Container Nursery Irrigation

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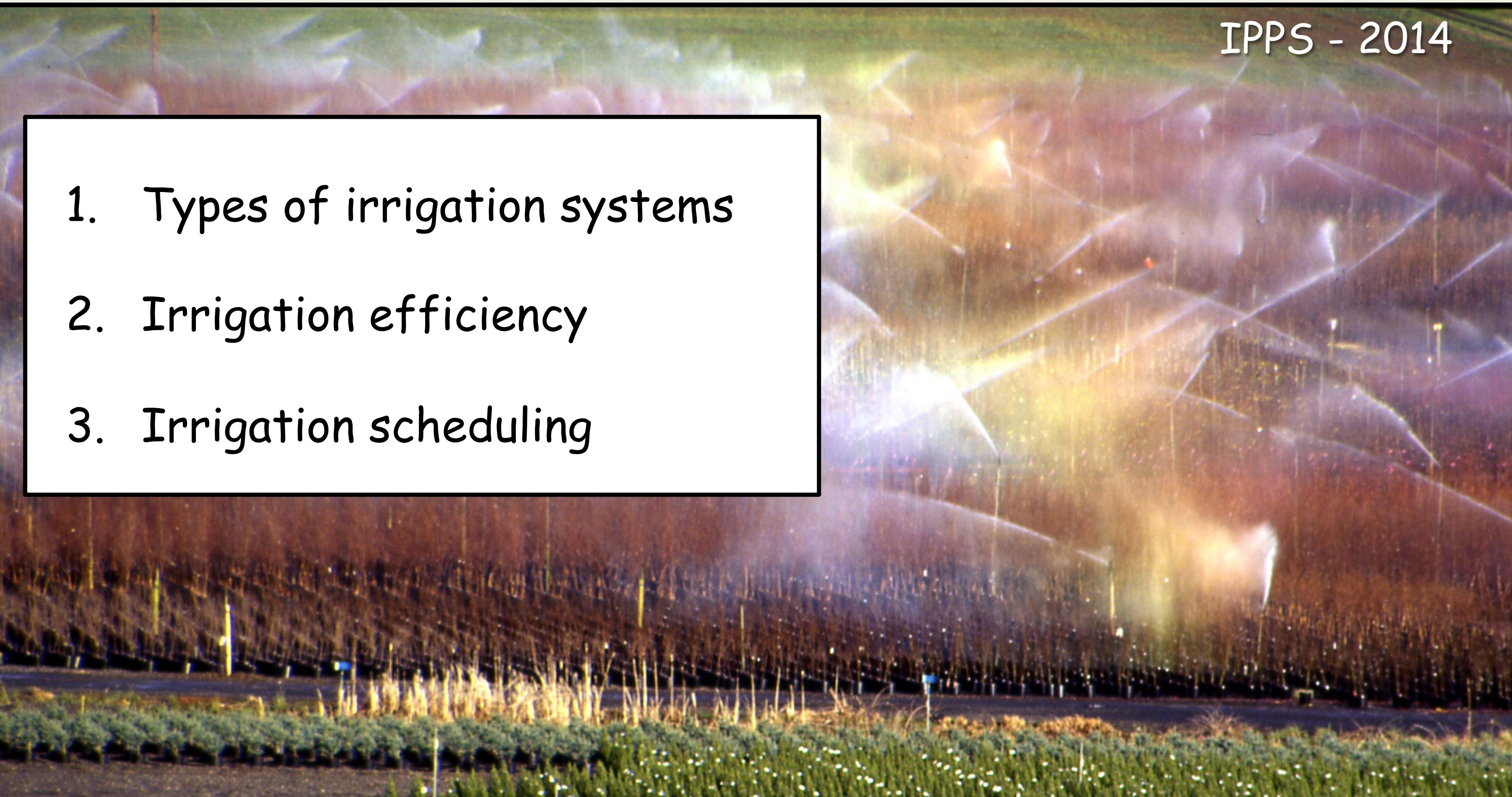
IPPS - 2014



