Sensing Plant-Available Water to Optimize Irrigation Management

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Smart Farms

SCRI-MINDS—Managing Irrigation and Nutrition via Distributed Sensing

saving water increasing efficiency reducing environmental impacts

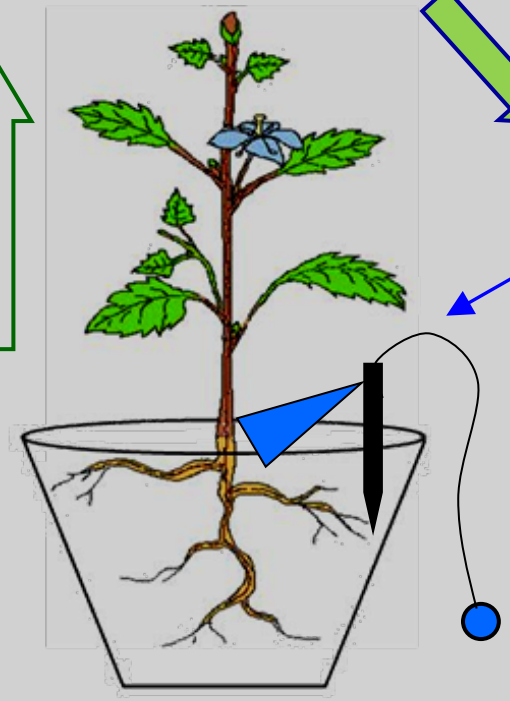
SCRI - CLEAN WATER^3

REDUCE, REMEDIATE, RECYCLE

Presentation Outline

- Irrigation Management – It's a Dynamic Environment
- Our 'Toolbox' – A Data-driven Approach
- System Capabilities (in Brief)
- Substrate Water Content and Plant-available Water
- Integrating Knowledge and IM Strategies
- Some Online Resources

Irrigation Management – Dynamic Relationships



Plant Species and Size

[Rainfall]
Temperature and RH,
Light (season)

