Innovations in Growing Technology for Blueberries

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Topics Covered in this Presentation

1. **Growing Systems** (From Traditional Soil Berms to Substrate Pots (…& derivations of each).
2. **Growing in Containers** (Rigid Pots vs. Bags).
3. **Innovations in Container Design** (Size, Shape, Colour, Drainage, Heat Protection).
4. **Innovations in Substrate Media** (Peat→ Peat-blends→ Peat-free (Coir/Pine-Bark/Wood-fibre).
5. **Innovations in Drip Irrigation** (Pot size & Dripper number, O-ring; Hard-wall Hose).
6. **Using Electronic Sensors to Monitor/Manage Crop Root & Aerial Environment(s).**
7. **Innovations in Irrigation Monitoring – Soil/Substrate** (Tensiometers/% VMC Sensors/Lysimeters).
8. **Growing Structures & Covers** (Tunnels/Shade Structures, Multi-Layer Plastic Cover Options).
9. **Heat Management** (Overhead Micro-sprinklers, Shade Cloth, Reflective Covers/Coatings).
10. **Other Innovations** (Drones to Monitor Bush Vigour; Thermal/Infra-Red Imaging).

From Soil Berms to Substrate Pots (…& derivations of each)

Traditional Soil Raised Beds (Berms) dressed with sawdust

Amended Bed (100-200l of Peat/Coir/Bark per m) & Mypex cover

Containerised Substrate System (35 litre Rigid pots)

Substrate System in 100% Coir (using 25 litre Pre-filled Bags)

Containerised Crops – Rigid Pots vs Bags

Rigid Pots – Advantages

- Highly durable (>10 yrs) – Can outlast most Crops.
- Large choice of sizes/designs/colours.
- Better thermal & light protection for roots.
- Better Drainage (Better root health).
- Easy to remove pot to inspect root system.
- More stable on ground (less tilting/collapse).
- Better protection from mechanical damage.
- Easier to move & less damage when moving.
- Can be re-used for another crop?

Rigid Pots – Disadvantages

- High Capital Cost.
- Extra pot filling costs (compared to pre-filled bags).
- Storage space required for unused pots?
- Disinfection system required before re-use.

Bags – Advantages

- Lower Capital cost.
- Lower potting costs (but only with pre-filled bags).
- Single Use product - no disinfection/storage requirement.

Bags – Disadvantages

- Fewer options for size, substrate type and colour.
- Less thermal & light protection for roots.
- Less stable (more tilting/collapse – especially in latter years).
- Worse drainage (Increased root dieback & leaf chlorosis risk).
- (Bags can be placed on a Tile or support stand to alleviate this).
- Difficult to inspect root system without damaging bag.
- Offer little protection from mechanical damage.
- More likelihood of damage when moving. (Less so with Mypex).

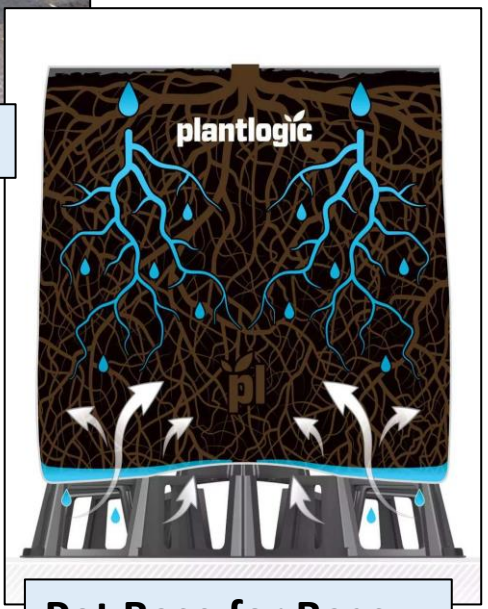
Innovations in Container Design

Square pots

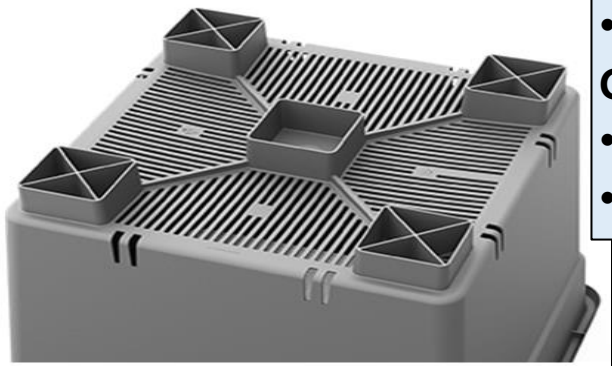
Round Pots

Pronounced leg for improved drainage/air pruning

Profiled base & large drain holes



Grid Base – extra drainage



Round Pots vs. Square?

- Round = better rooting & less breakage?

Grid Base vs Drain holes?

- Grid = better drainage (no basal saturation)
- But, higher drought & frost damage risk?

Pot Base for Bags

- More Stability
- Better drainage?

Zephyr 1 & 2 Pots - Mexico

Zephyr Principle

- Removeable corrugated sidewalls
- (Easier for crop inspection).
- Holes in sidewalls give improved root aeration.

Zephyr 1

- Flat (low) vertical profile
- Tends to lay bit wet at base.
- Issues with impeded drainage
- and “rooting through”.

Zephyr 2 (Taller profile & different corrugations).

- Taller profiled base (better drainage & air pruning.
- No holes in top layer (better moisture retention).

Rigid Plastic Pots - Colour and Size

35 litre square pot

Pot Colour

- Black (Generally cheapest & most durable option).
- **In temperate growing areas**: Gives a useful gain in earliness.
- **In warm growing areas**: Roots suffer more heat stress/dieback.
- Coloured pots absorb less solar radiation (cooler roots).
- White pots, coolest but least durable. Must be fully opaque!

Pot Size

- Commonly, 25-40l pot (Compromise – cost vs root volume)
- 60l pot (Extra pot & substrate costs; marginal gain in yield)!
- 18-24l pot (Cheaper costs, but more pressure on irrigation/roots).

Terracotta Coloured Plastic Pots

18 litre square pot

Conventional Black Plastic Pots

(Opaque) White Plastic Pots

Heat Protection To Blueberry Roots

Root & Shoot Growth decreases with increasing Substrate Temperature in SHB (*Spiers, 1995*)

Variable	New growth (dry wt in g) Shoot	Root	Total plant	Root length (cm)
Temperature (°C)				
16	4.8	15.2	20.0	22.8
27	3.2	9.7	12.9	20.4
38	1.5	7.3	8.8	14.7
Linear	***	***	***	***

White Polythene Cooling Skirt

White Zephyr 2 Pot

Reflective Woven Ground Cover

Various solutions are used to mitigate heat build-up in substrate/soil crops:

1. Reflective (white, or light coloured) pots:
- Ensuring they are opaque to sunlight
- & have sufficient UV Inhibitor.

2. Reflective cooling strip (or skirt):
- Temporarily installed around black pots.
- May restrict airflow/drainage?

3. Innovative pot design
- **(e.g. Plant Logic – Zephyr 2)**
- White outer walls (for heat reflection)
- Black inside wall (to exclude light)
- Ventilation holes (for airflow/cooling)

4. Reflective soil covering
- White/Grey/Silver polythene
- (or woven ground cover material).

Innovations in Blueberry Substrate Media

Peat: for many years was the preferred substrate for Blueberries grown in containers.

