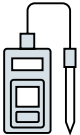
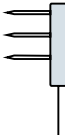




PRECISION FOR SUCCESS

The key to achieving optimal plant growth depends on making precise adjustments to both the environment and rootzone. Once all environmental factors are properly managed, implementing a proper irrigation strategy can elevate your cultivation to the next level. In this guide to Precision Irrigation Strategy we will familiarize you with the common terms, necessary tools, and techniques that lead to precision and success.

NECESSARY TOOLS

	
EC/pH Meters	Substrate Sensor
	
Controller/Timer	Precision Irrigation Equipment

COMMON IRRIGATION TERMS

Volumetric Water Content (VWC%): The volume of water a substrate is holding at any given time.
Shot: A single irrigation event.
Maintenance Shots: P2 irrigation events that maintain Peak VWC% Target throughout the day.
Field Capacity: Maximum VWC% of a substrate prior to runoff.
Full Saturation: When a substrate can no longer hold anymore water and peak VWC% can no longer increase.
Runoff: Water that is drained from a substrate.
Dryback: The period between irrigation events when the substrate is drying out.
Additional Dryback: The decrease in VWC% that occurs during P3, after the lights turn on and before the first irrigation event of the day.
Pore water EC (pwEC): The EC of the water within the pores of the substrate. (We also refer to this as Substrate EC in this document).
Input EC: The EC of the solution applied through irrigation events.
Peak VWC% Target: The goal for maximum VWC% established by the last P1 event and maintained throughout the P2 phase.
EC Stacking: The strategy of limiting runoff with bigger overnight drybacks, to increase substrate EC.

OPTIMAL ENVIRONMENT

	VEG	FLOWER STRETCH	FLOWER BULK	FLOWER FINISH
Temp	22.2° - 27.7° C	25.5° - 27.7° C	23.8° - 26.6° C	18.3° - 22.2° C
RH	58 - 75%	60 - 72%	60 - 70%	50 - 60%
VPD	0.8 - 1.0 kPa	1.0 - 1.2 kPa	1.0 - 1.2 kPa	1.2 - 1.4 kPa
PPFD	300 - 600	600 - 1000	850 - 1200	600 - 900



SUBSTRATE SIZING

A proper Precision Irrigation Strategy is best achieved with smaller pot sizes. Using smaller containers allows a substrate to dry back faster, enabling the grower to easily manipulate and fine-tune substrate EC through strategic irrigation events.

Pot size based on veg time:



RECOMMENDED SUBSTRATE TYPES

	100% Coco: A homogeneous substrate that allows substrate sensors to have more consistent readings without interference from aeration material such as perlite. Pot Type: Compressed pre-filled or fabric pots Pot Size: 4-10 liters
	Rockwool: A homogeneous substrate with a consistent field capacity and a quick dryback allowing easy control over substrate EC. Rockwool Size: Hugo 15 cm x 15 cm or Delta 10 cm x 10 cm on Unislab or Multi Plant Slab.



WARNING: RUNNING A HIGH SUBSTRATE EC MAY BURN YOUR PLANTS WHEN ALL ENVIRONMENTAL FACTORS ARE NOT WITHIN THE CORRECT RANGES.

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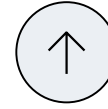
WHAT IS CROP STEERING?

Crop steering is an advanced cultivation technique that manipulates key factors of growing, such as irrigation, temperature, humidity, and light to precisely guide plant growth towards desired outcomes. Crop steering effectively encourages either **Vegetative** or **Generative** growth by strategically inducing stress at specific growth stages. **Precision Irrigation Strategy** utilizes both types of crop steering. Finding the right balance is crucial for achieving high quality flower.

CROP STEERING OPTIMIZES:



PLANT
DEVELOPMENT



YIELD

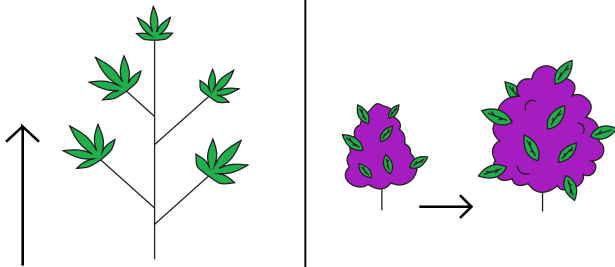


FLOWER
QUALITY

2 Types of Crop Steering

VEGETATIVE

A smaller dryback (low substrate EC) promotes **Vegetative Growth**, resulting in taller plants and swelling of the buds.



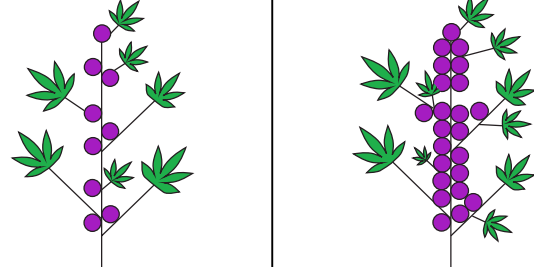
Taller plants

LESS STRESS

Bud swell

GENERATIVE

A larger dryback (high substrate EC) encourages **Generative Growth**, leading to quicker flower site formation and compact plants.



Flower site formation

MORE STRESS

Compact plant

VEGETATIVE

P1

VS

P1

Peak VWC% Target above field capacity to increase runoff.

MORE RUNOFF

Peak VWC% Target equal to or below field capacity to decrease runoff.

LESS RUNOFF

P2

VS

P2

Maintenance shots increase runoff, resulting in a decrease in substrate EC.

DECREASE EC

Maintenance shots decrease runoff, resulting in an increase in substrate EC.

INCREASE EC

P3

VS

P3

Small dryback to keep the substrate EC low.

SMALL DRYBACK

Large dryback to keep the substrate EC high.