Irrigation System
Type and
Uniformity

Plant Daily
Water Use

Irrigation Water
Volume and Duration

Precision
Scheduling

Container Size +
Substrate Physical
Properties + Porosity

Over-irrigation typically leads to nutrient and pathogen management issues

Leaching

Surface runoff

Water, Nutrient and
Pathogen Movement

Lea-Cox et al., 2013

The Process

Data → Information → Knowledge → Action

The System

Sensors → Software → 'Analyst' → Decision-Maker

Radio Datalogger Evolution

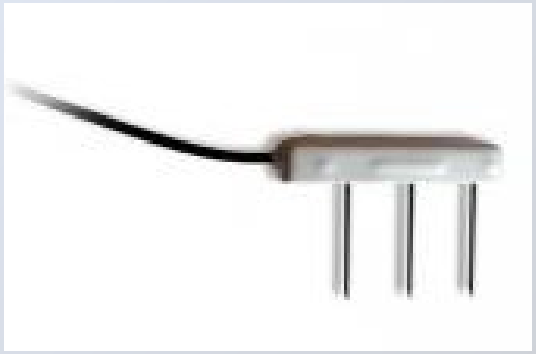
EM50R Radio
900 MHz Logger

EM50G (2G /3G)
Cellular Logger

Zentra (4G /5G)
Cellular Logger

Soil Moisture, EC Sensors

Various soil moisture sensors



GS3: EC, soil moisture, soil temperature

Line pressure

In-line/Tank EC

Water Potential

Environmental Sensors

Photosynthetic
and Total radiation

Wind speed
and direction

Precipitation

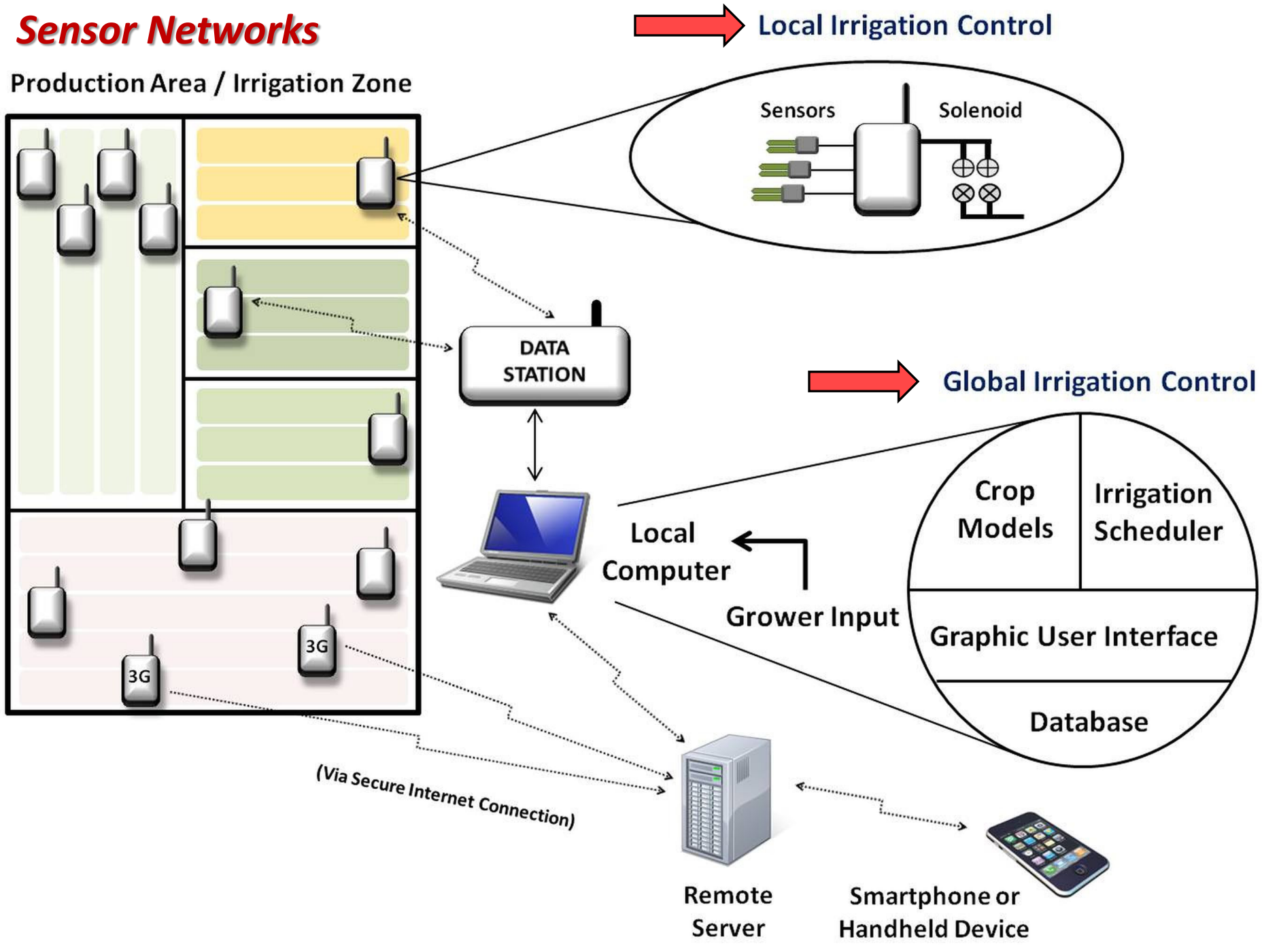
temperature, RH
and VPD

Sonic anemometer

Leaf wetness, Dew and Ice

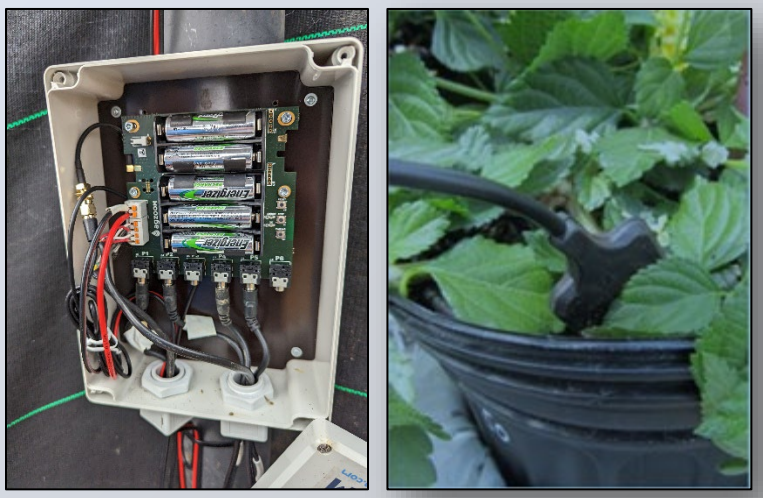
Canopy-level Microclimate Sensors

Sensor Networks



Automated Control Capability

- Developed an advanced node, capable of reading any sensor input, controlling irrigation autonomously based on threshold values set by the grower
- Data is used by growers to make real-time decisions and monitor crop/field conditions
- Plant irrigation can be determined automatically based on sensor values or by using plant water use models
- Sensor data and irrigation control can be accessed anywhere with an internet-enabled device
- System is fault-tolerant and reliable