- It is light weight, readily available, and naturally acidic in pH.

Substrate manufacturers can further improve physical properties:

- by blending Peat with various proportions of Coir & Perlite.

Example:

A popular Blueberry blend from a leading Dutch supplier contains:

- 50% Coir Pith (washed & buffered, strawberry coir)
- 25% White block-peat Mix (from Irish & Baltic sources)
- 10% Coir Short-fibre mix
- 15% Perlite (1-6 mm)

Peat/Coir/Perlite Blend

Peat Substrate

Screened Coir Pith/Short Fibre Mix

Due to rising substrate costs & concerns over Peat-extraction

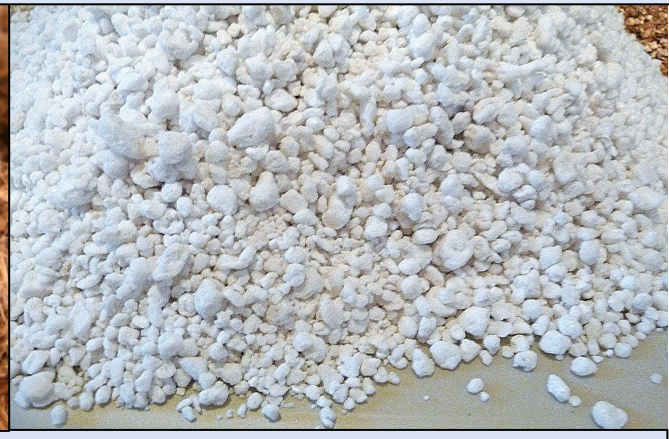
- (Biodiversity/Habitat destruction & high CO_2 emissions).

Cheaper & more sustainable Peat-free alternatives are required for substrate Blueberries.

Highly Suitable materials are: 100% Coir & 100% Pine-Bark

- (or Coir/Pine-bark blends - sometimes with added Perlite).
- Another material of interest is virgin-Wood-fibre.

Virgin Wood-fibre



Medium Grade Horticultural Perlite

Growing Blueberries in 100% Peat-Free Substrate

100% Coir: (Ideally with 0-2 mm fines removed & 2-6 mm Chips added).

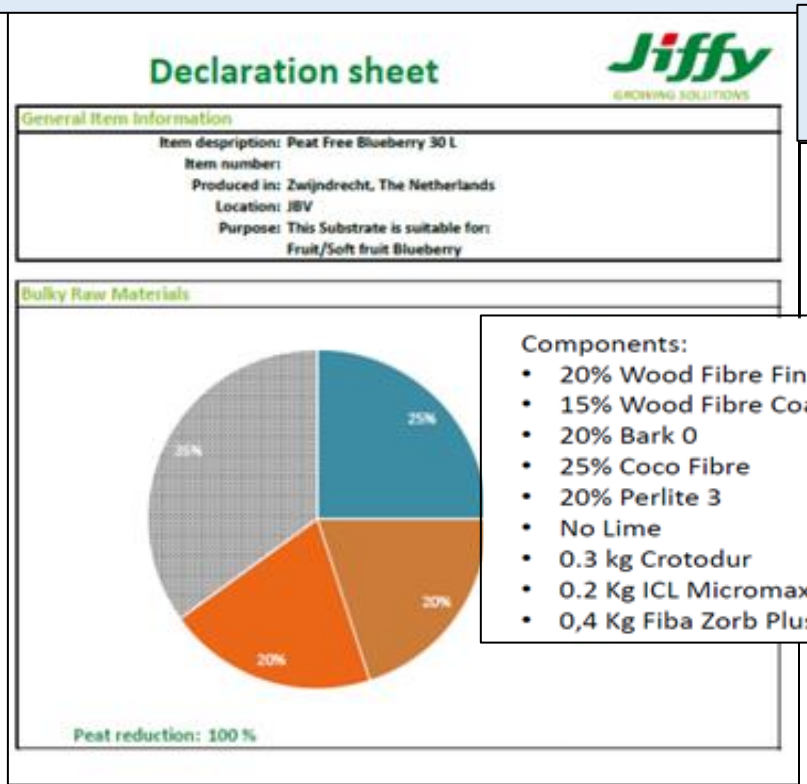
- ≥90% porosity = Good water retention with high Air-holding Capacity.
- Excellent root health over full (6-10+ year) crop duration.
- Supplied as Naked blocks, or Open top Containers (bags) in dry, compressed form.
- Gives significant savings in transport costs. Simple installation (just add water).
- Must be chemically treated (Washed & Calcium buffered) to be safe to plant into.

Naked Dried 100% Coir Block (2-5 mm)

100% Aged Pine-Bark: (ideally with 6mm+ particles removed). Cheap & under-utilized.

- A significant container-grown Ornamental industry already exists in US, SA, NZ, etc.
- Product must be aged (to reduce N drawdown) & screened to remove large chunks.

Lower porosity (75%) & lower water retention.
Potentially toxic Mn levels - if pH drops <4.0.



Declaration sheet

Jiffy GROWING SOLUTIONS

General Item Information

Item despription: Peat Free Blueberry 30 L
Item number:
Produced in: Zwijndrecht, The Netherlands
Location: JBV
Purpose: This Substrate is suitable for:
Fruit/Soft fruit Blueberry

Bulky Raw Materials

Components:

- 20% Wood Fibre Fine
- 15% Wood Fibre Coarse
- 20% Bark 0
- 25% Coco Fibre
- 20% Perlite 3
- No Lime
- 0.3 kg Crotodur
- 0.2 Kg ICL Micromax
- 0,4 Kg Fiba Zorb Plus

Peat reduction: 100 %

100% Peat-Free Ready Mixed Blends

- Becoming increasingly more available
- Mostly blends of Wood-fibre/Coir/Bark/Perlite

Generally expensive & high transport costs.
Do the job but 100% Coir & 100% Bark cheaper?