1. Types of irrigation systems
2. Irrigation efficiency
3. Irrigation scheduling

Container Nursery Irrigation

Major Types of Container Irrigation Systems

Overhead sprinklers

Micro-irrigation

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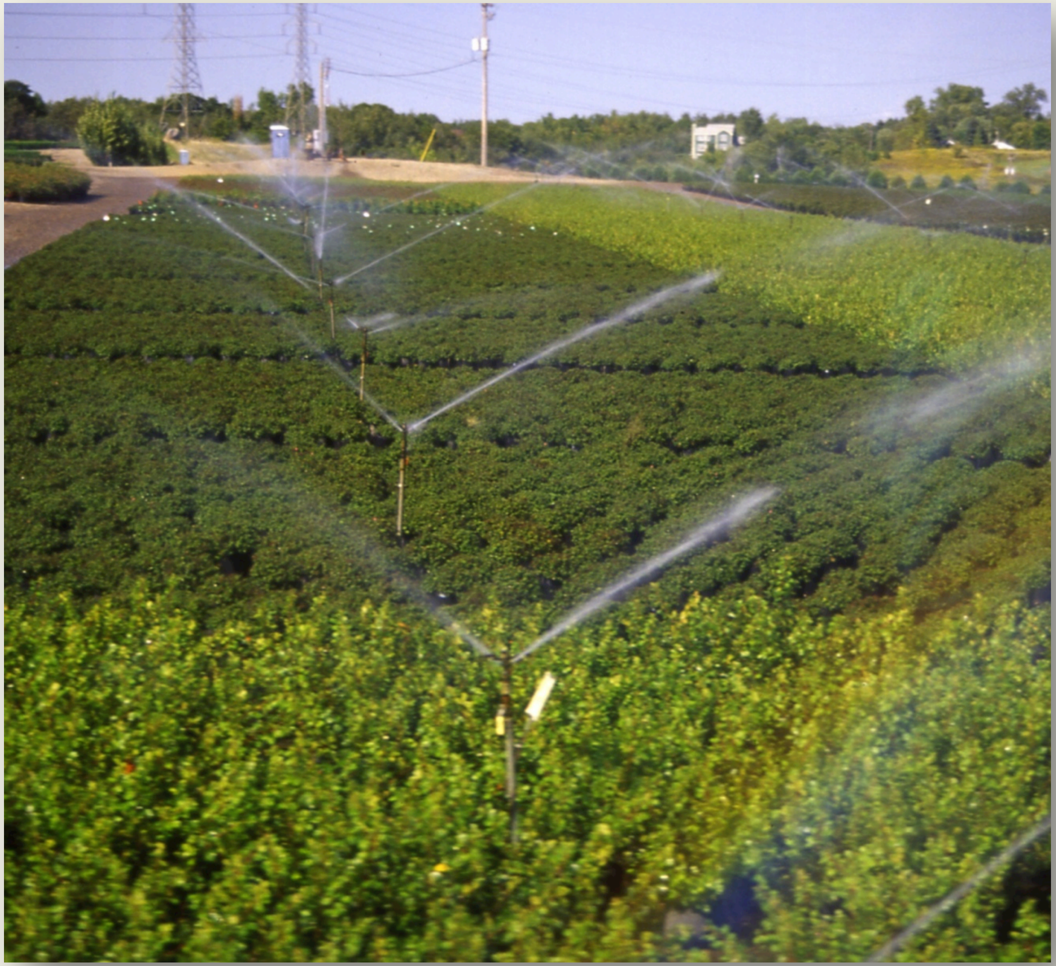
Overhead Sprinklers

There are three basic sprinkler systems

- Rotary
- Stationary
- Traveling



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Rotary Sprinkler Heads

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Rotary Sprinkler Heads

Impact rotors

Spinning heads

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Rotary Sprinkler Heads

Overhead

Free standing

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Rotary Sprinkler Heads

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Stationary Sprinkler Heads

Stationary sprinkler heads do not rotate.

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Stationary Sprinkler Heads

Water is forced through the head to form a smaller droplet size.

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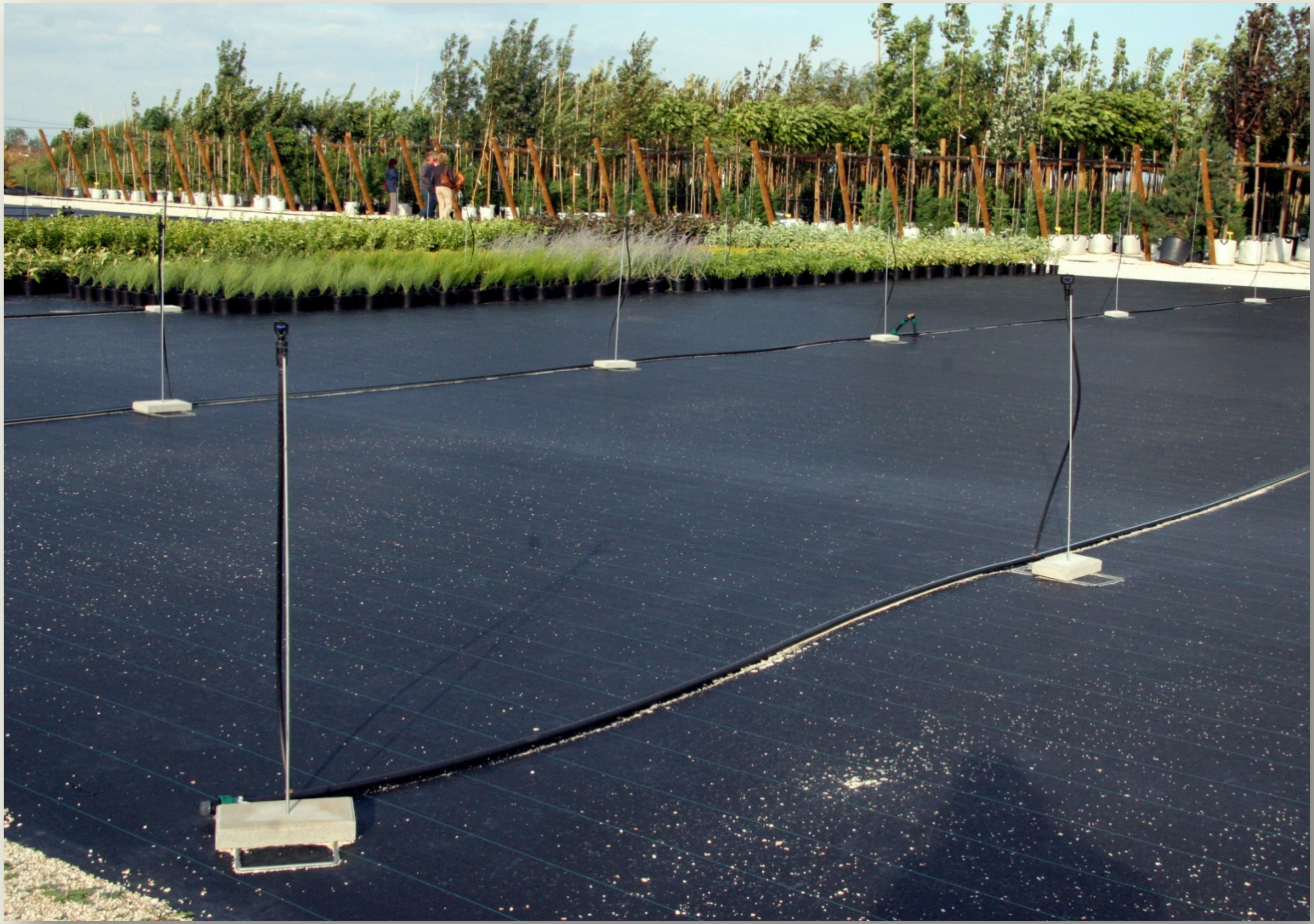
Stationary Sprinkler Heads

Heads are placed uniformly within the crop on risers.