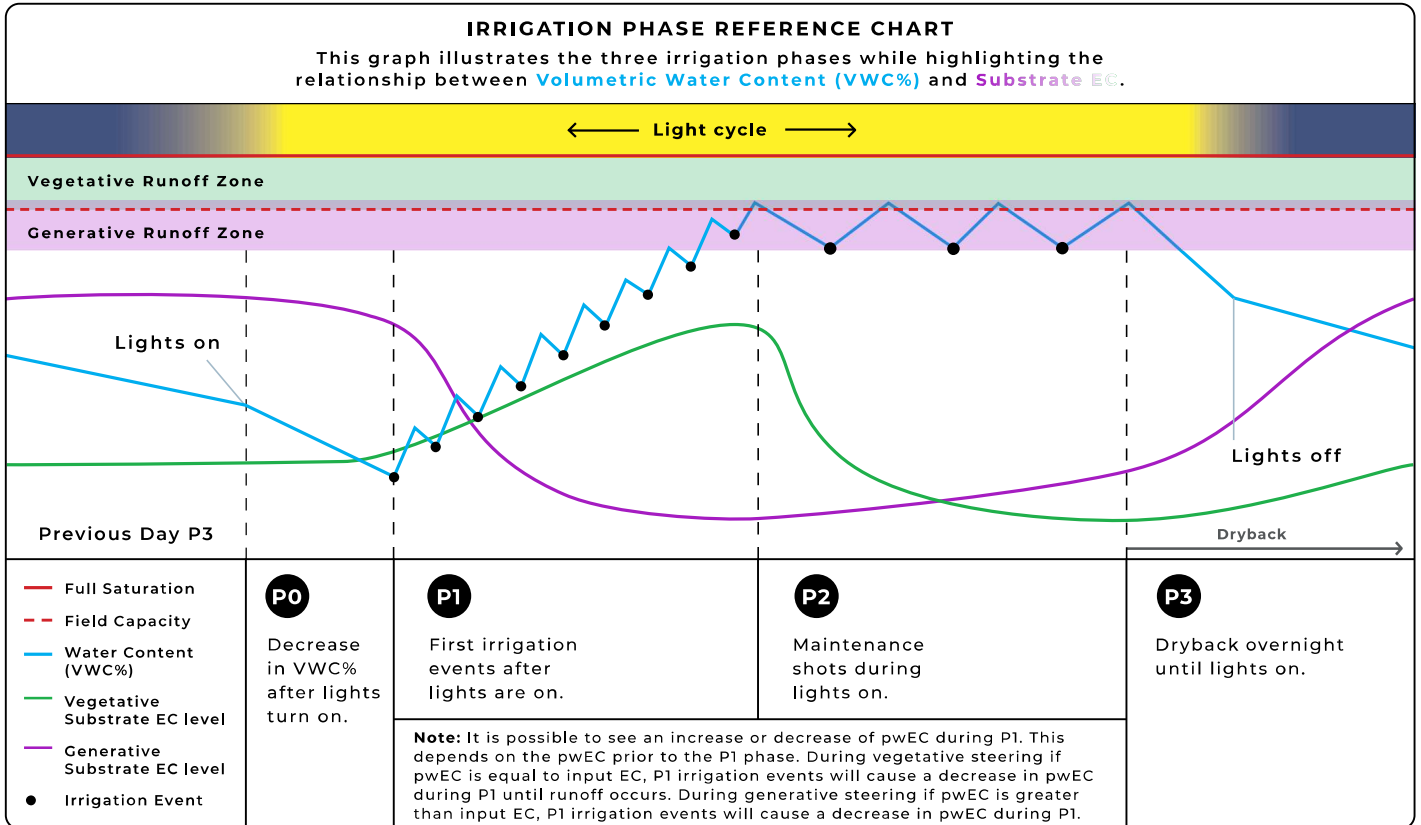
LARGE DRYBACK

Crop Steering Strategy by Growth Stage

	GOAL	STRATEGY
Veg	Promote rapid growth of roots, shoots, and leaves	Vegetative
Flower Stretch (weeks 1-4)	Initiate flower formation and decrease internodal spacing (stacking)	Generative
Flower Bulk (weeks 5-7)	Increase Bud Size	Vegetative
Flower Finish (weeks 8-10)	Reduce built up substrate EC and encourage ripening	Vegetative (substrate EC) + Generative (dryback)

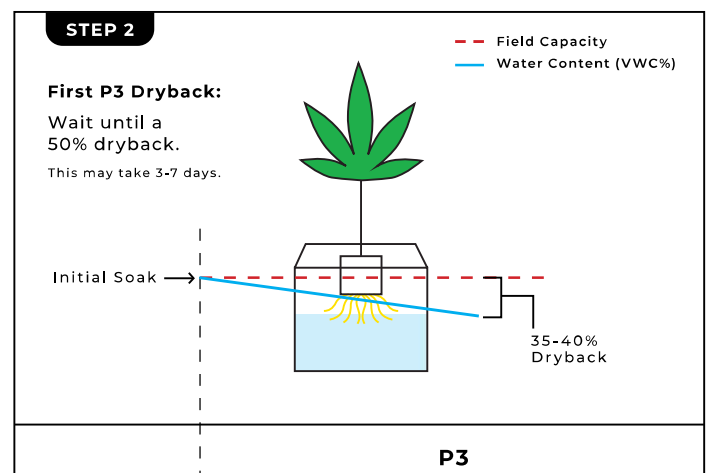
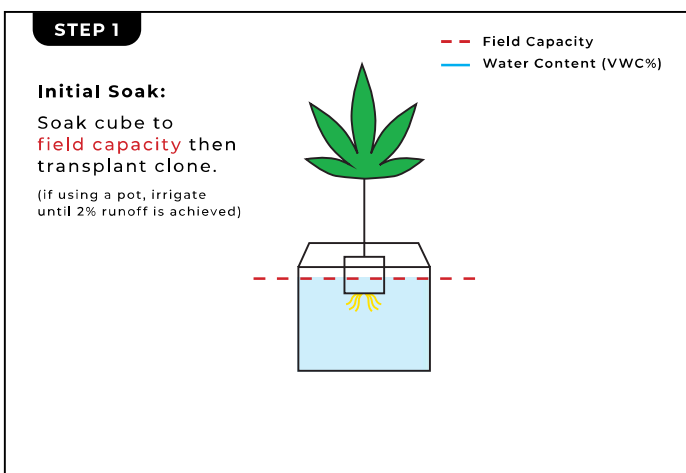
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Veg Irrigation Strategy

During **veg**, hitting the correct targets becomes crucial to enable our plants to reach their full potential. When transplanting clones into new media, we must be extremely careful to not overwater the substrate. Excess water can lead to stagnant roots and delayed growth. During Veg we will focus solely on the **P1** and **P3** phases because growth is slower and plants transpire less rapidly. After dryback exceeds 25%, introducing **P2** events becomes necessary to maintain optimal substrate moisture.