Bulkdensity (kg/m3-EN):	~ 230	NEN 13040	Dry weight	~ 1	kg/m3-EN
Dry matter:	~ 36%	NEN 13040			
Organic matter:	~ 74%	NEN 13039			
Moisture content:	~ 62%	NEN 13040			
Air content (-10cm):	~ 35%	NEN 13041			
Pore volume:	~ 87%	NEN 13041			
Water holding capacity (-10cm):	~ 51%	NEN 13041			

Aged Pine-Bark (0 to 6 mm+)

Drip Irrigation Systems for Substrate Crops

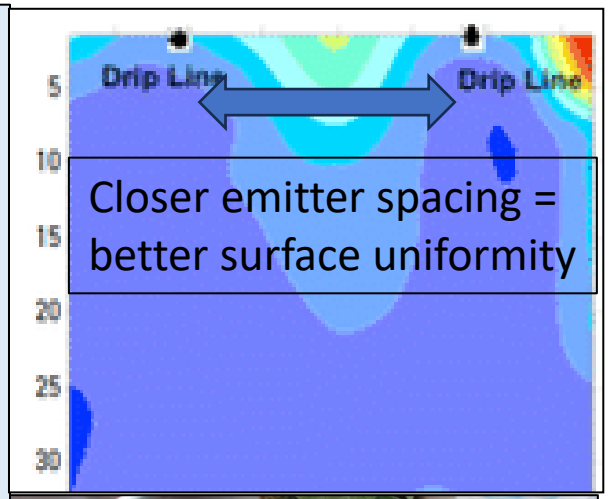
Spaghetti Systems (with Dripper Stakes) – Optimal set ups

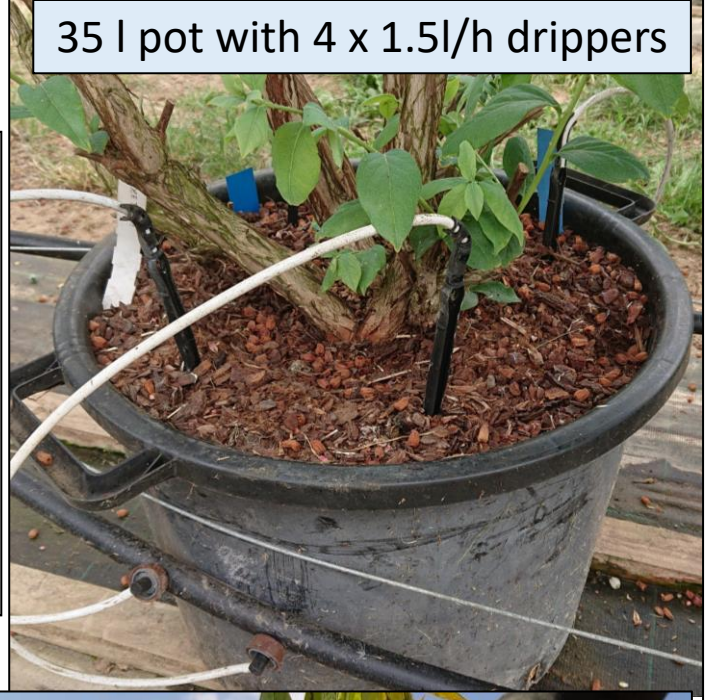
- Use 2-3 drippers for smaller (10-16 litre) pots.
- Use 3-4 drippers for larger (25-40 litre) pots.
- Use 4-6 drippers in largest (45-60 litre) pots.

Gives more uniform surface moisture (+ fertilizer) distribution (= Uniform root distribution & optimal water/nutrient uptake).

Ideal dripper output = 1.2-1.6 litres/hr

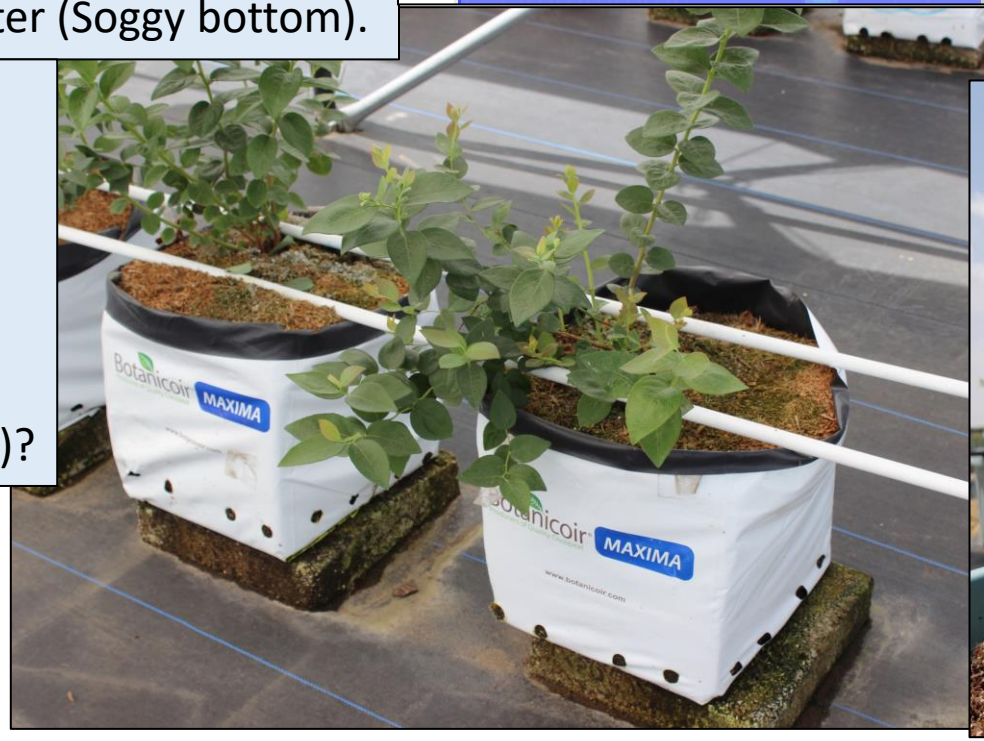
- **Lower Output** = less lateral spread (via capillary action).
- **Higher Output** = Over-watering risk greater (Soggy bottom).





Dripper Ring Innovation

- Placed in contact with the substrate
- (encircling the plant).
- To give more even surface moisture distribution?
- But greater risk of dry pots
- (if the feeder pipe is damaged/dislodged)?



Hard-wall Hose Option

- No Spaghetti tubes to pull out/damage.
- Pressure compensating emitters only
- Ideally fix hose to a wire.
- (prevents movement/dislodgement).

Electronic Sensors for Monitoring Root and Aerial Environment(s)

With modern technology: a wide range of sensors are available to monitor & help optimise climate & root environment(s).