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Traveling Boom Systems

Traveling booms have stationary heads that move over the crop.

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Traveling Boom Systems

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Traveling Boom Systems

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Micro-irrigation Systems

Micro-irrigation is a low volume system that delivers water directly to the crop.

There are three basic micro-irrigation emitters

- Micro-sprayers
- Drip emitters
- In-line drip tubes

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Micro-Sprayers

Micro-sprayers or spray stakes deliver water in a sprinkler pattern over a specific diameter.

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Drip Emitters

Drip emitters are placed at the end of a "spaghetti" tube and drip water into the container over a limited area.

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In-line Drip Emitters

In-line systems do not have extension tubes and are best used in crops on a regular spacing in rows. A punch is used to create an opening in the main poly line to drip water.

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Micro-irrigation Systems

Larger containers need blow-over support and the micro-irrigation system is often tied into the support system.

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Micro-irrigation Systems

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Micro-irrigation Systems

With each container anchored to the nursery pad, a more traditional micro-irrigation system can be used.

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Micro-irrigation Systems

Typical micro-irrigation set up with main PVC lines and periodic feeder lines leading to each container.

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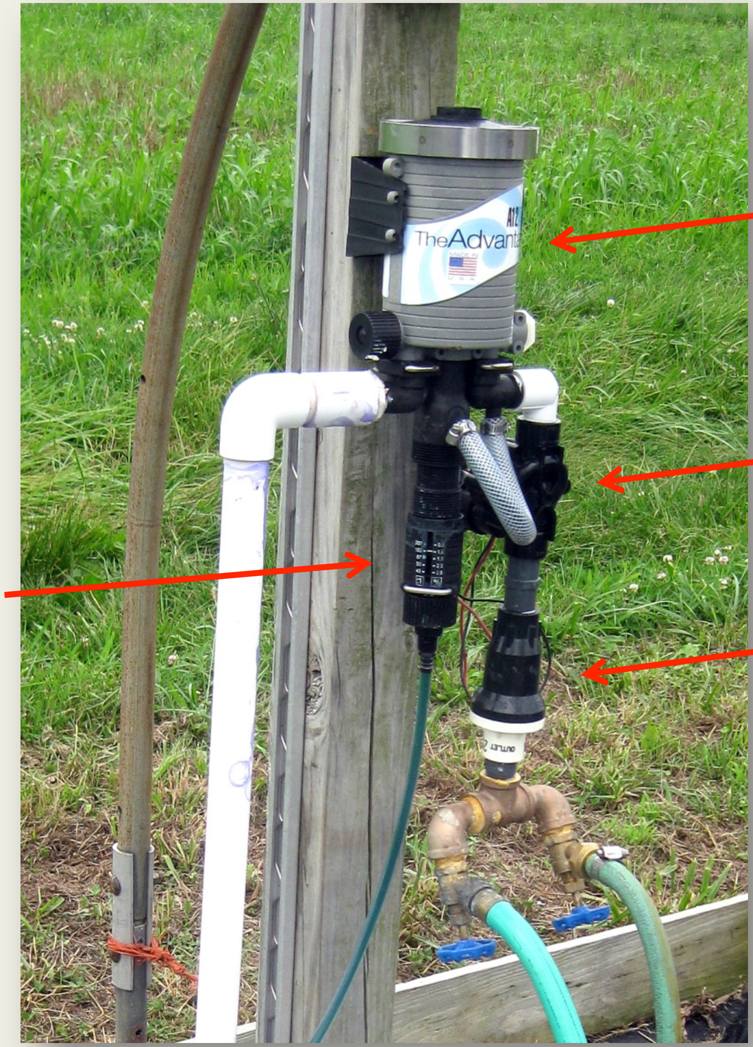
Micro-irrigation Systems

200 mesh basket filter

Battery operated solenoid

Fertilizer proportioner

30 PSI pressure regulator



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Micro-irrigation Systems

Water meters are helpful in monitoring water use.