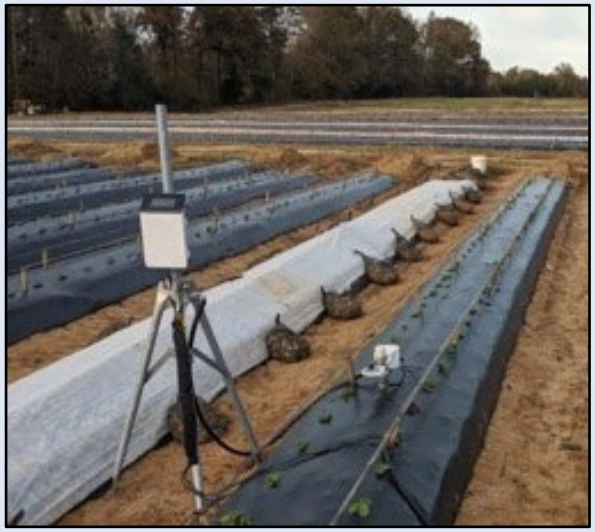


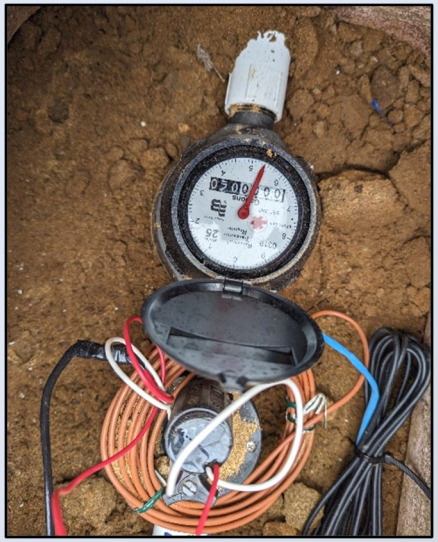
Ag-Zoom Control Logger

Kohanbash, Kantor, Martin and Crawford, 2013
HortTechnology 23: 725-734

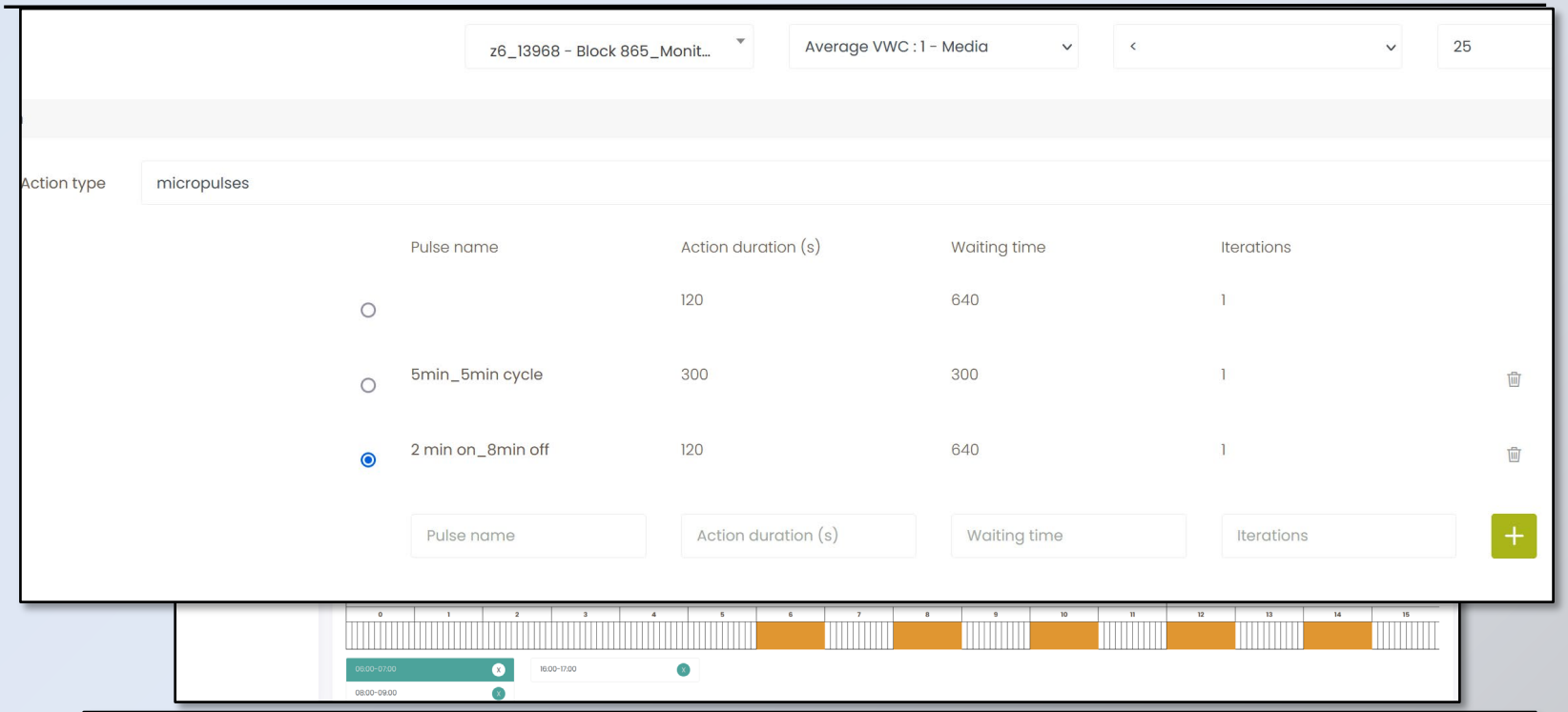
https://smart-farms.net/publications

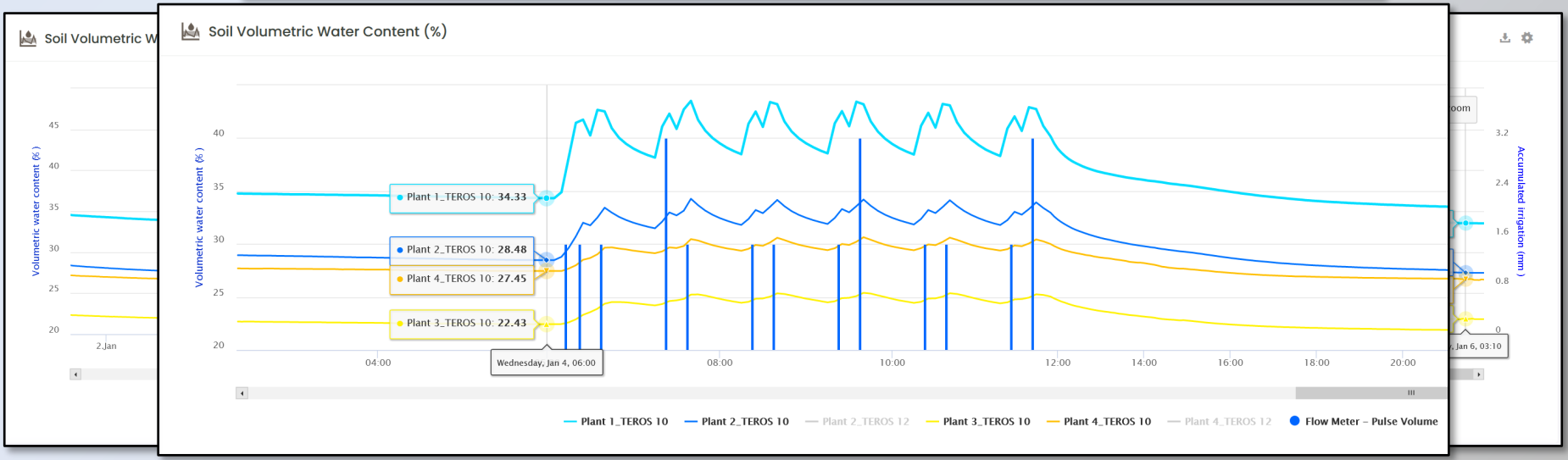
Autonomous Irrigation Control (2020 – present)