In-situ Probes to monitor root environment:

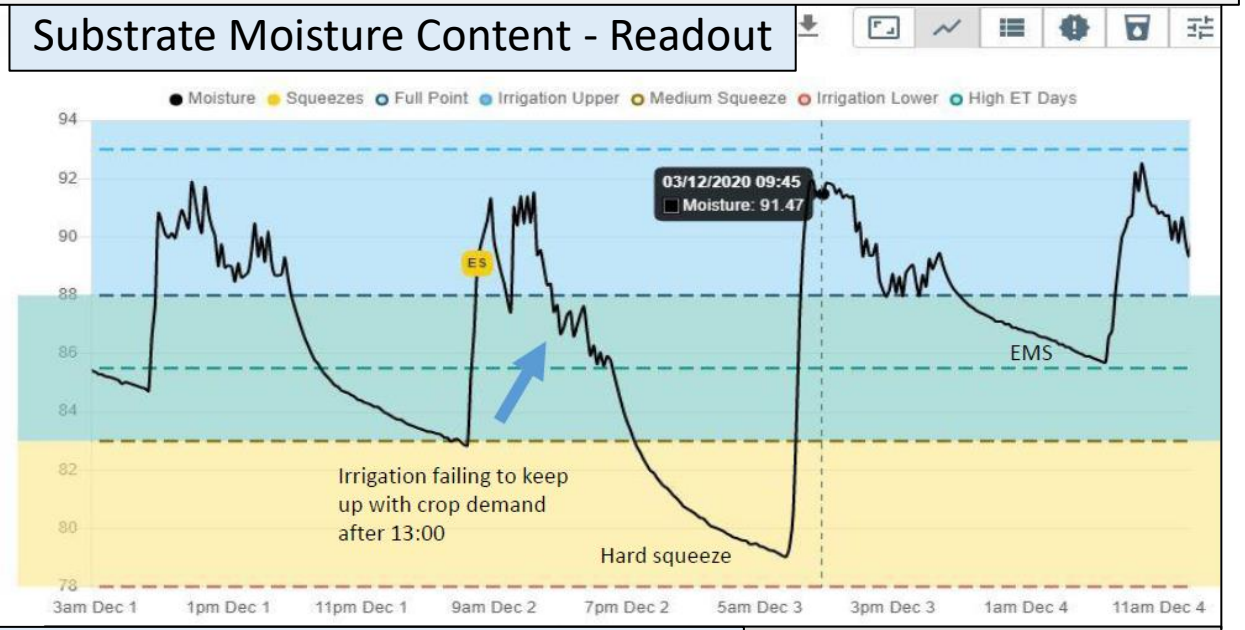
- Moisture
- Temperature
- EC

On each of the six Sensors placed at 10 cm intervals

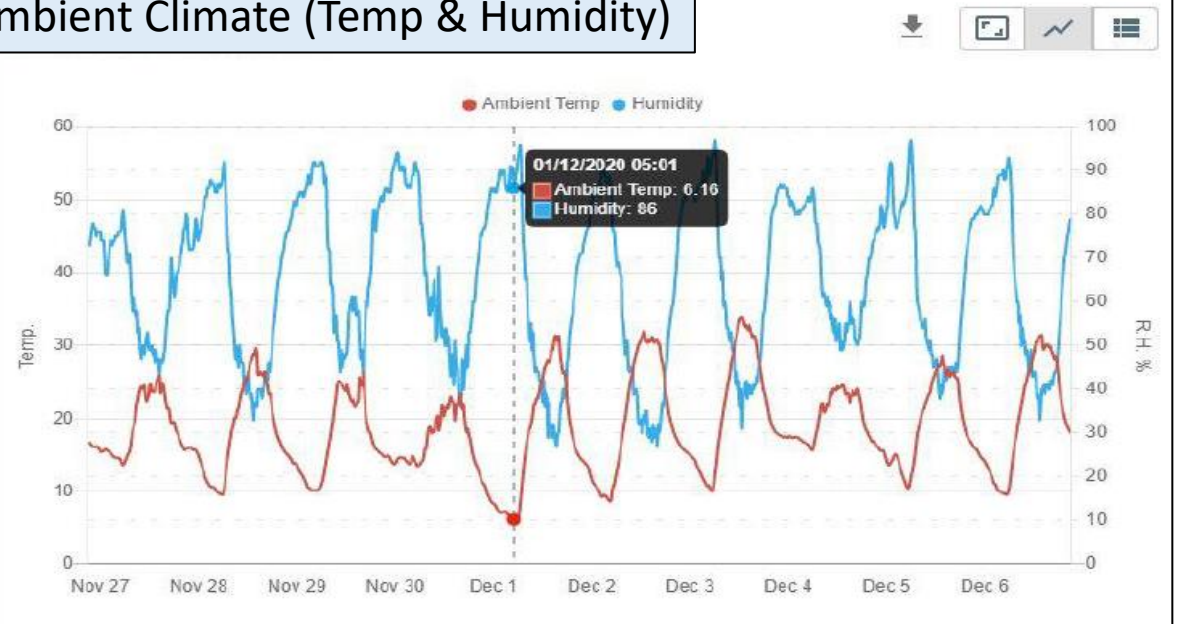
External sensors to monitor climate & drain (run off):

- Run-off
- Temperature / humidity
- PAR sensors (light)
- Wind speed

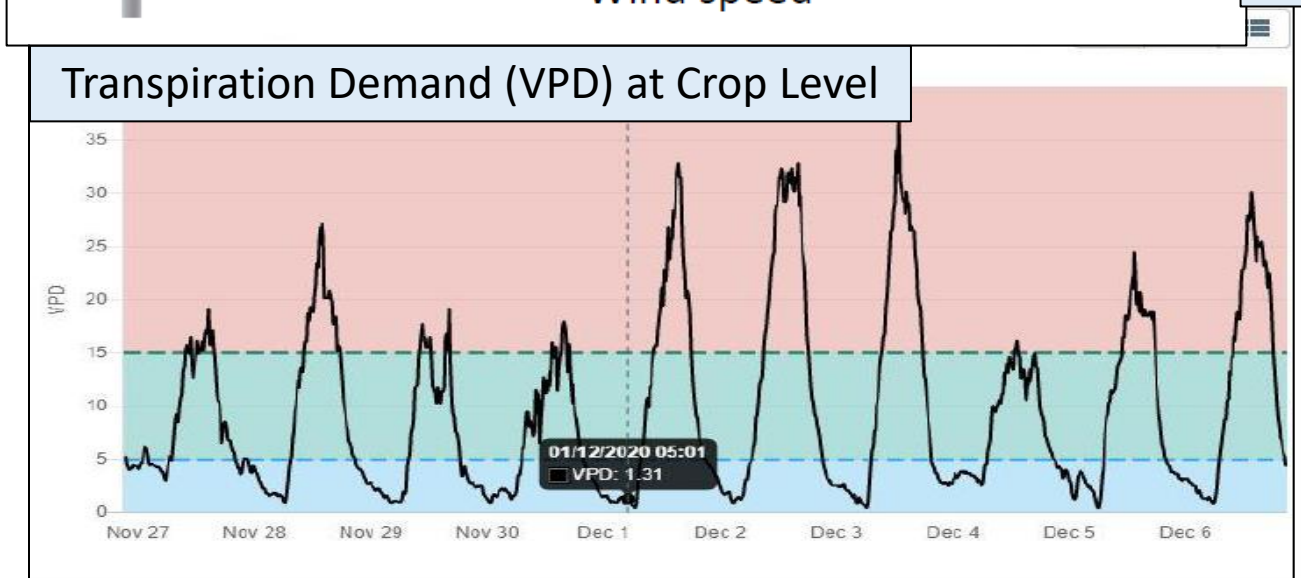
Substrate Moisture Content - Readout



Ambient Climate (Temp & Humidity)