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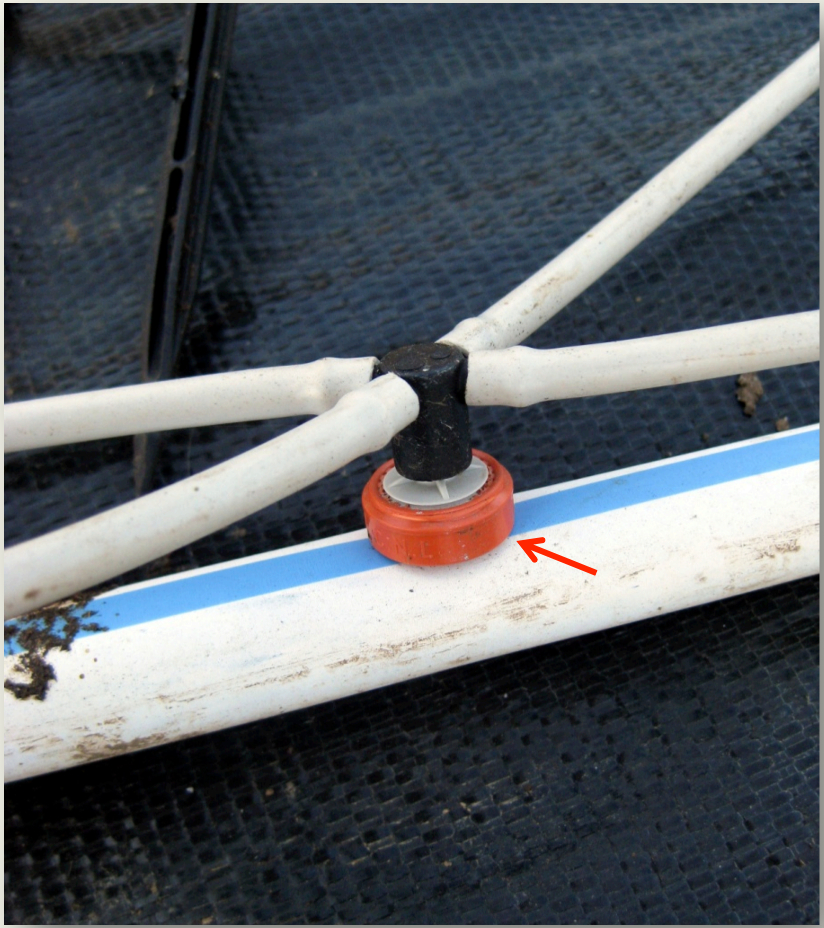
Micro-irrigation Systems

There are also in-line pressure equalizers that allow uniform distribution of water over the entire emitter line.



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Micro-irrigation Systems

Large scale operations require a primary filtration system and the most common type are sand media filters.

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Subirrigation Systems

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Subirrigation Systems

Container Nursery Irrigation

Irrigation Efficiency

Irrigation efficiency is described based on:

1. Application uniformity.

2. The amount of water that enters the containers compared to between the containers.

3. The amount of water retained within the substrate following irrigation.

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Irrigation Efficiency

Overhead irrigation is relatively inefficient.

1. High operating pump pressure.
2. Poor irrigation application uniformity.
3. Large water droplet size is needed to reduce evaporation during application, but can lead to water and nutrient leaching.
4. Poor target water application.

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Irrigation Efficiency

Up to 70% of the water applied by overhead irrigation may not enter the container substrate.

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Irrigation Efficiency

Water recapture improves water use efficiency, but not irrigation efficiency.

Container Nursery Irrigation

Irrigation Efficiency

Micro-irrigation is relatively efficient.

1. Low operating pump pressure.
2. High irrigation application uniformity.
3. Targeted water application.

Container Nursery Irrigation

Irrigation Efficiency

Overhead irrigation efficiency can be improved by:

1. Grouping plants into irrigation zones based on relative water usage.

2. Crop spacing.

3. Cyclic irrigation.

Container Nursery Irrigation

Irrigation Efficiency

Micro-irrigation efficiency can be improved by:

1. Grouping plants into irrigation zones based on relative water usage.

2. Cyclic irrigation.

3. Pot-in-Pot.

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Irrigation Efficiency

Grouping plants into irrigation zones based on relative water usage.

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Irrigation Efficiency

Crop spacing

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Irrigation Efficiency

Crop spacing and irrigation interception efficiency

Container surface diameter (in)	On-center spacing (in)
10	10
10	15
10	20

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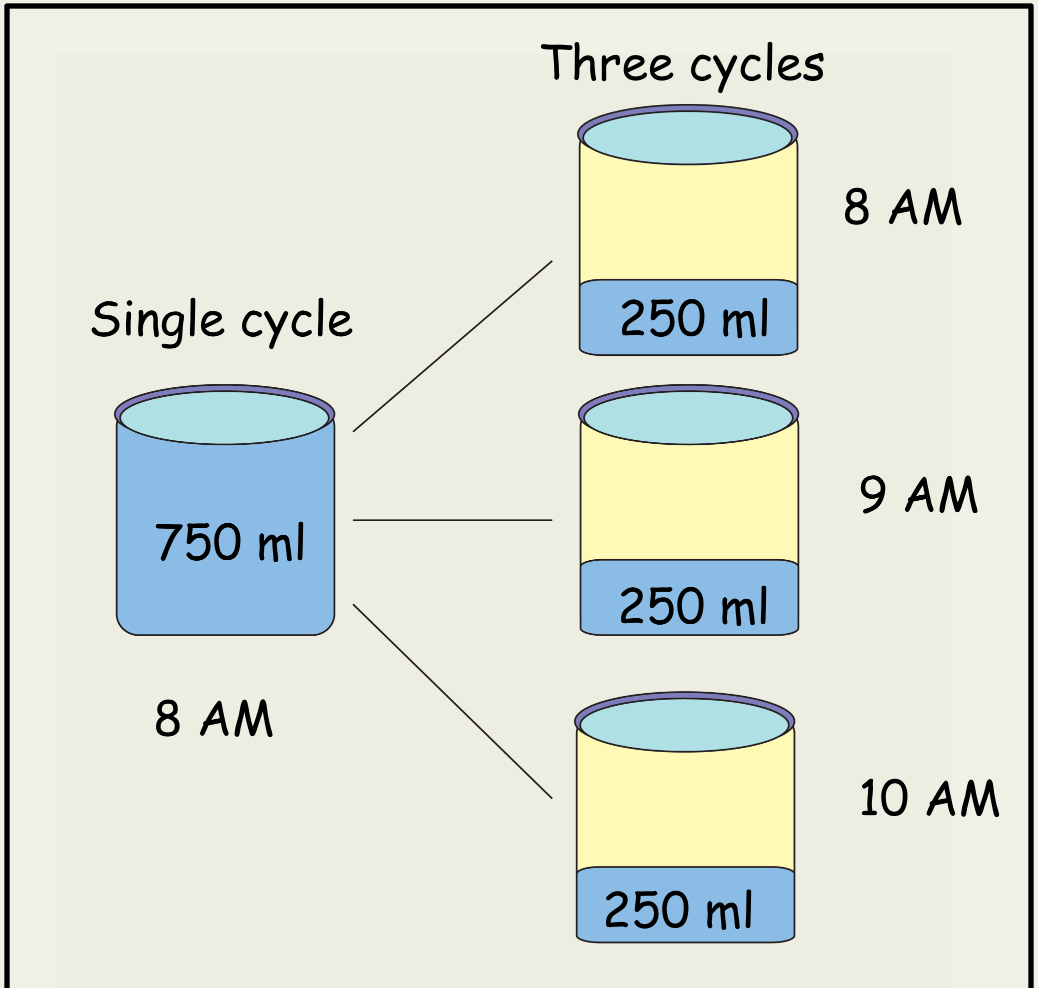
Irrigation Efficiency