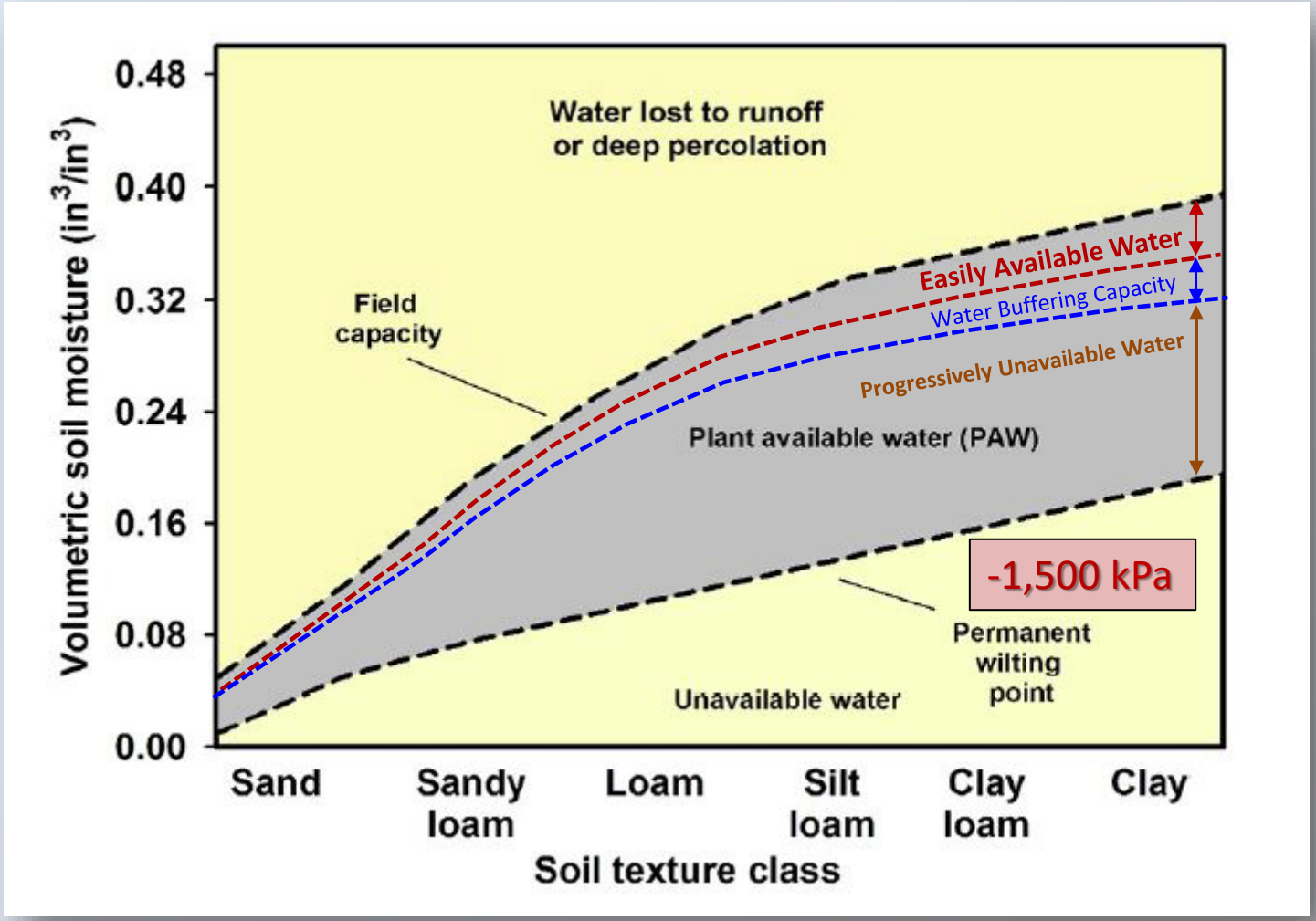


Ag-Zoom Micro-Pulse Irrigation Scheduling Capability





Water Content (VWC) and Plant-Available Water (PAW)



Modified from Zotarelli et al, 2015

Plant Available Water – Soilless Substrates

RAW

Author	Substrate	PAW (%) 0 – 100 kPa	EAW (%) 0 – 5 kPa	WBC (%) 5 – 10 kPa	UW (%) >100 kPa
Bunt, 1961	60% soil: 40% peat	≈46	--	--	--
De Boodt and Verdonck, 1972	100% perlite	--	**12.5**	**4.9**	--
Fonteno, 1981	60% pine bark: 20% Sphagnum peat: 20% concrete sand	--	**22.0**	**3.1**	--
Milks et al, 1989	50% peat: 50% vermiculite	51.6	--	--	24.1

Soil Matric Potential Sensors

Advantages
- Direct measurement
- Accuracy in wet range high
- Precise wet range

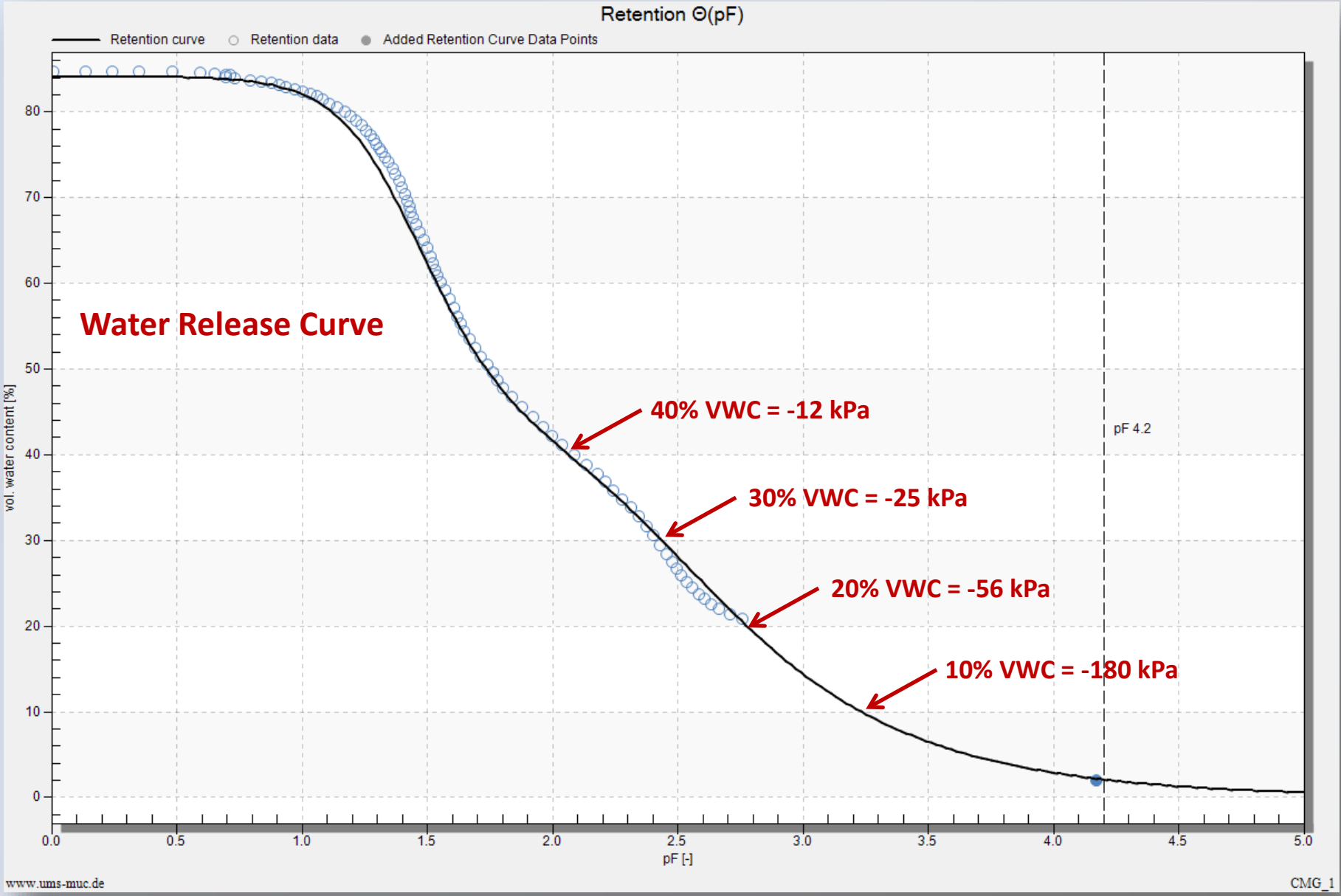
Disadvantages
- Maintenance (filling)
- Manual readings
- Narrow range
- $$ to $$$$

Advantages
- No maintenance or calibration required
- Dry range measurements
- Real-time readings