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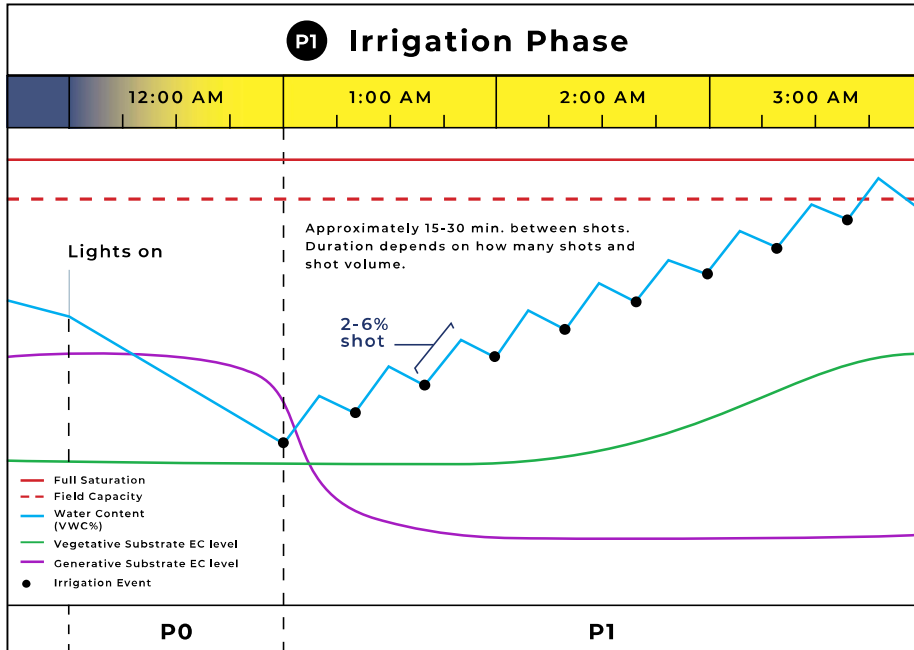
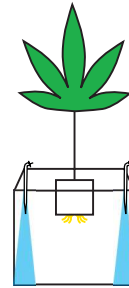
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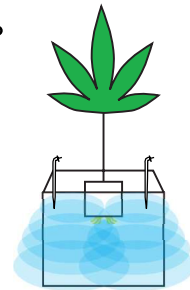
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Starting P1 Phase

This is the first irrigation phase of a lights on cycle until target **VWC%** is reached. The first shot in this phase will occur 1-2 hours after the lights turn on. This will allow the plant's stomata to open and begin to transpire before the media is saturated "transpiration before irrigation." During this phase we will use multiple **2-6% shots** spaced 15-30 mins apart to slowly saturate the media to avoid channeling through the substrate.

**CHANNELING**

Channeling will occur when too large of shots are used and water isn't allowed to slowly saturate into the substrate.

PROPERLY SATURATED

2%-6% shots, spaced 15-30 minutes apart allows the substrate to gradually build up to target VWC%.

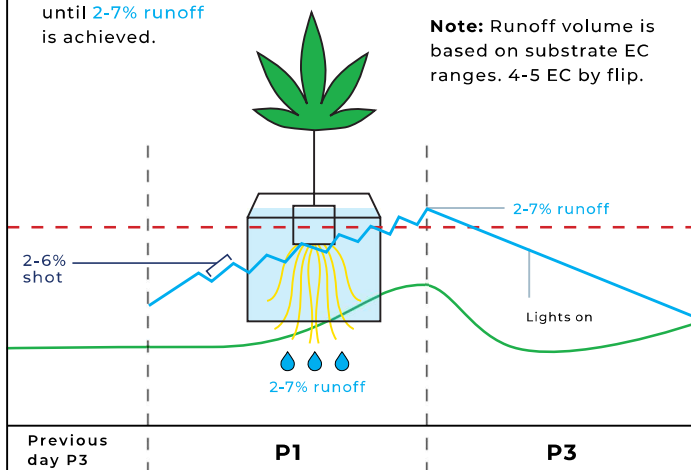
STEP 3**Initiate P1**

Use **2-6% shots** every 15-30 minutes until **2-7% runoff** is achieved.

Legend:

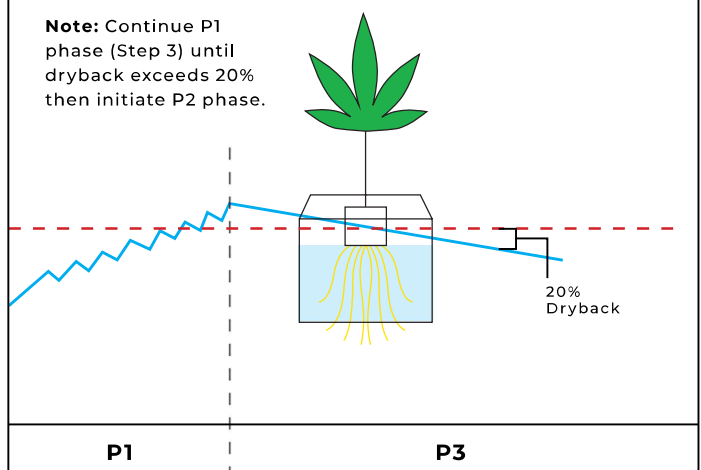
- Field Capacity (Red dashed line)
- Water Content (VWC%) (Blue line)
- Vegetative Substrate EC (Green line)

Note: Runoff volume is based on substrate EC ranges. 4-5 EC by flip.

**STEP 4****All Other P3 Drybacks**

Dryback to 25%.

Note: Continue P1 phase (Step 3) until dryback exceeds 20% then initiate P2 phase.