Transpiration Demand (VPD) at Crop Level

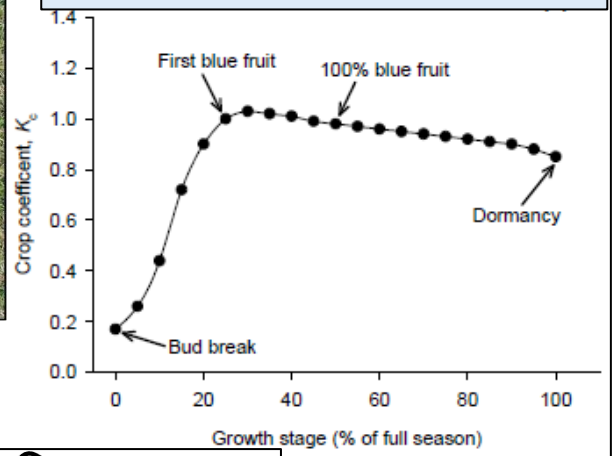


Irrigation Monitoring Technologies for Soil & Substrate Grown Berries

Soil-Grown Crops

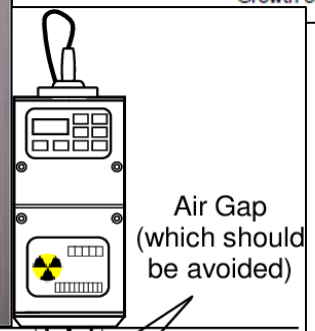
- **Physical Checks:** Using "old-tech" Corer/Spade.
- **Estimated E-T Demand:** (From: Local Reference Crop E-T data x Crop Coefficient)
- **Measuring Soil Matric Potential (Tension)**: Using in situ Tensiometers (30/60 cm)
- **Measuring Soil Volumetric Moisture Content (% VMC):** Using In situ probes.
- Neutron Probe, Capacitance Probes (e.g. Drill & Drop & Enviroscan).

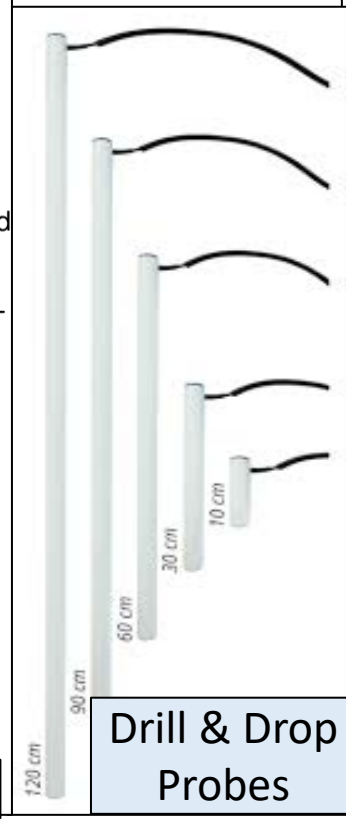
Blueberry Crop Coefficients



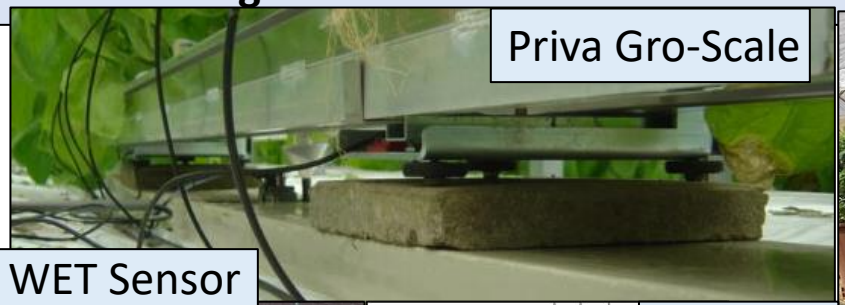
Substrate Grown-Crops

- **Drain Monitoring**: Using Lysimeters (Drain Collection stations).
- **Measuring Substrate Matric Potential (Tension):** With in-situ Micro-tensiometer.
- **Measuring Volumetric Moisture Content (%VMC)**: Using in situ/roving probes
- Capacitance Probes (Drill & Drop), TDR/FDR Devices (e.g. WET Sensor/Teros 12).
- **Weigh Scales:** Using Priva Gro-Scale or similar.
- **Measuring Plant Water Potential**: With Dendrometer (Stem diameter measure).



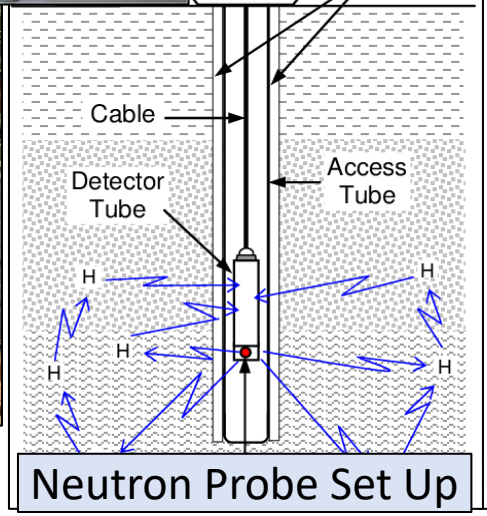


Drill & Drop Probes



Priva Gro-Scale

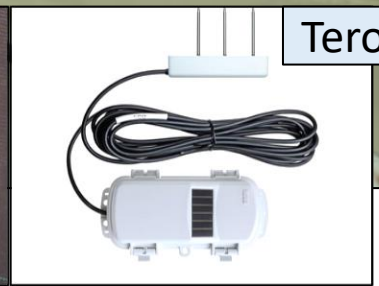
3 Pot Lysimeter – Substrate Blueberry



Neutron Probe Set Up

WET Sensor

Teros 12



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Automated Irrigation Monitoring in Soil Grown Blueberries

Neutron Probe – Neutron source lowered by cable into a metal access tube.
- Moisture readings taken every 5-7 days in one or more sites (at 10-90 cm depth).