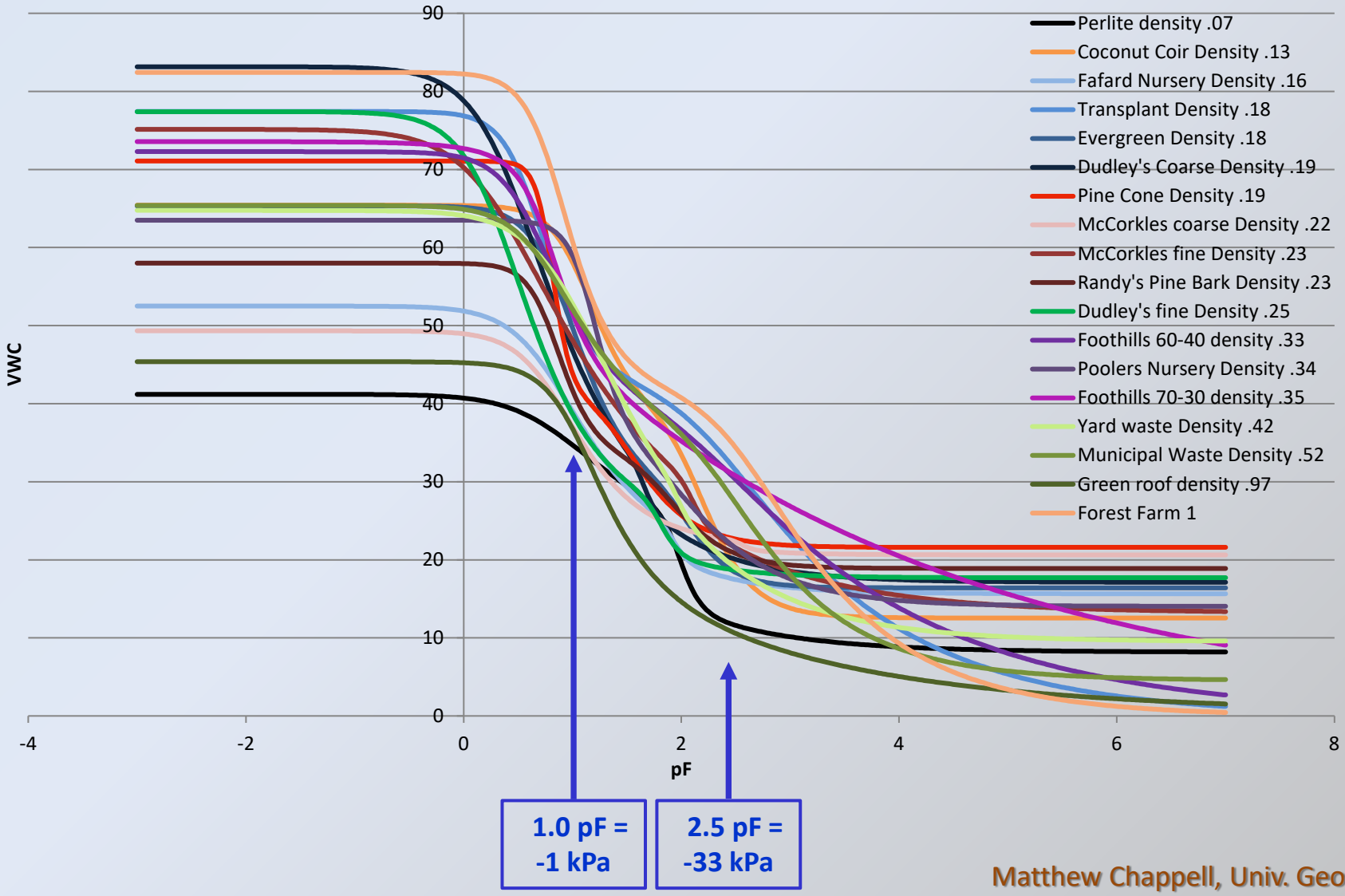
Disadvantages
- Indirect measurement
- Accuracy low
- $$$