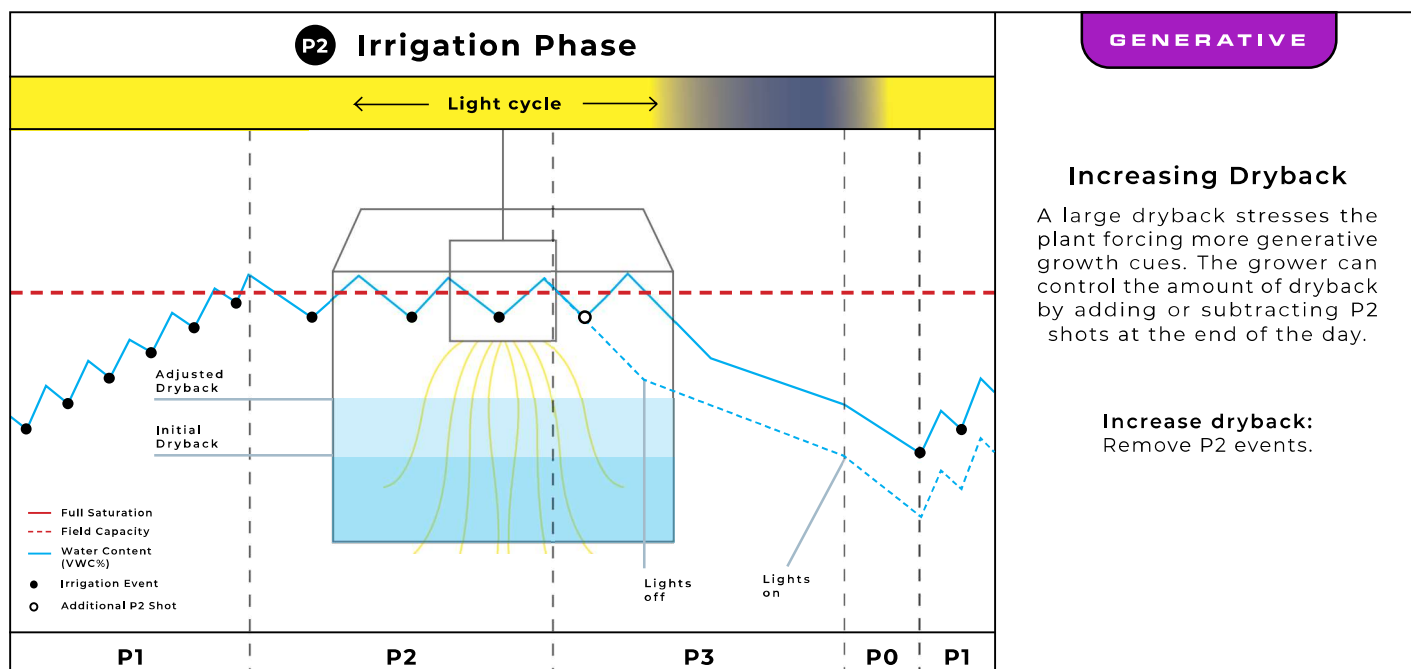
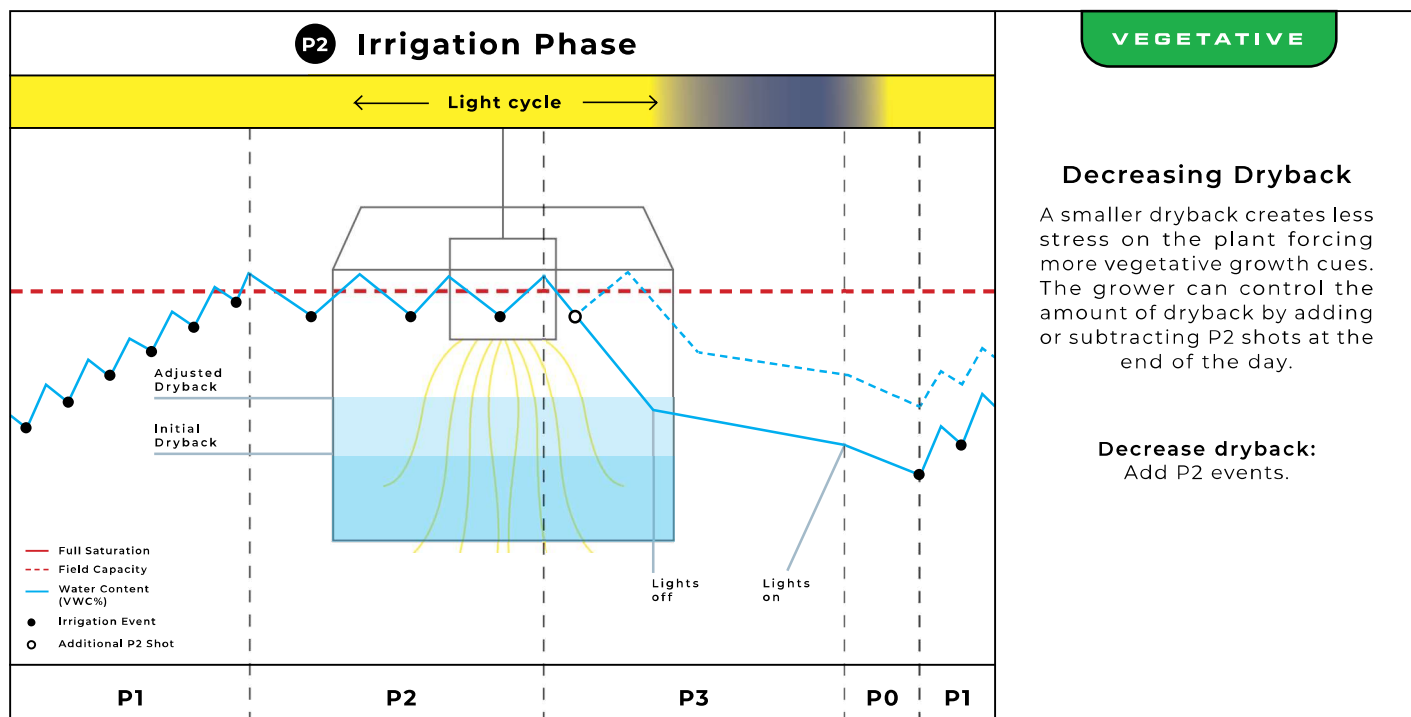


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P2 Irrigation Phase

The P2 phase is used to maintain a desired VWC% throughout the lights on period. This is the most important phase for controlling substrate EC and dryback. These are the two different ways to control substrate EC and dryback.



