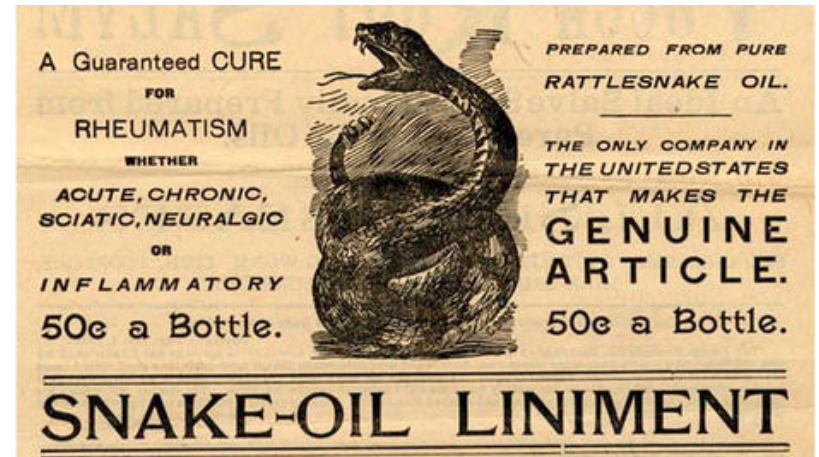


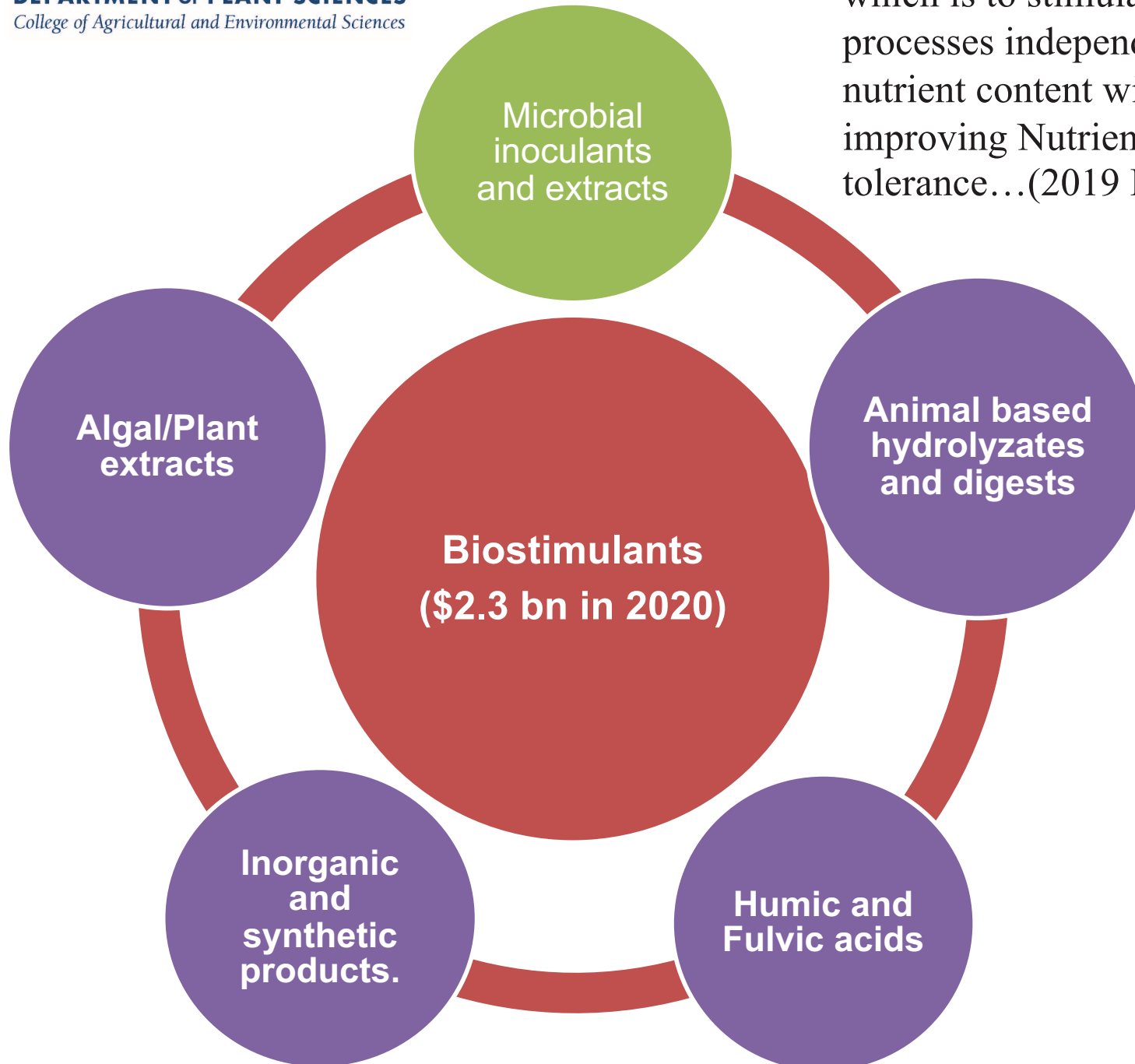
Biostimulants in Agriculture: Tomato Field Trials