Soilless substrates – need continuous contact with media solution

Commercial Peat : Perlite Substrate

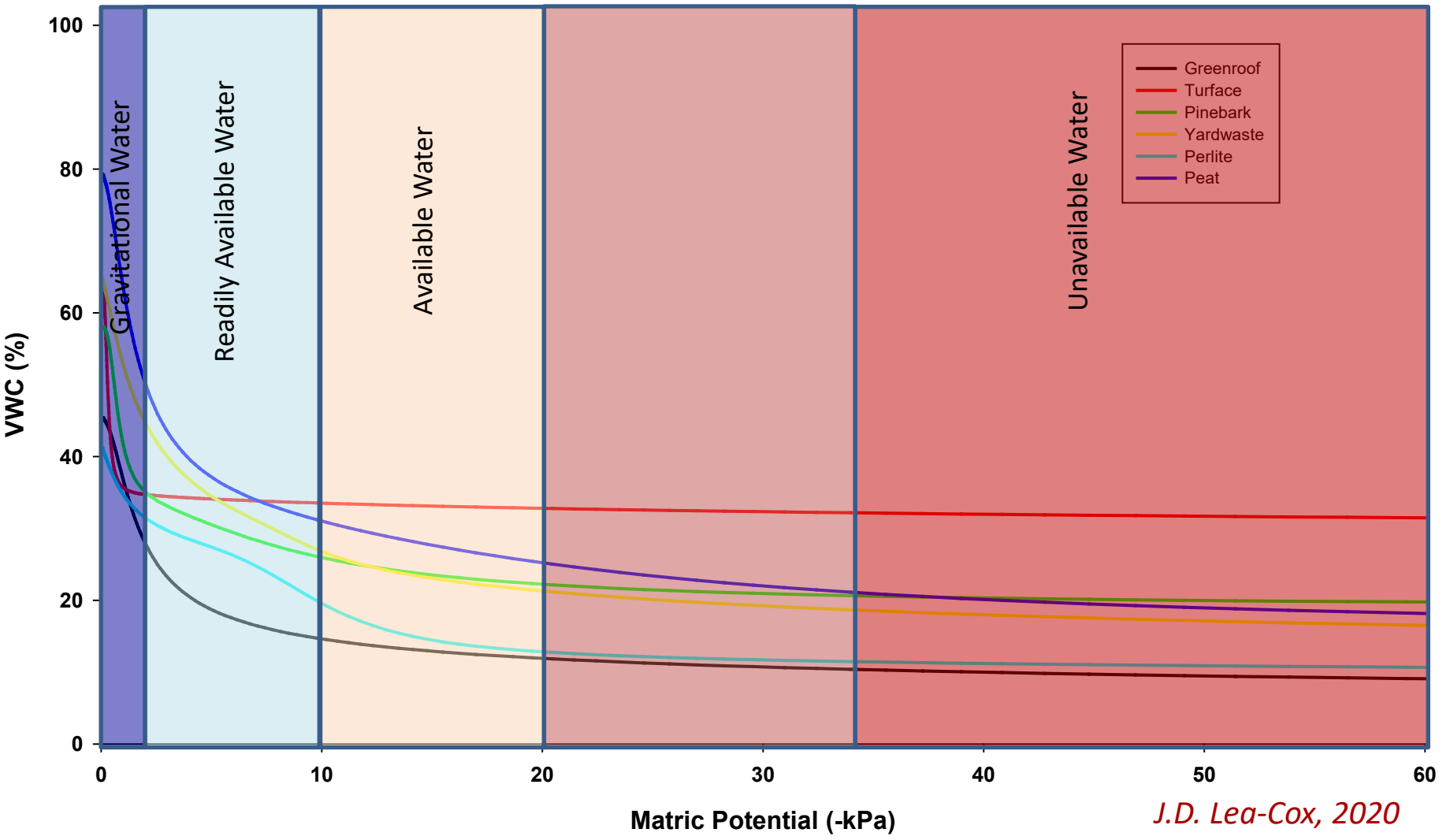


Moisture Release Curves – Horticultural Substrates



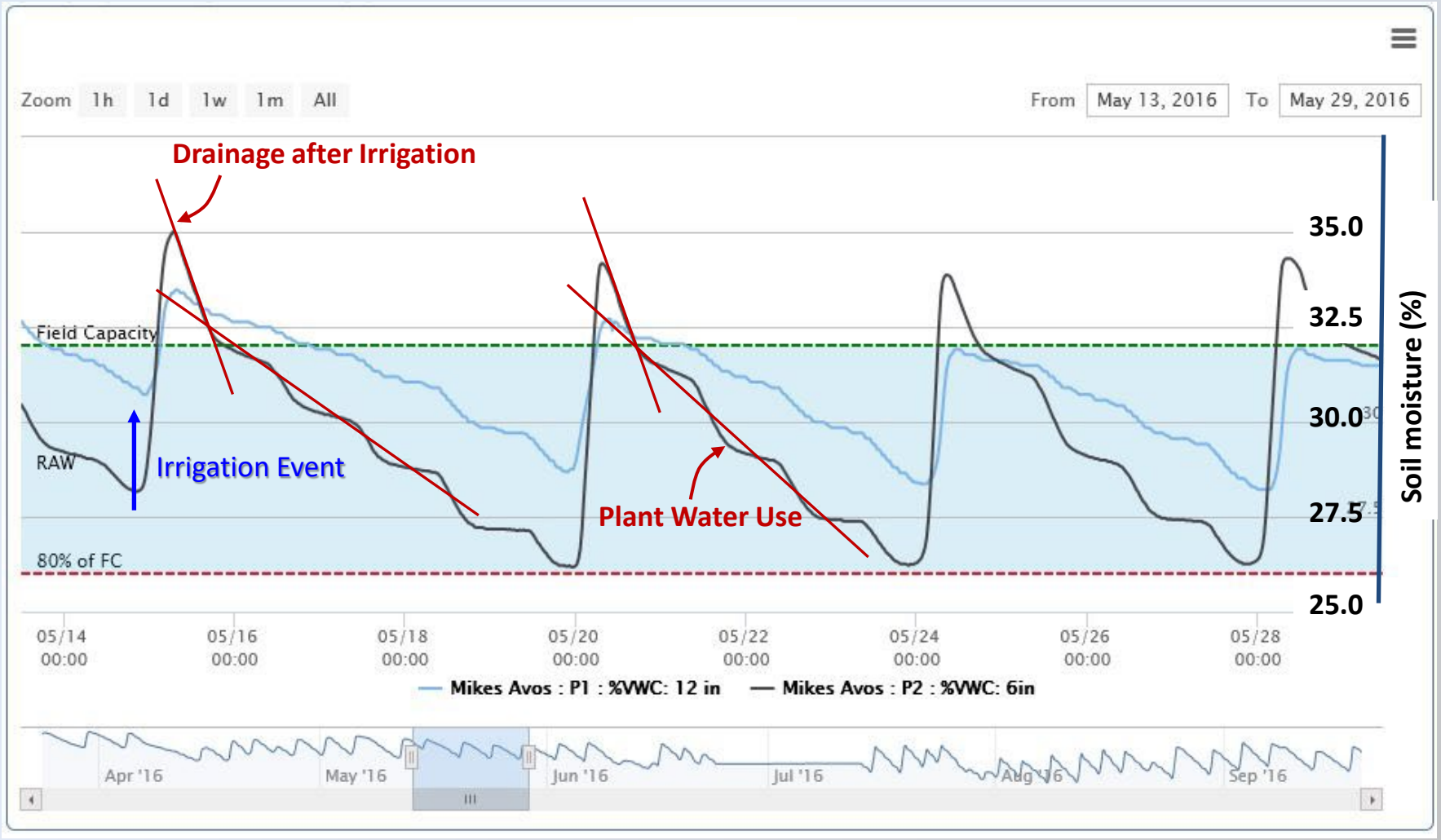
Matthew Chappell, Univ. Georgia
(Unpublished data)