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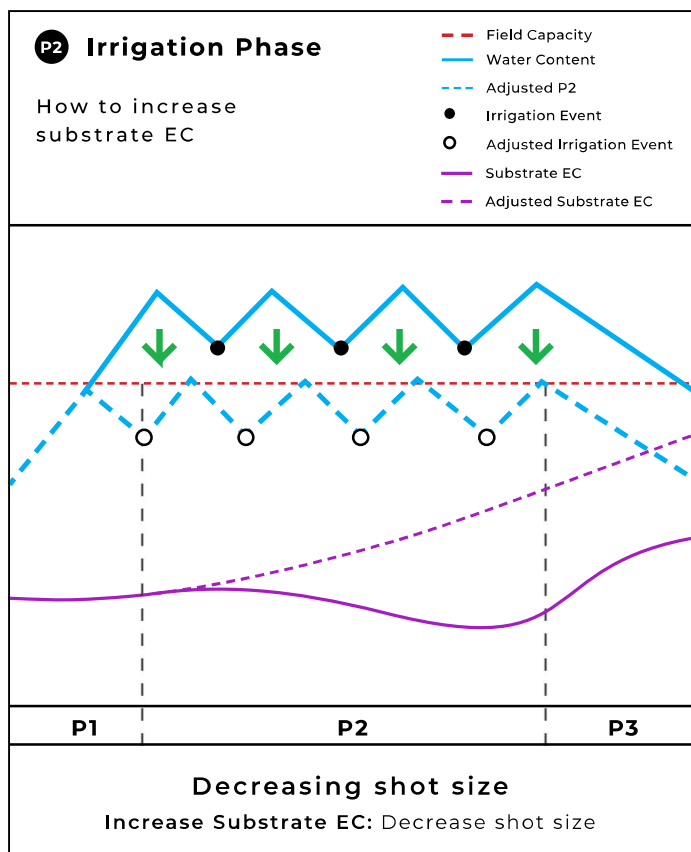
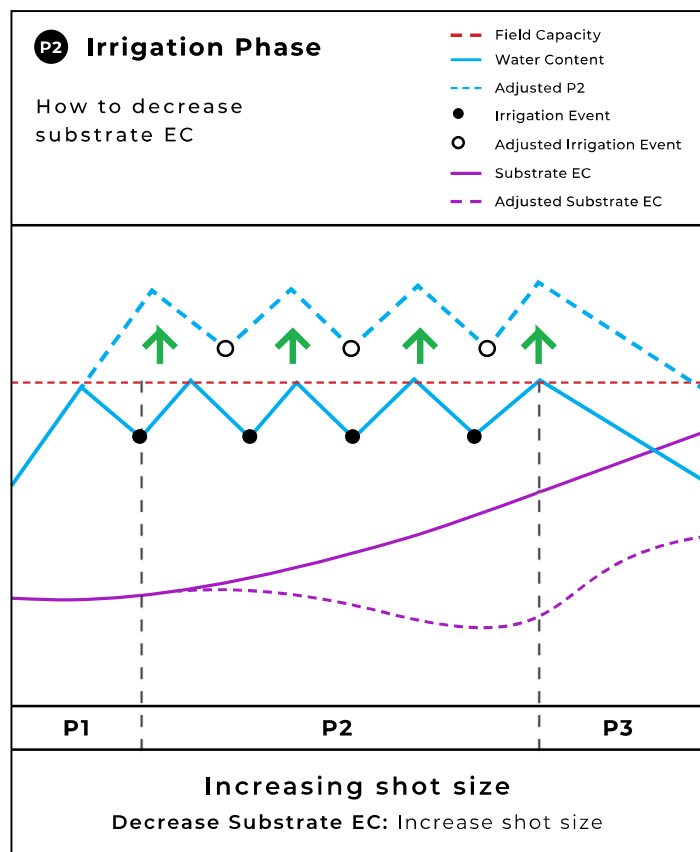
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When to add P2 events

As plants grow and the rate of dryback increases it is now necessary to add P2 events to keep the substrate from drying back too much. Shot size % is determined by substrate size (please refer to the shot volumes chart). The grower can utilize various shot sizes to manipulate substrate EC by controlling the amount of runoff generated. Increasing shot size above the point of field capacity will force more run off causing pwEC to decrease. On the other hand, decreasing shot size slightly above or below field capacity will increase pwEC, this technique is called EC stacking.



Irrigation Controller Settings

It is important to know when to add P2 shots, manage shot size, calculate dryback, and calculate runoff volume. To help plan your irrigation events, scan code to use our Irrigation Strategy Calculator.



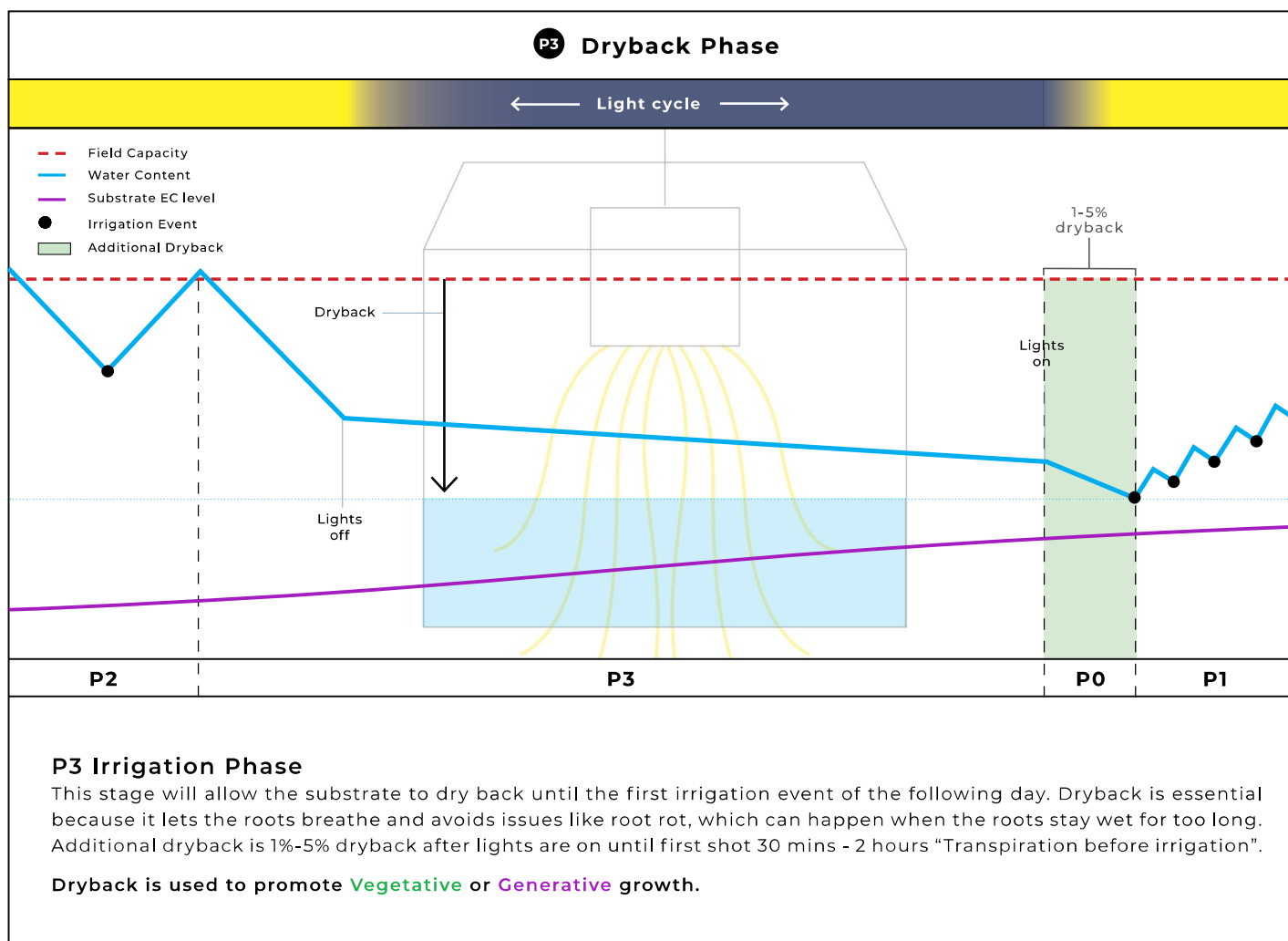
SCAN

to access our **Irrigation Strategy Calculator** to help plan your irrigation events using your rate of dryback.