Cyclic irrigation

Cyclic irrigation is the application of the daily irrigation divided into timed smaller quantities.

Cyclic irrigation reduces runoff by up to 30%.

Can improve crop growth.



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Irrigation Efficiency

Cyclic irrigation

Red maple (*Acer rubrum*)
15 – gal; pot-in-pot

Irrigation	Shoot dry weight (g)	Height increase (cm)	Trunk caliper (cm)
Single	1100.0	103.9	0.73
3 - cycles	➡ 1349.4	➡ 120.9	➡ 1.88
6 - cycles	➡ 1284.2	➡ 113.0	➡ 1.88

Fain, Tilt and Silbey, 2000

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Irrigation Efficiency

Cyclic irrigation

Eastern redbud (*Cercis canadensis*)
7- gal; pot-in-pot

Irrigation time	Total water use ($L \cdot plant^{-1} \cdot day^{-1}$)	Daily water use ($L \cdot plant^{-1} \cdot day^{-1}$)	Trunk caliper (cm)
AM	59.9	3.0	0.29
Noon	⇨ 71.1	⇨ 3.6	⇨ 0.36
PM	64.9	3.2	0.30

Nambuthiri and Geneve, 2014

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Irrigation Efficiency

Pot-in-Pot

Pot-in-pot is the most sustainable nursery production system.

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Irrigation Efficiency

Micro-irrigation in a pot-in-pot has the greatest irrigation efficiency because the below ground container reduces evapotranspiration.

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Irrigation Efficiency

Daily water use by plants is a function of evapotranspiration.

Evapotranspiration is water loss due to:

Transpiration from the leaves.

Evaporation from the container substrate.

Both processes are impacted by temperature.

Container Nursery Irrigation

Table 1. Comparison of key features of pot-in-pot nursery production compared to above-ground or in-ground shade tree production.

Production system	Irrigation type	Substrate	Staking	Over wintering	Harvest time	Plants per hectare[z]	Cost per plant ($)[z]
Pot-in-pot	Microirrigation	Bark-based	For plant structure	No special requirements	Any time of year	950	21.50
Field	Principally overhead irrigation	Soil	For plant structure	No special requirements	Primarily spring and Fall	770	23.71
Above-ground container	Overhead irrigation	Bark-based	For plant structure and blow over support	Quonset structures in Northern production areas	Any time	870	23.73

Plants per hectare and costs were from a 1996 study for three-year crape myrtle (*Lagerstroemia*) production on a typical 15 acre (6 hectare) USA nursery with plants grown on a spacing of 5.6, 6.3, and 6.2 plants per m^2 for pot-in-pot, field and above-ground containers, respectively.

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Irrigation Efficiency

http://www.youtube.com/watch?v=wNeBurkznIk

Container Nursery Irrigation

Irrigation scheduling and quantity

Irrigation can be scheduled based on:

1. Static controllers
2. Plant-based control
3. Substrate moisture sensors

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Irrigation scheduling and quantity

Static controllers

The most common irrigation scheduling is done with timers that open a solenoid for a set time to provide a pre-set water amount.

Container Nursery Irrigation

Irrigation scheduling and quantity

Static controllers

Static control is the least efficient irrigation scheduling method, but its efficiency can be improved by installing rain sensors to postpone irrigation events.

The grower may also alter the quantity of irrigation based on weather information.