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Snake Oils and Jungle Juices?





...an EU fertilising product the function of which is to stimulate plant nutrition processes independently of the product's nutrient content with the sole aim of improving Nutrient Use or Plant Stress tolerance...(2019 EU)

Physiological Rationale for Biostimulants

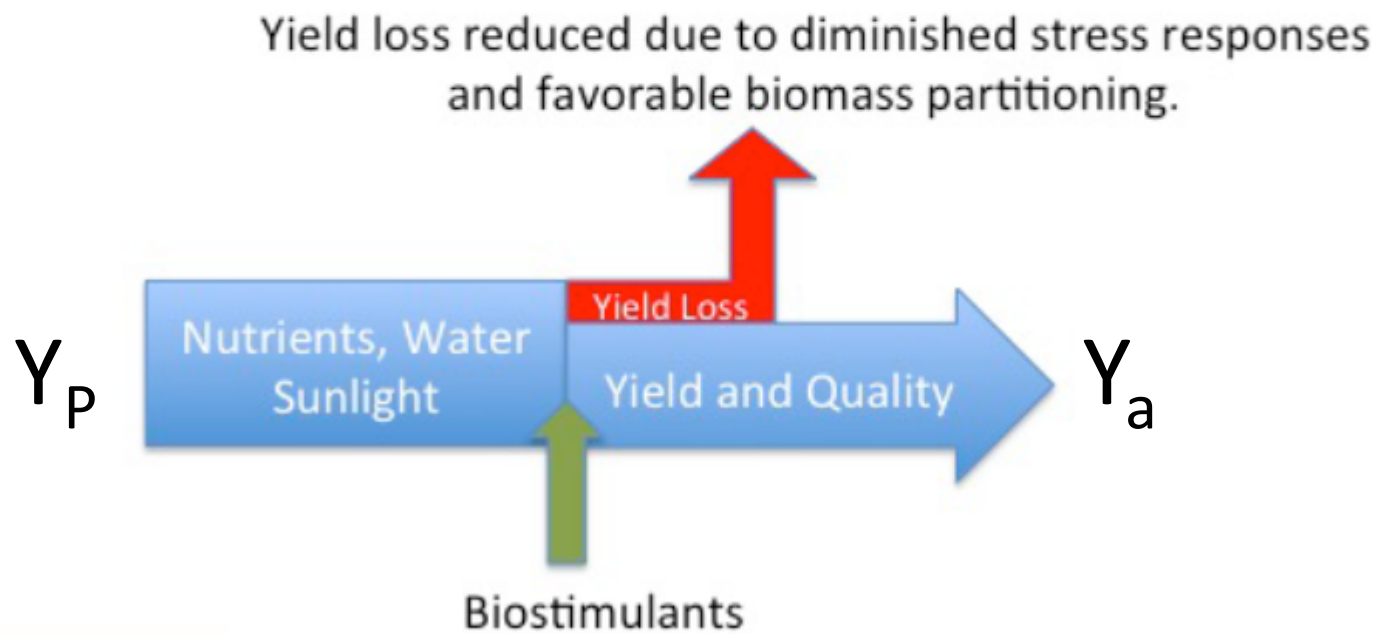
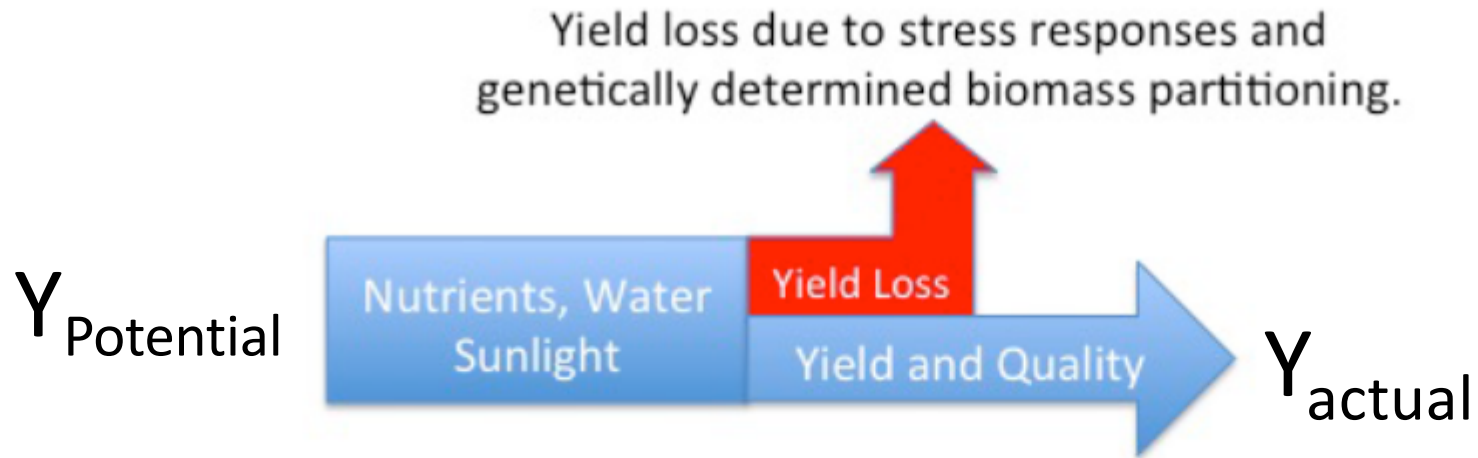
Stress Hypothesis