Moisture Release Curves

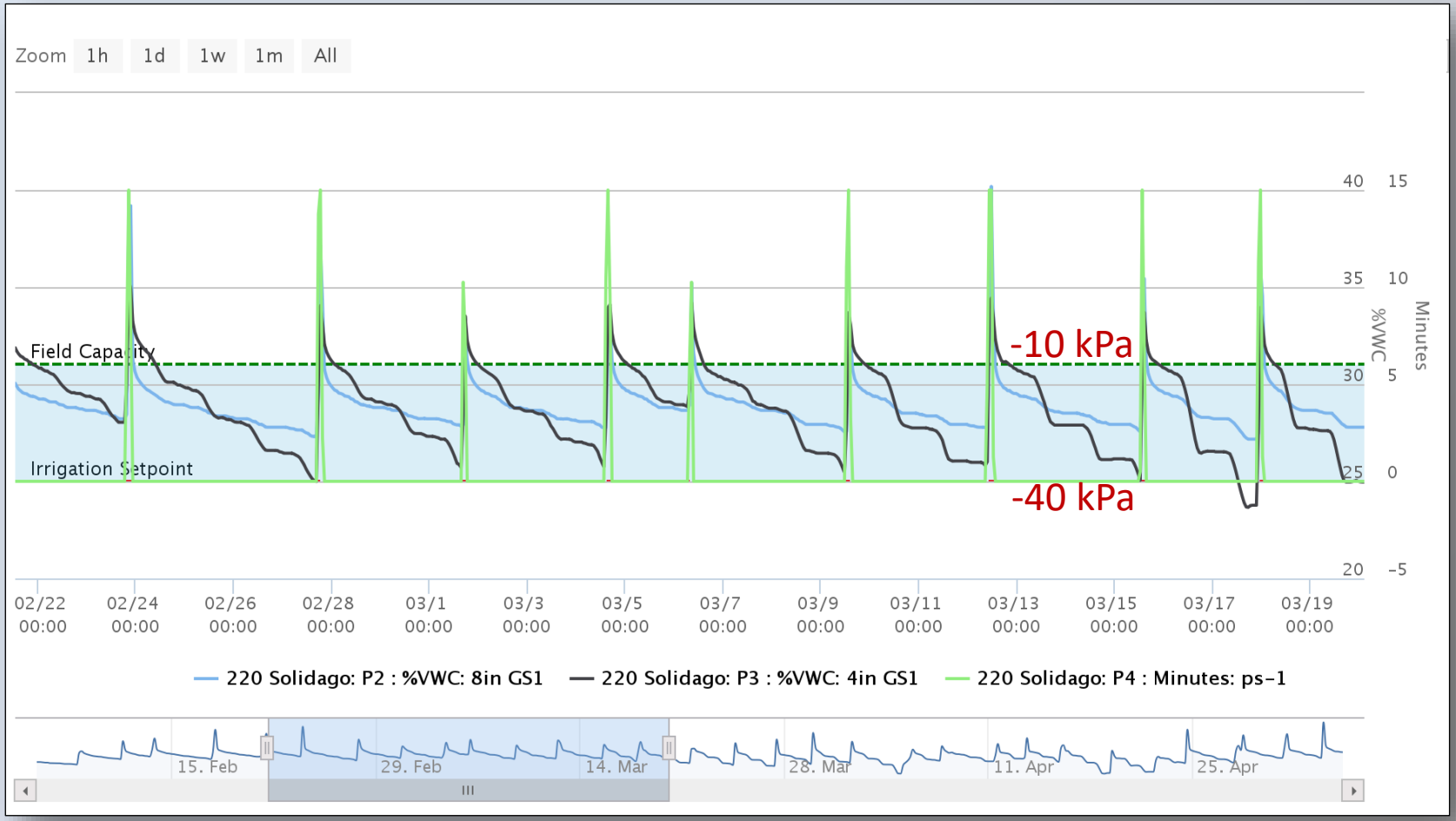


J.D. Lea-Cox, 2020

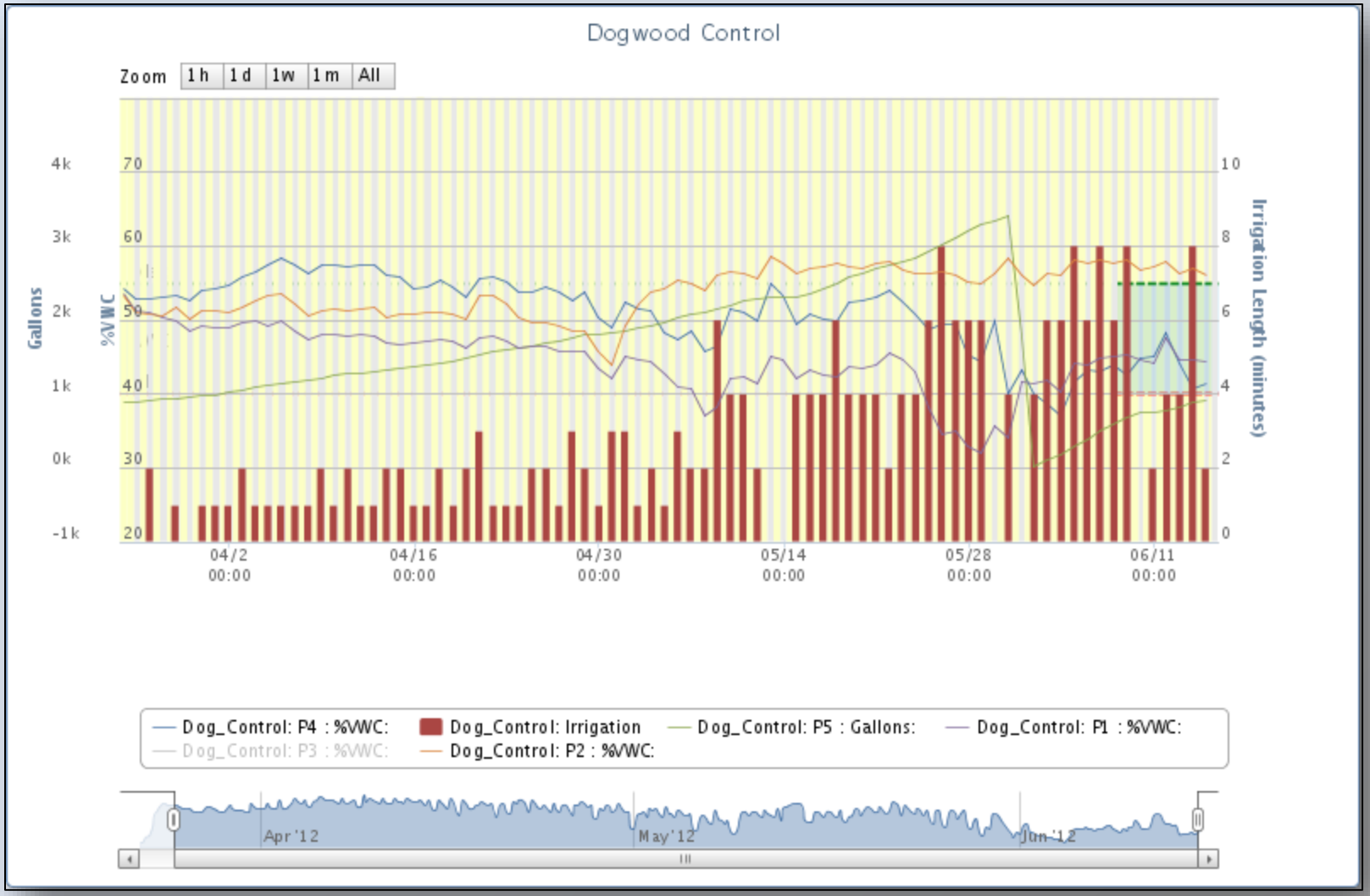
Irrigation Dynamics – Soil Moisture



Integrating Irrigation Thresholds



Dynamic Autonomous Irrigation Scheduling



Belayneh, Lea-Cox and Lichtenberg, 2013. HortTechnology 23:760-769

The Process

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The System

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An Empirical Approach to Calculate PAW

gpn
GREENHOUSE PRODUCT NEWS

CULTURE | PLANT HEALTH | MANAGEMENT | BIG GROWER | PRODUCTS | MAGAZINE

PRODUCTION

When Exactly Should I Irrigate?