Rain sensor

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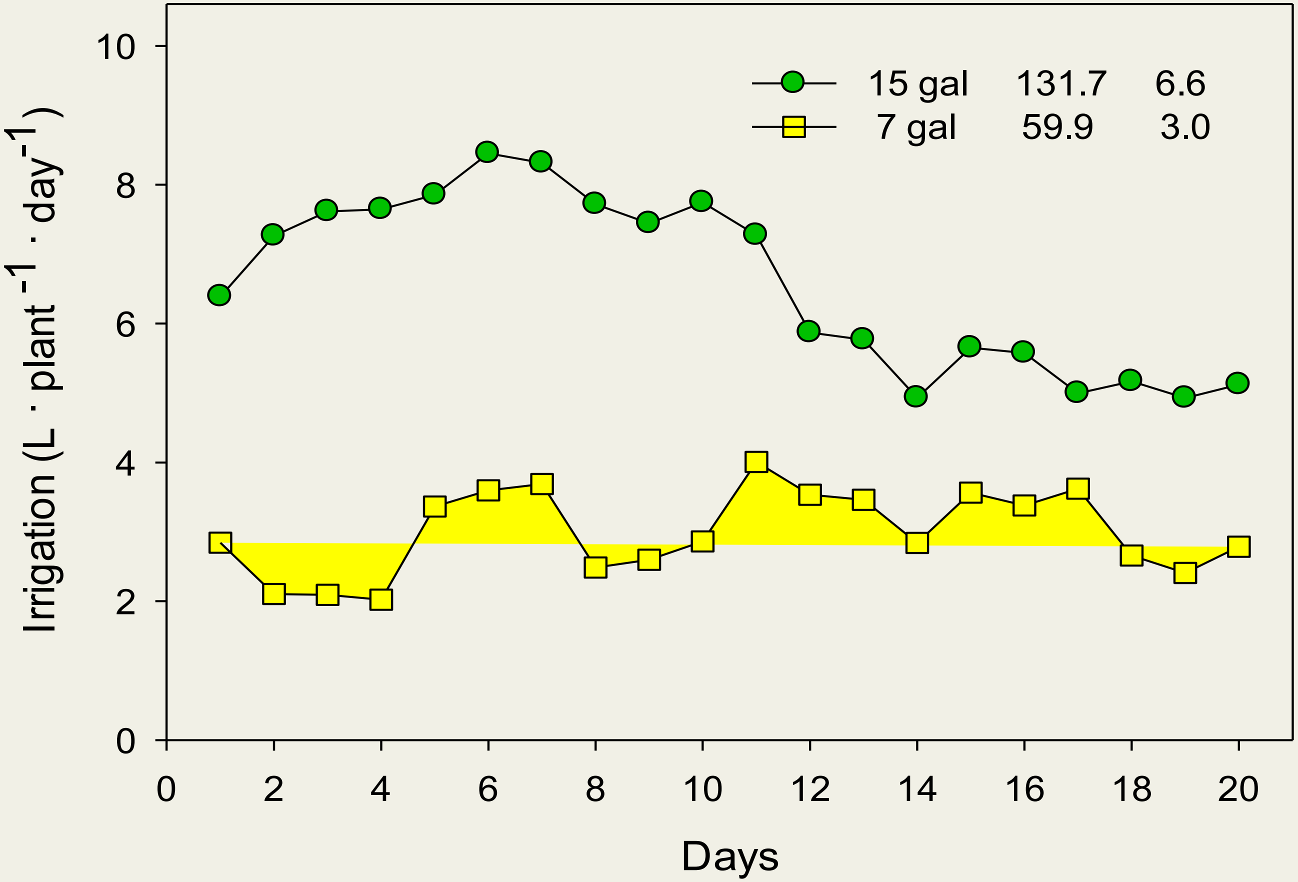
Irrigation scheduling and quantity

Daily water use varies depending on the environment, plant type and container size.



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Irrigation scheduling and quantity

Plant-based control

Plant evapotranspiration models have be developed that are beginning to be commercialized for nursery production.

Evapotranspiration chamber

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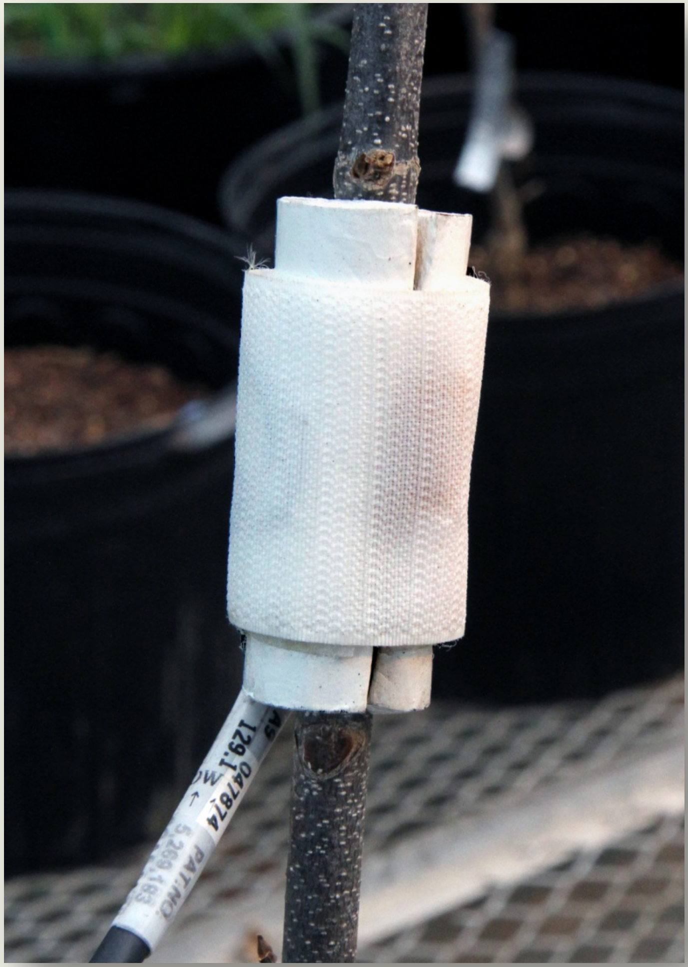
Irrigation scheduling and quantity

Plant-based control

The plant sapflow meter has been shown to be a useful plant-based method for estimating transpiration.



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Irrigation scheduling and quantity

Substrate-based moisture sensors

The two basic substrate-based moisture sensors include:

Tensiometers and electrical resistance sensors.

Tensiometers measure substrate suction and control irrigation based on substrate matric potential settings.

Tensiometer

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Irrigation scheduling and quantity

Substrate-based moisture sensors

Electrical resistance sensors measure electrical resistance and relate the resistance reading to substrate moisture levels.

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Irrigation scheduling and quantity

Substrate-based moisture sensors

Irrigation events are triggered when the sensor indicates the substrate moisture content has reached a predetermined set-point.