VEGETATIVE	GENERATIVE
LESS STRESS	MORE STRESS
<p>Larger shots</p> <p>↓</p> <p>More runoff</p> <p>↓</p> <p>Lower substrate EC</p>	<p>Smaller shots</p> <p>↓</p> <p>Less runoff</p> <p>↓</p> <p>Higher substrate EC</p>

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Rate of Dryback

The Rate of Dryback is the difference in VWC% over a period of time. **For example:** If a substrate at Field Capacity measures 50% VWC and one hour later measures at 48% VWC, the Rate of Dryback is 2%/hour, this rate is useful when planning P2 irrigation events and to keep dryback within a desired range. Dryback rate during lights off is also needed to accurately plan irrigation events using our Irrigation Strategy Calculator.



SCAN
to access our **Irrigation Strategy Calculator** to help plan your irrigation events using your rate of dryback.

Note: Please note that the dryback targets provided here are based on a relative change, whereas some dryback recommendations rely on absolute change. Utilizing relative change is essential for greater accuracy when dealing with substrates that have varying field capacity and full saturation points. This is due to the fact that the change in volumetric water content (VWC%) will be directly proportional to the total volume of solution in the substrate. Understanding which type of measurement is being used is crucial for fine-tuning an exact and effective irrigation strategy.

P3 Dryback Targets	
VEGETATIVE	GENERATIVE
30-40%	40-50%
Less Stress	More Stress
Lengthy Growth/ Bud Swell	Shorter Compact Plants

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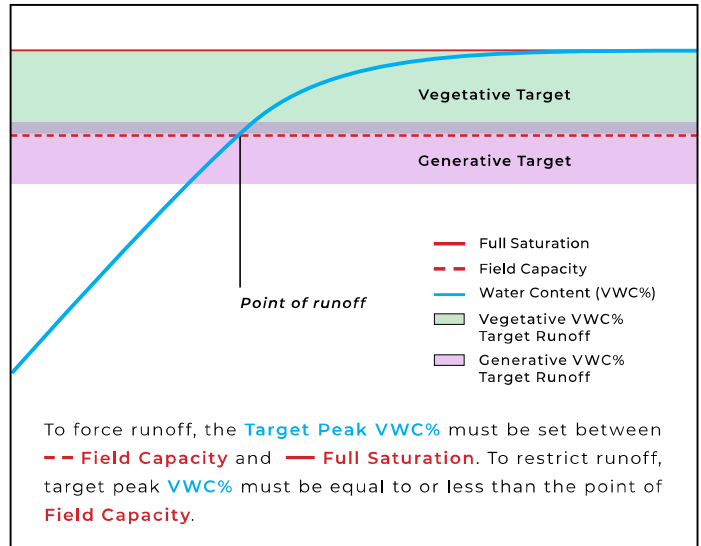
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Determining Target Runoff

Once **Full Saturation** is reached, **VWC%** will remain constant. Any additional water added to the substrate at **Full Saturation** will be drained and will not increase **VWC%**.

Determining the **VWC%** at the *point of runoff* is crucial to manipulating substrate EC by controlling the volume of runoff produced by irrigation events. The grower must strategically determine a target **VWC%** while considering **VWC%** at **Field Capacity** and **Full Saturation**. Setting a target **VWC%** above the point of **Full Saturation** will cause excessive runoff and is a target that is impossible to reach.

PRO TIP: Have an extra set of emitters placed in a pitcher to catch irrigation water to monitor shot volume.



SHOT VOLUMES	
Substrate Size	1% Shot volume
4 Liter Pot	40 mL
7 Liter Pot	70 mL
10 Liter Pot	100 mL
10 cm Rockwool (Delta 6.5)	6.5 mL
10 cm Rockwool (Delta 10)	10 mL
15 cm Rockwool (Hugo)	35 mL
Uni-Slab Rockwool	50 mL
15 cm Rockwool Slab	100 mL

Runoff Targets Based on Substrate Size		
By adjusting our shot sizes to increase or decrease the volume of runoff, we can precisely control and fine-tune the substrate EC.		
Substrate Size	Vegetative Runoff Volume (8%-16%)	Generative Runoff Volume (1%-7%)
4 Liter Pot	320 mL - 640 mL	40 mL - 280 mL
7 Liter Pot	560 mL - 1,120 mL	70 mL - 490 mL
10 Liter Pot	800 mL - 1,600 mL	100 mL - 700 mL
10 cm Rockwool (Delta 6.5)	56 mL - 112 mL	7 mL - 46 mL
10 cm Rockwool (Delta 10)	80 mL - 160 mL	10 mL - 70 mL
15 cm Rockwool (Hugo)	280 mL - 560 mL	35 mL - 245 mL

IRRIGATION STRATEGY TARGETS				
Growth Stages	Veg	Flower Stretch	Flower Bulk	Flower Finish
Weeks	2 - 4	1 - 4	5 - 7	8 - 9
Substrate EC	3 - 5	4 - 10	3.5 - 6	3 - 4
Dryback	50% initial, 25% all following	40% - 50%	30% - 40%	40% - 50%
Strategy	Vegetative	Generative	Vegetative	Vegetative Substrate EC, Generative dryback

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Runoff Procedure

CAUTION: MAKE SURE TO MONITOR THE DRYBACKS IN LARGER PLANTS TO AVOID DRYING BACK PAST WILTING POINT.

