study



18

Results

- Tensiometers performed well at 25 - 32%
- Watermark sensors were good at 19 - 30%
- Aqua-Tel performed well at 18 - 30%
- Aquaterr readings were better at 17-32%
- VIRRIB sensors under predicted by 3-7%

19

Things to note

- Watermark and tensiometers gave capillary pressure readings and can be a trigger.
- The soil moisture characteristic curve is needed for converting the capillary pressure data to volumetric basis.
- Aquaterr sensor was found to be sensitive to temperature effects.
- Aquatel sensors gave accurate readings.

20

How do we use the sensors?

- The FC of the soil should be known
- Soil moisture characteristics should be known
- Get the volumetric water content data from the sensors (IM)
- Depth of next irrigation = $(FC - IM) * \text{Rooting depth}$

21

Questions

22