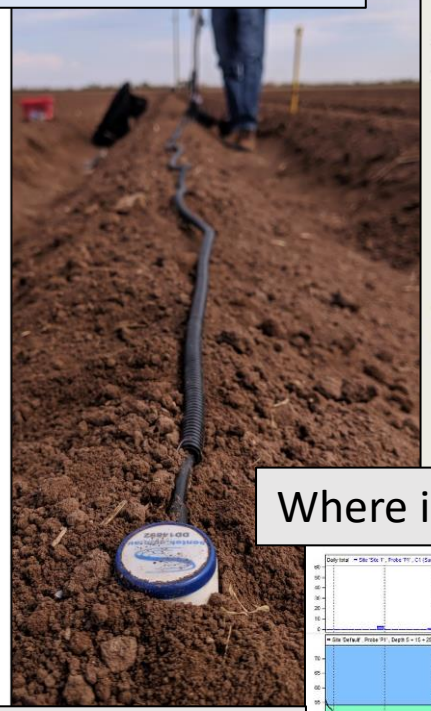
Enviroscan – Capacitance Sensors located at 10 cm intervals (at 30->100 cm depth).
- Device inserted into a pre-installed PVC access tube. Readings taken continuously.

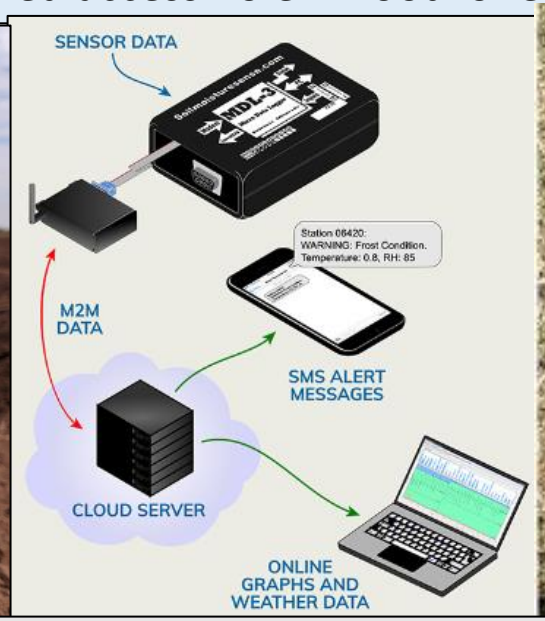
Drill & Drop – Capacitance device in different lengths (10-120 cm)
- (Sensors located every 10 cm). Inserted into a pre-drilled access hole in root zone.

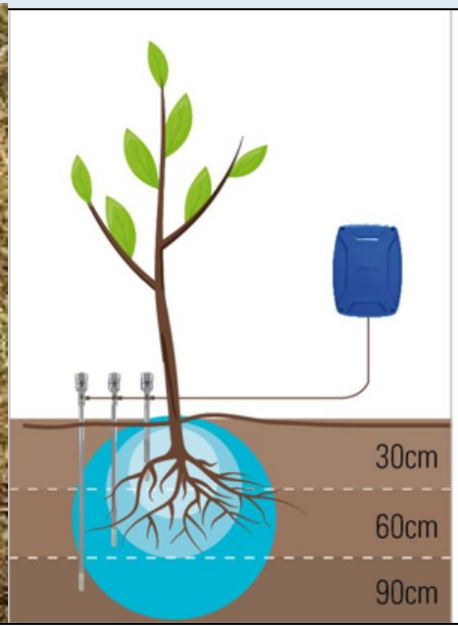
In-situ Tensiometer
- Fitted with an electronic transducer
- Continuously monitors & reports readings digitally.
- More than 1 tensiometer installed
- To obtain readings at several depths.

Enviroscan - Soil Blueberry

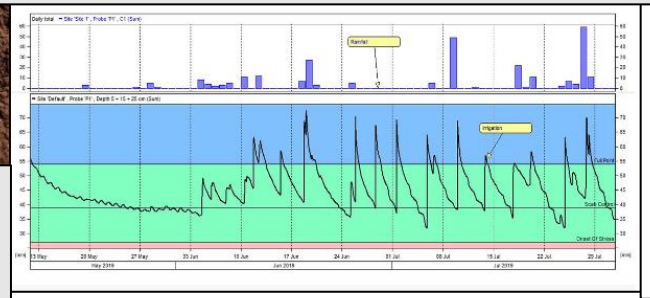
Drill & Drop Probe (Field Set-Up)

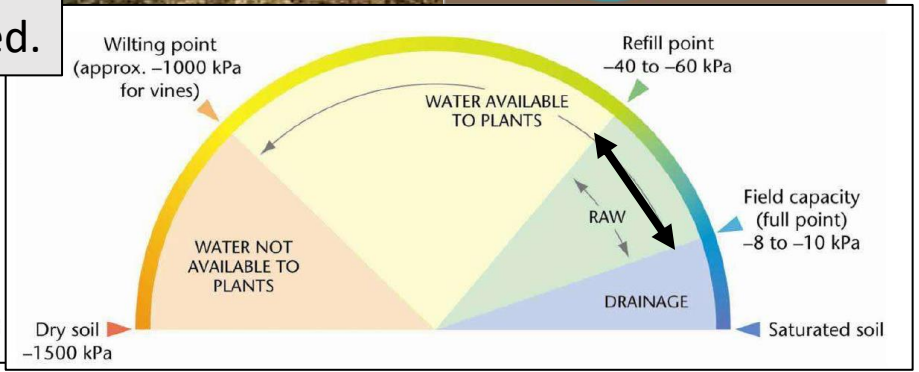






Where irrigation reports generated.



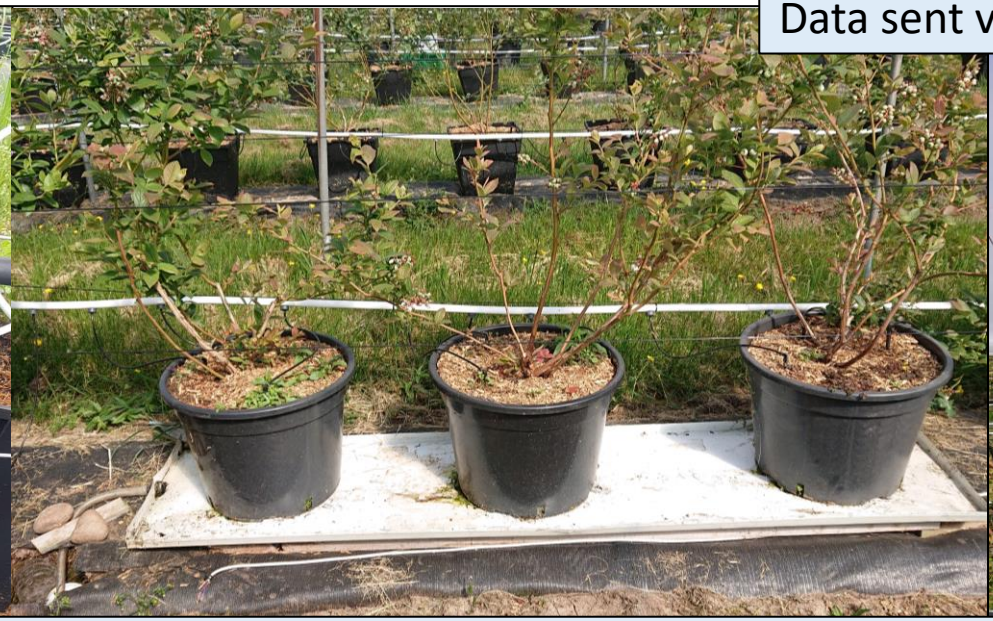


Data from all these devices is sent to a modem.
- From there linked to the suppliers website.