1 Select	Before P1 Irrigation Phase begins, select 2-3 average size plants within each irrigation zone. This will give the best representation of the average runoff for plants within the zone.
2 Place	Place each selected plant on top of a clone tray with insert. This will allow plants to freely drain into the tray without sitting in runoff.
3 Irrigate	Allow P1 and P2 irrigation phases to run as normal.
4 Collect	Collect runoff from each tray immediately after the P2 irrigation phase ends to avoid loss of water due to evaporation.
5 Measure	Measure volume of runoff in a graduated cylinder.
6 Test	Using a calibrated EC and pH meter, test runoff EC and pH.
7 Compare	Compare runoff EC to substrate EC on substrate sensor to validate accuracy of substrate sensor. Runoff EC tends to be slightly lower than substrate EC.
8 Adjust	Refer to the runoff and substrate EC ranges charts in precision irrigation strategy procedure and adjust irrigation events accordingly to keep substrate EC within the correct range based on growth stage.
9 pH	Based on runoff pH adjust input nutrient solution pH to bring substrate pH within the correct range. Note: The runoff pH should be slightly higher than the input nutrient solution pH to indicate a healthy developing plant. A lower runoff pH indicates that the plant is having problems using the nutrients within the rootzone. The lower pH usually happens when the rootzone is too wet and roots are sitting in too much moisture and rot.

PRO TIP: To ensure an accurate sensor reading, pack the coco tightly around the sensor to avoid air pockets.

Substrate Sensor Placement

4 L Pot	7 L Pot	10 L Pot	Rockwool
2.5 cm from bottom	5 cm from bottom	5 cm from bottom	2.5 cm from bottom

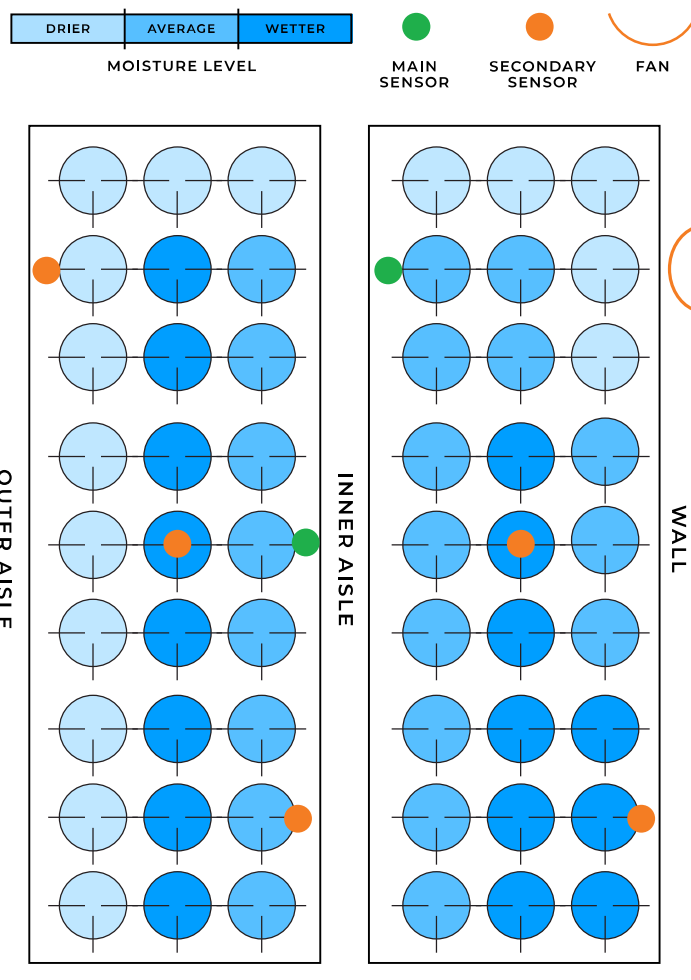
Irrigation Zone Sensor Placement

Plants positioned in different areas within an irrigation zone experience different rates of dryback due to variations in environmental variables such as temperature and airflow. For example plants next to a fan or an aisle would have an increased rate of dryback as opposed to plants in the center of an irrigation zone.

When choosing the best location for a substrate sensor to control an irrigation zone it is crucial to select a plant that best represents the average moisture level of all the plants within the zone. For larger irrigation zones, it may be required to utilize multiple sensors placed in different areas to dial in your irrigation strategy. Depending on the irrigation controller additional sensors may be used as supplemental data or may be used to take average readings.

PRO TIP: Designate individual strains to specific irrigation zones due to varying rates of dryback.

The image below shows the variance in VWC% that can be seen in different areas of the irrigation zone based on environmental factors within a grow room.



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HAND WATERING IRRIGATION STRATEGY

PRO

Pro Line Feed/Runoff Targets													
	VEG				FLOWER								
	W1	W2	W3	W4	W1	W2	W3	W4	W5	W6	W7	*W8	**W9/ Flush
EC	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0 - 1.0
PH	5.8 - 6.2	5.8 - 6.2	5.8 - 6.2	5.8 - 6.2	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3
RUNOFF TARGET EC	4.0 - 5.0	4.0 - 5.0	4.0 - 5.0	4.0 - 5.0	6.0 - 7.0	6.0 - 7.0	6.0 - 7.0	5.0 - 6.0	5.0 - 6.0	5.0 - 6.0	4.0 - 5.0	3.0 - 3.5	0.0 - 1.0
RUNOFF TARGET PH	5.8 - 6.2	5.8 - 6.2	5.8 - 6.2	5.8 - 6.2	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3	5.9 - 6.3
DRYBACK TARGET	30% - 40% WC	30% - 40% WC	30% - 40% WC	30% - 40% WC	30% - 40% WC	50% - 60% WC	50% - 60% WC	30% - 40% WC	30% - 40% WC	30% - 40% WC	30% - 40% WC	50% - 60% WC	50% - 60% WC

MONITORING DRYBACK

The key is having your substrate dryback overnight to the targeted percentage.

You can monitor drybacks by:

1 	2
Picking up each pot before feeding to make a judgement call on how dry the substrate is.	Use a water content meter to monitor how much water is in the substrate.

Strive for one feed each morning with roughly 10-25% runoff when the lights come on. Aim for the substrate to dry back over a 24 hour period. This dryback period is very important to allow for optimal root development.



WARNING: IF THE SUBSTRATE IS NOT DRYING BACK BY MORNING, YOU NEED TO LET IT DRYBACK BEFORE FEEDING TO AVOID OVERWATERING ISSUES.



The goal is to have the whole garden feeding and drying back consistently every day.



You **DO NOT** want a situation where you're hand feeding multiple times per day.

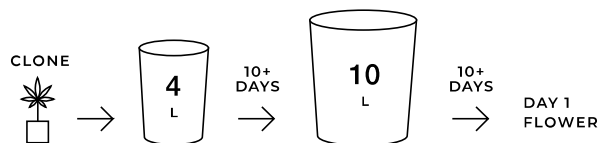
CHECKING RUNOFF

Monitor the runoff and make adjustments for the next feeding (if needed) based on runoff EC/pH and plant health. You want to be within ± 1 EC of suggested runoff targets and within $\pm 10\%$ of dryback targets.