By John Lea-Cox

Increase crop growth and quality with proper irrigation management.

This is a question that bedevils most growers, since the consequences of not irrigating at the correct time can lead to reduced growth (if irrigations are not timed to replace daily plant water use) or nutrient leaching and perhaps increased root disease, if irrigations are too frequent or too long.

Knowing exactly *when* to irrigate provides the opportunity for real increases in crop growth and quality and

http://www.gpnmag.com/article/when-exactly-should-i-irrigate

Knowledge Center: http://waternut.org/moodle

Water and Nutrient Management for the Nursery and Greenhouse Industries

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English (en_us)

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- Student Guide
- Developer Guide
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- Surface Water
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Online Users

(last 5 minutes)

Guest User

Welcome to the Knowledge Center Learning Modules!

This is the Knowledge Center Homepage for the Nursery and Greenhouse Industry. From here, you can access individual learning modules that cover a broad range of substrate, irrigation, surface water, nutrient and plant health management issues, with a focus on developing and implementing best management practices for nursery and greenhouse operations.

The objective of each module is to give participants an in-depth knowledge of that specific topic, to improve resource efficiency, productivity and the profitability in the most sustainable way.

To access individual modules, you can:

1. Click on the links in graphic chart below;
2. Read the outlines and access individual modules, by using the course categories menu on the left.

Substrate Management	Irrigation Management	Management Tools	Surface Water Management	Nutrient Management	Crop Health Management
Basic Overview of Substrates - 'Ideal Substrates'	Selection of Water Source: Understanding Water Quality	Irrigation System Audits	Basics of Surface Water Management	Basics of Fertilization	Fundamentals of plant Disease and Diagnosis
Substrate Materials & Ecology	Basic Hydraulics: Irrigation Management	Plant Water Use and Modeling	Capture and Recycling of Irrigation Water	Fertilization Strategies	Disease Prevention and Control
Physical Properties of Substrates	Irrigation System Design and Components	Irrigation Scheduling	Management Practices for Surface Runoff	Nutrient Use and Efficiency	Management of Pathogens in Irrigation Water
Chemical Properties of Substrates	Best Management Practices: Overhead Irrigation	Irrigation Tools and Technology		Water & Nutrient Management Planning	
Biological Properties of Substrates	Best Management Practices: Micro Irrigation	Containment Basin Design			
Substrate Composting					

We gratefully acknowledge funding for this project through a ***Section 406 Competitive Grant*** from the ***USDA-CSREES National Water Quality Program***

Calendar

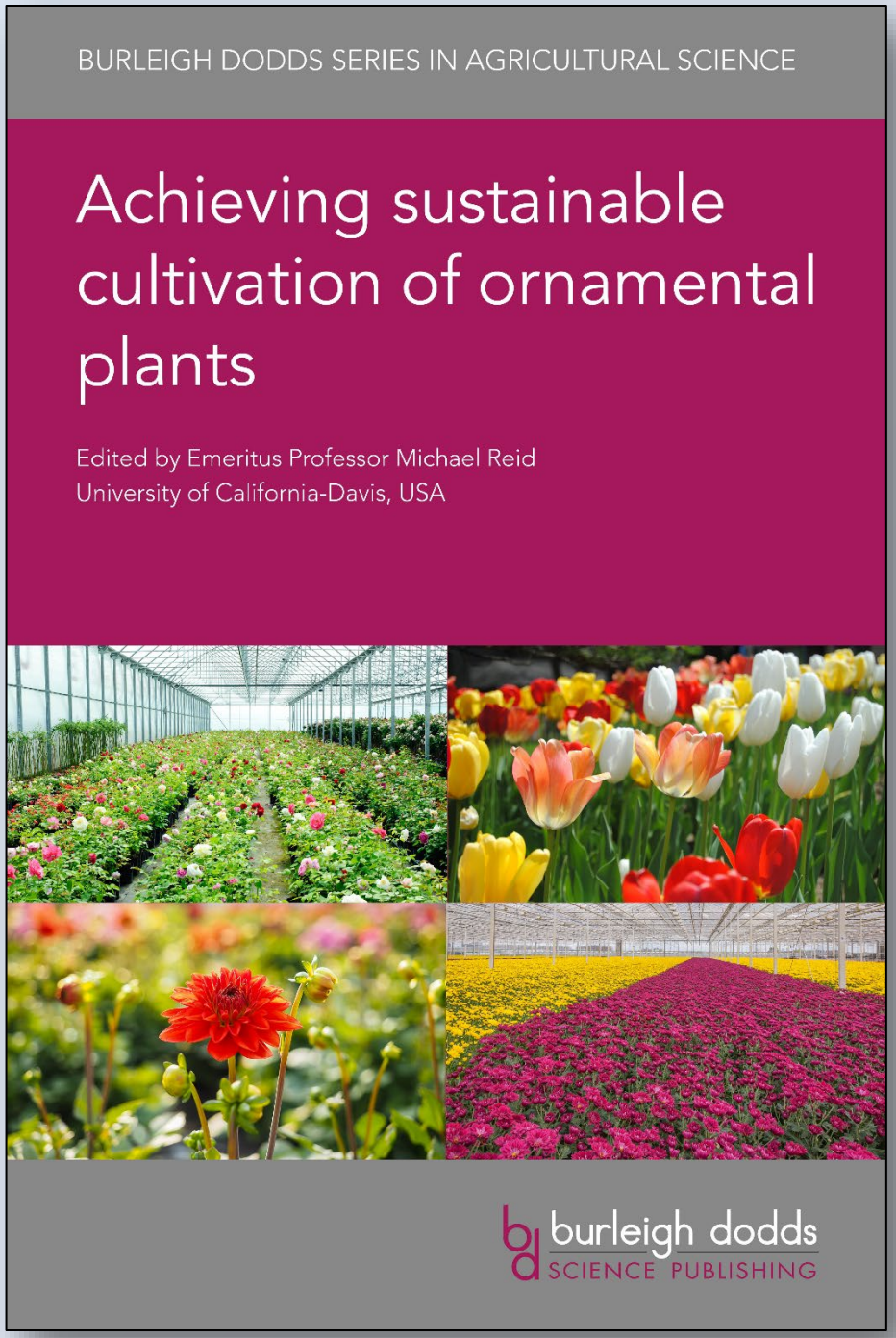
◄ March 2020 ►

Mon	Tue	Wed	Thu	Fri	Sat	Sun
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Upcoming Events

There are no upcoming events

Go to calendar...



My Thanks!

Any Questions?

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