Irrigation controller


Electrical resistance sensor

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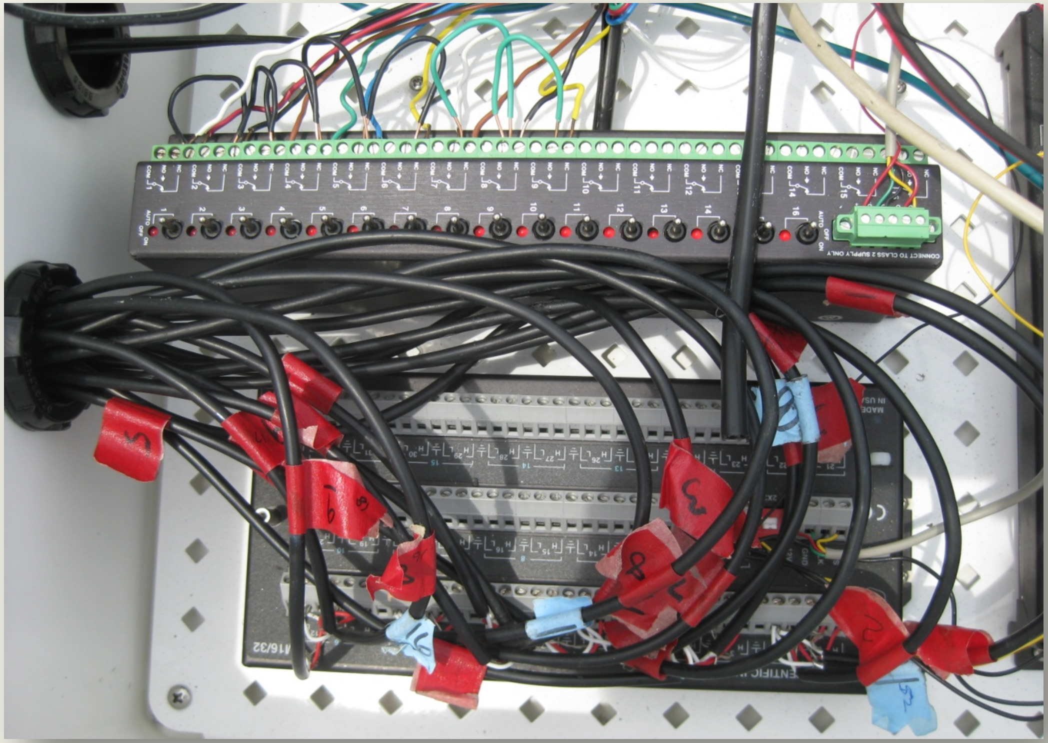
Irrigation scheduling and quantity

Substrate-based moisture sensors

A drawback with most sensor-based irrigation scheduling is the extensive wiring that is required to link the sensor to the controller and the controller to the solenoid.



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Irrigation scheduling and quantity

Substrate-based moisture sensors

However, remote sensing has recently become available and will eventually replace hard-wired systems for acquisition and control of irrigation.

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Irrigation scheduling and quantity

Irrigation scheduling

Regardless of the sensor system chosen, irrigation set-points are required for optimal irrigation scheduling.

Daily water replacement

On-demand irrigation

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Irrigation scheduling and quantity

Daily water replacement

The daily water replacement irrigation system was developed to replace water used during the previous day's use for container production.

It always irrigates at the same time each day, but the quantity of irrigation varies depending on the previous day's use.

On-demand irrigation

The on-demand irrigation system uses a specific plant-based set-point designed to minimize water use, but maintain optimal plant growth.

It always provides the same quantity of irrigation, but irrigation timing varies depending on plant use.

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Irrigation scheduling and quantity

Comparison of growth and water use between systems in hydrangea and boxwood.

Treatment

Daily water

On-demand

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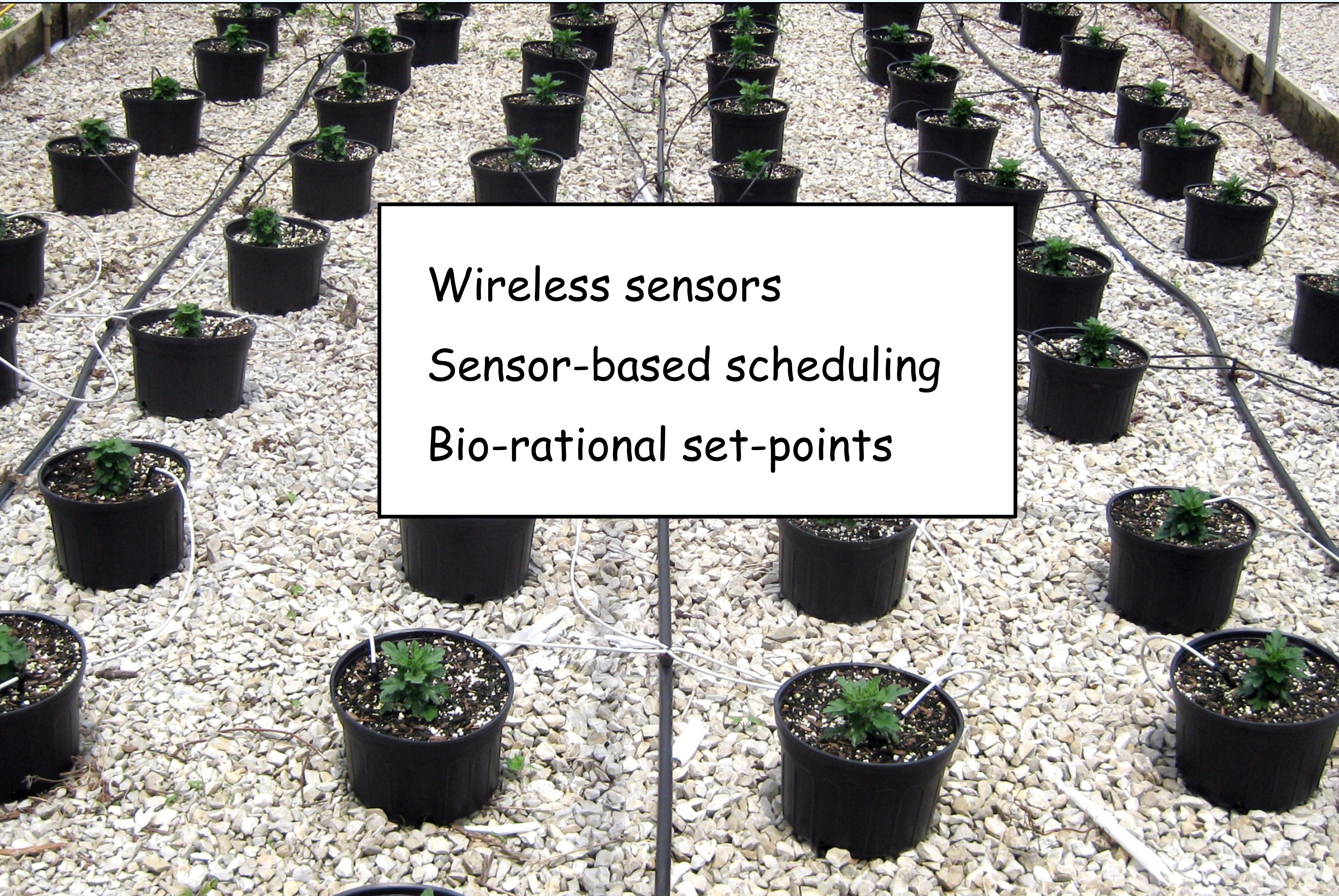