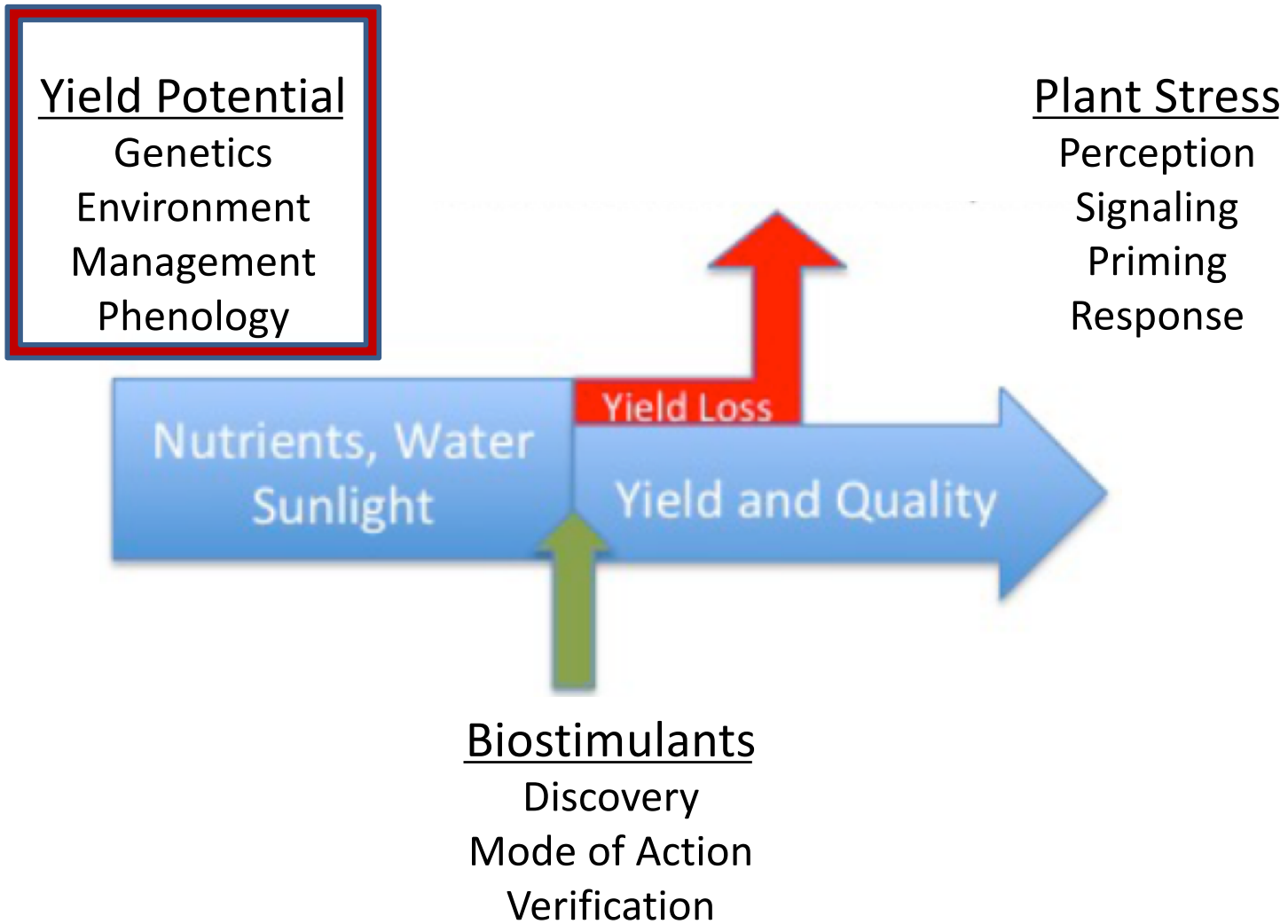
- Abiotic** 'stress' occurs in all environments and as a consequence yield rarely reaches full potential.
 - Biostimulants enable plants to respond more effectively to stress