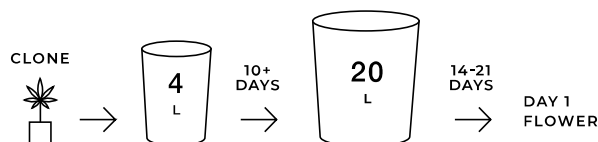
If you run more water through the substrate, there will be lower EC in the substrate.



3-3.5 Week Veg – 6 plants per 1.2mx1.2m/1.5mx1.5m area



4-5 Week Veg – 4 plants per 1.2mx1.2m/1.5mx1.5m area



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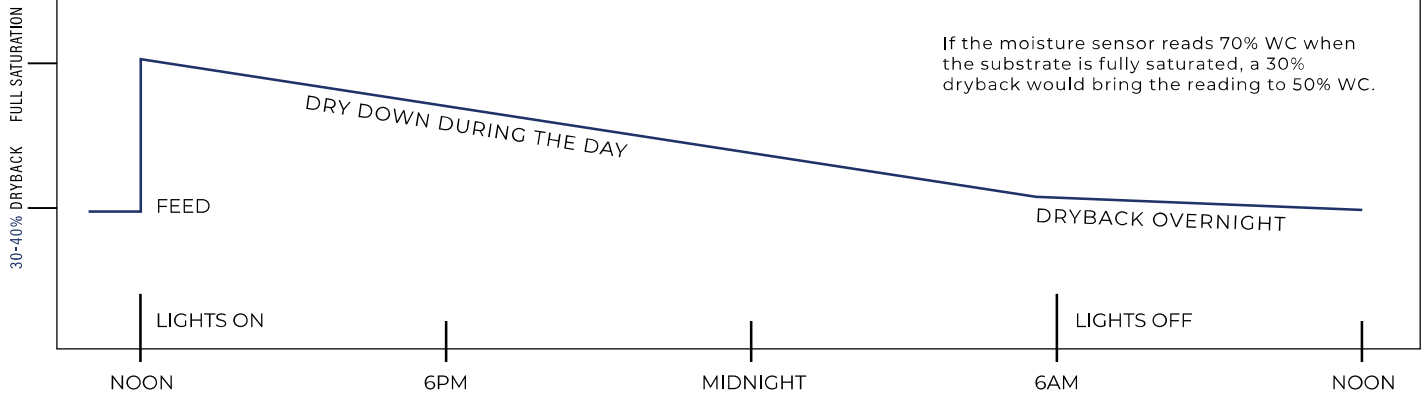


HAND WATERING IRRIGATION STRATEGY

PRO

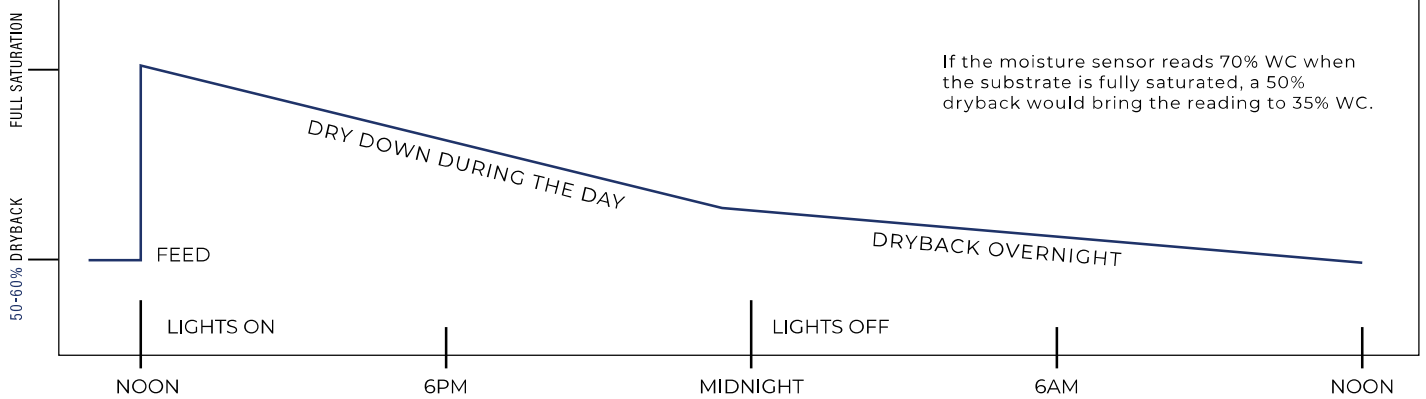
VEG – Lighting Cycle 18/6

VEGETATIVE STEERING



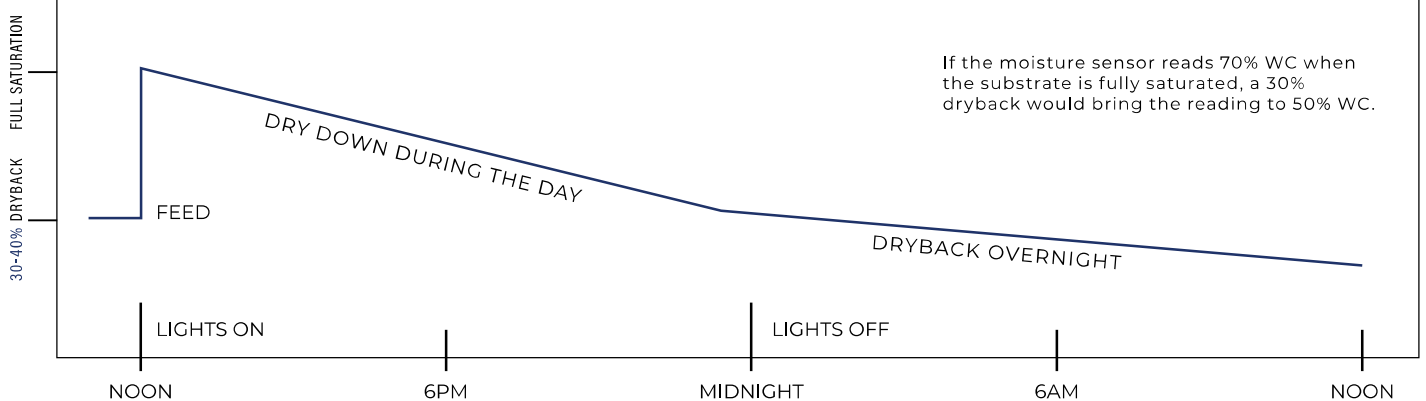
Stretch and Flush – Lighting Cycle 12/12

GENERATIVE STEERING



Flower bulk – Lighting Cycle 12/12

BULKING



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