Wireless sensors

Sensor-based scheduling

Bio-rational set-points

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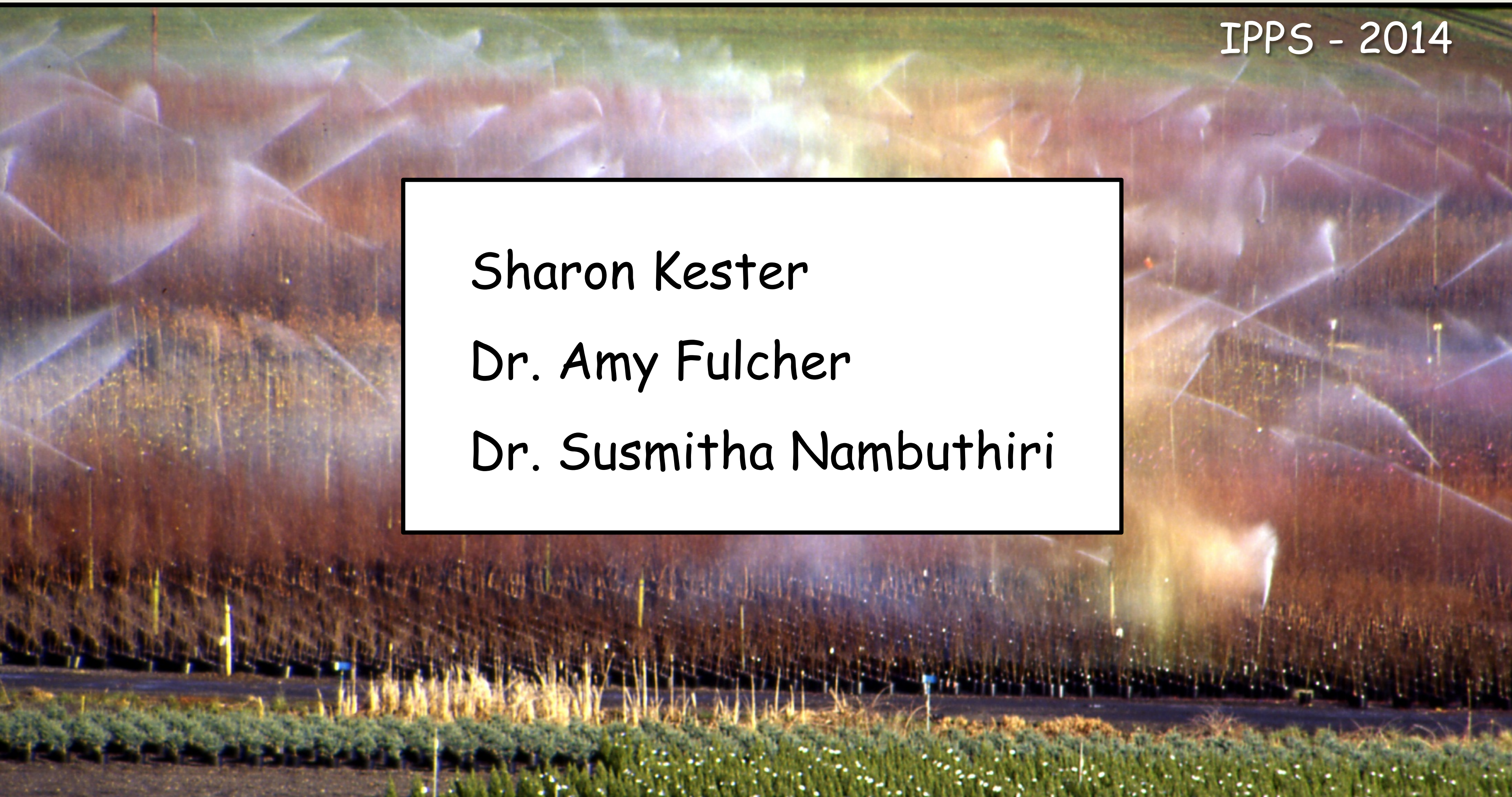

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