Microbiome Hypothesis

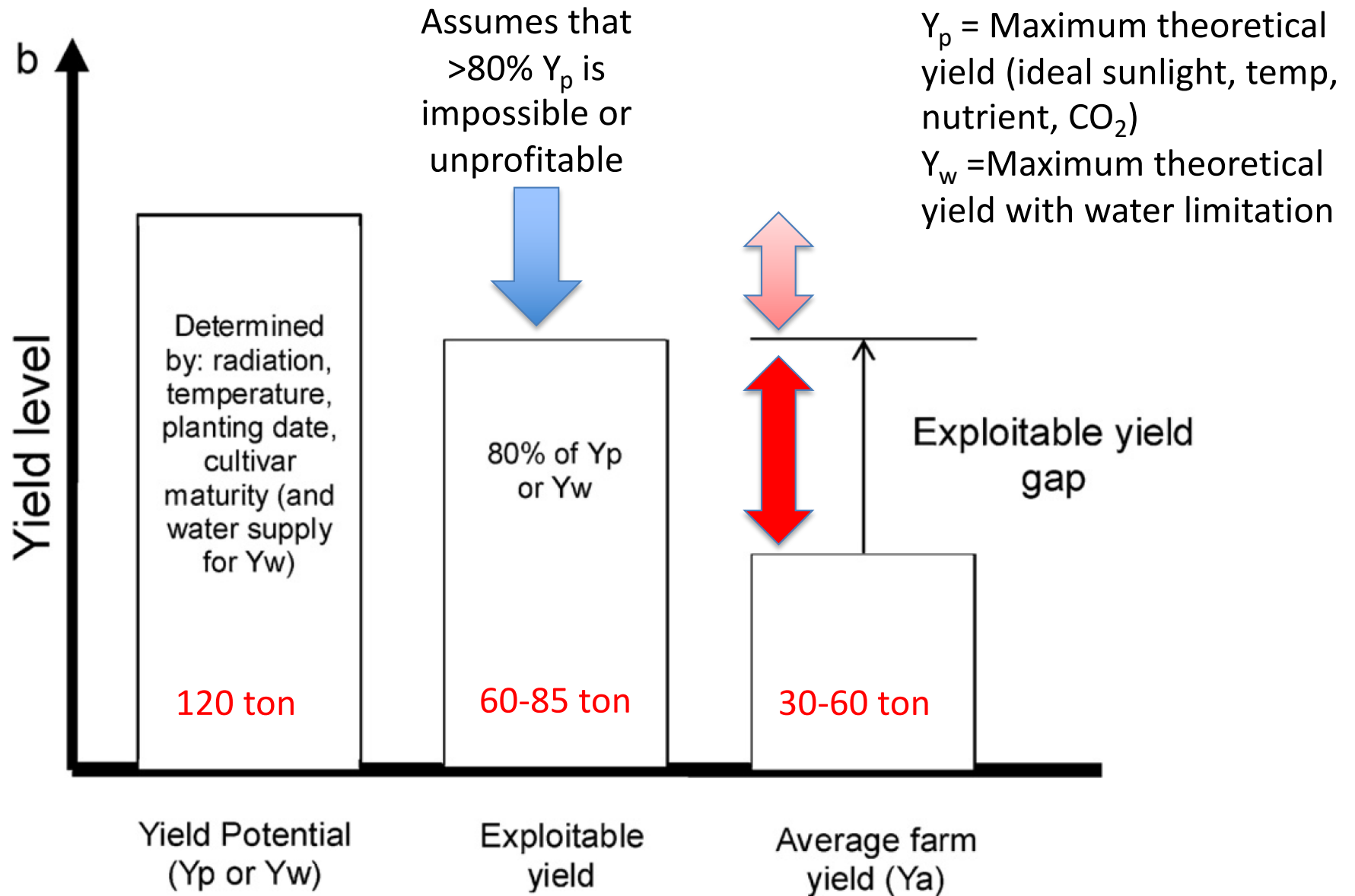
- Microbes in the environment have beneficial effects on crop growth primarily by modulating plant response to stress
 - Biostimulants can favorably alter the plant microbiome