Automatic Monitoring of Drip & Drain Volume, % VMC & Tension in Substrate

10 cm Drill & Drop Probe

Micro-Tensiometer



≥3 pots on a sloping/rigid drain tray (not elevated)

Data sent via modem to cloud server

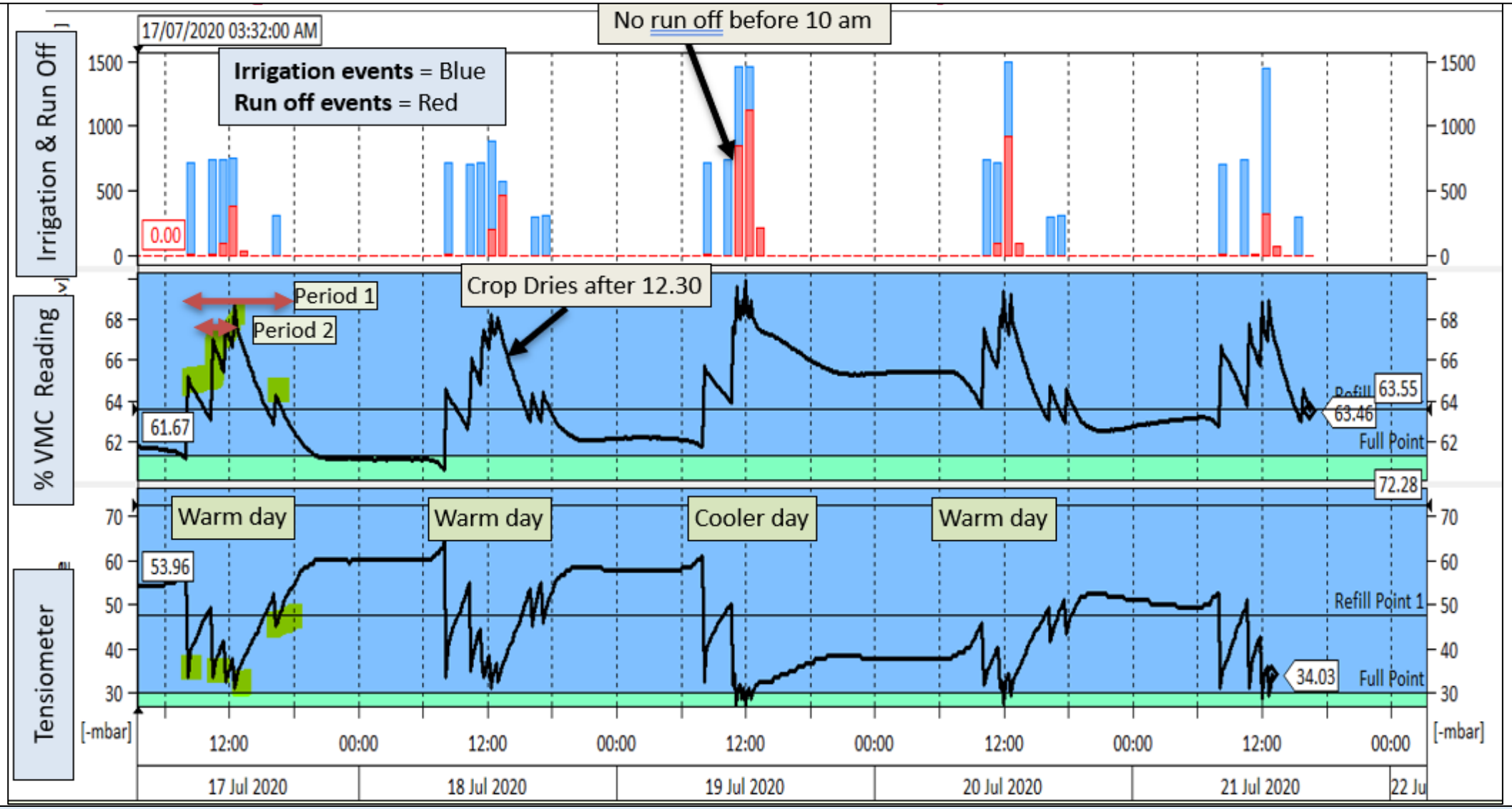
Install Sensor(s)10 cm from pot base

Drain runs into a tipper spoon

- (Measures drain volume each cycle)

Water meter records drip vol each cycle

Comparison of Tensiometer & Capacitance (%VMC) Data & Drip/Drain Analysis



Tensiometer and % VMC readings are mirror images of each other (low tension = high % VMC; & vice-versa.

- Irrigation controller triggered at 63% VMC (7.30 am – 6 pm). From 10.00-2 pm a 2nd period has trigger point of 68% VMC.
- Drain only achieved in 2nd period (10.00-2 pm). Plants too dry rest of time. Soil Moisture Tension too high (>45 mbar).

Growing Structures & Plastic Cover Options for Blueberries

Spring Forced Tunnel Production – UK

Choice of Tunnel Covering Materials – Multi-Layer Technology (8+)

- **Clear:** for max light transmission in low light areas.
- **Diffusing**: (50%-95%) dissipates light intensity in high light areas.
- **Anti Drip/Anti Condensation:** Surfactants spread water droplets.
- **Anti-Dust:** Smooth layer sheds dust more easily.
- **UV Open/Closed:** UV Open for max pollinator activity/fruit quality.
- **Thermic:** Reflects Infra-Red Irradiation to keep warmer at night.
- **Cooling:** Infra-Red Reflection (Mica); Heat barrier (Aluminium) particles
- **Pesticide Resistant:** (To Sulphur/Chlorides).

Shade House/Hail Protection – S Africa

Greenhouse with Retractable Shade Screen - Mexico

Coloured Polythene

Yellow (Insect Control)

- SWD/Thrips?

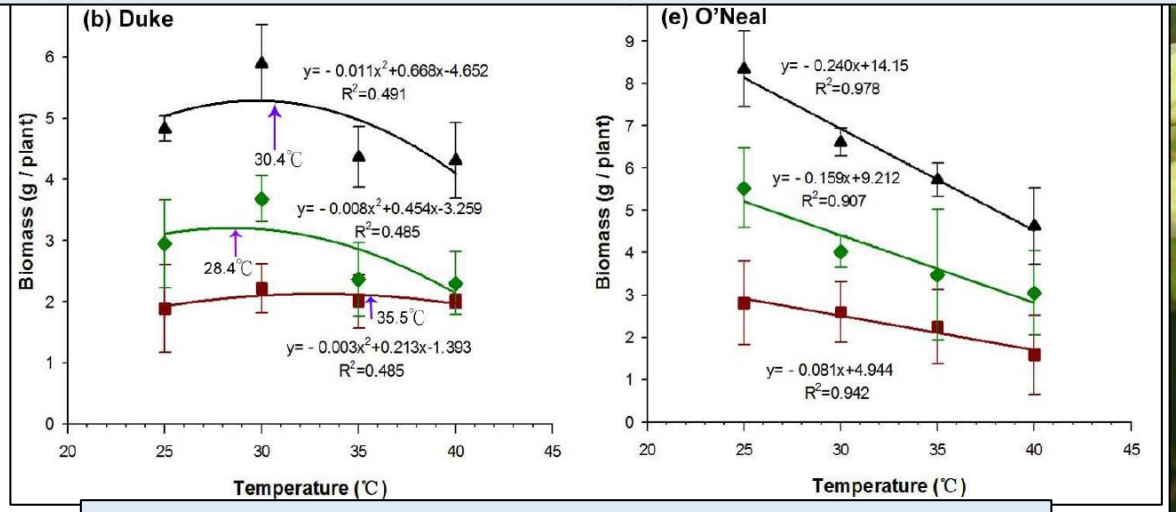
Pink (Increases PAR)

- 25% yield increase in winter crop (Spain)

Heat Management in Blueberries

Blueberry Growers are increasingly suffering increased crop damage/yield loss due to excess light intensity & temperatures.

Heat Damage to Fruits



Reduced Plant Growth/Fruit Size in High Temps

Leaf Damage in Hi Light Intensity

Heat Amelioration Technologies in Blueberries

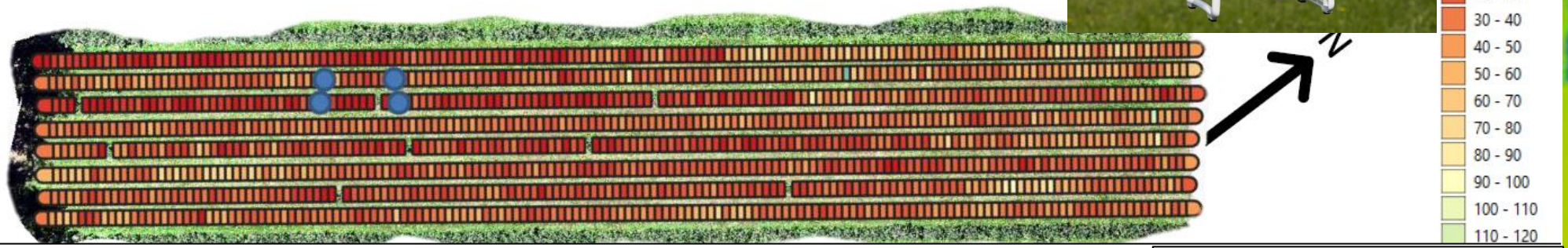
1. **Overhead (Micro-sprinkler) Cooling**
   - (*Bryla et al*: 15 mins/hr, when temps > 32C).
2. **Shade Cloth (Use a light colour, <u>not</u> black)**
   - Temporary Deployment over Tunnels
   - Permanent Shade-House structure
   - Retractable Shade Screen in Greenhouse.
3. **Reflective Covers**
   - Mica/Metallic particle Impregnated Plastics
   - Temporary Spray-on Coatings (Spray-Chalk).

Drones for Crop Vigour Assessment & Thermal Imaging Cameras

Vigour assessment of Blueberry Plantations by Drone (UAV)

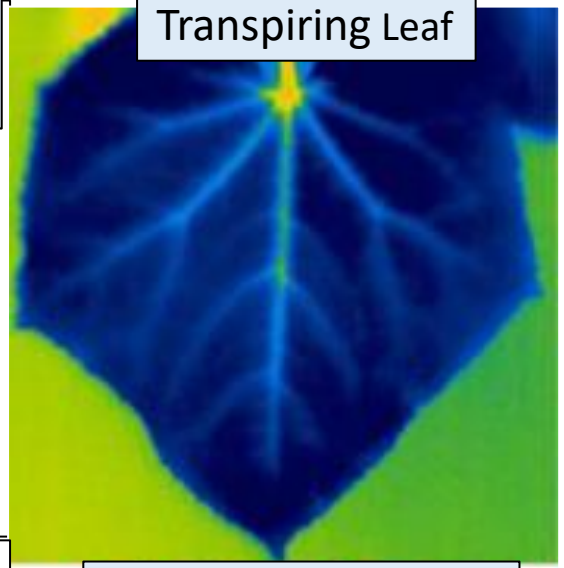
Plants on right upper part seems more vigorous

3e row from the bottom on the end seems more vigorous



Vigour Score

Transpiring Leaf



Thermal Imaging of Transpiring & Non-Transpiring Leaves

An actively transpiring plant leaf is **4-5C cooler** than the surrounding air.

A non-transpiring (stressed) leaf heats up.

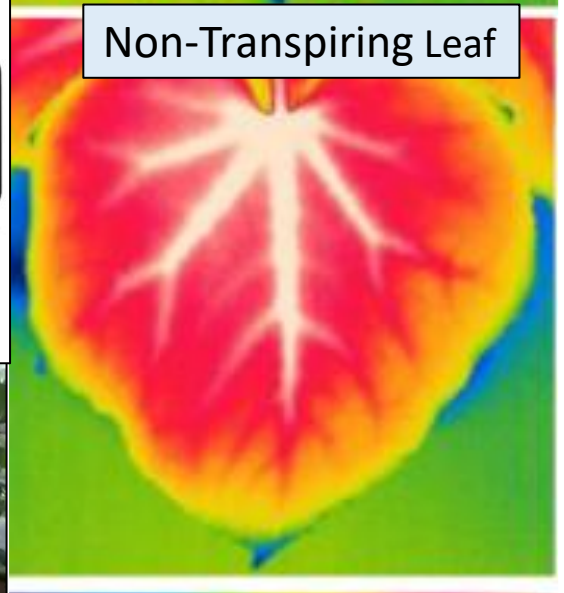
- Stressed leaves can be **5-7C warmer** than the surrounding air.
- (plant being cooked in its own juices!).
- Stress can be from: dry pots, high VPD, high wind speed, crop damage.

Thermal Imaging cameras can pictorially show plant stress:

- **before it becomes visually evident**.

Visual Wind-Stress

Non-Transpiring Leaf



Ambient Air Temp

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IBO SUMMIT 2023

Lublin, 3-6 July 2023

Thanks for your attention

Questions?