**Drought, heat, mineral deficiency or toxicity, salinity etc.

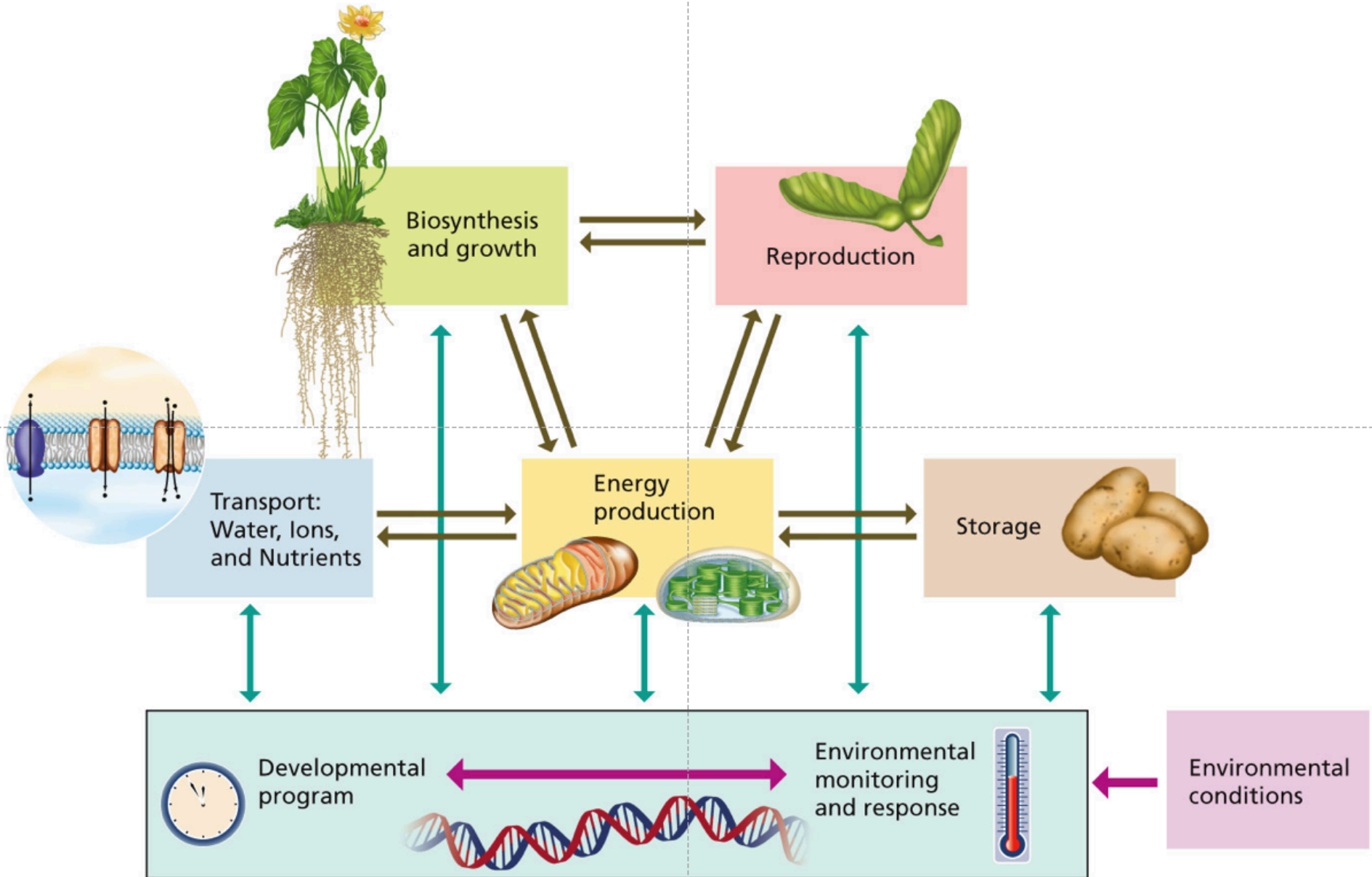




Yield Gap Analysis



Interactions between environmental conditions and plant development, growth, energy production, and ion and nutrient balance and storage



PLANT PHYSIOLOGY AND DEVELOPMENT 6e, Figure 24.1

MAIZE GROWTH STAGES

Flowering and Grain Fill

Disease and stalk borer control important

Critical moisture requirement

Heat, Drought, Wind,
N-P-K-Ca-Zn-B

Rapid Vegetative

Germination and
Emergence
Weed control

Cold, Waterlogging,
Drought, N-P-K
Zn-Mn

Hidden stresses occur in the growth of all crops and this reduces yield.

Questions:

- What are these stresses and how do plants react?
- Can we identify, prevent or mitigate these stresses?



V0	V2	V5	V8	V10	V12	V14	VT	R1	R2 - R3	R3 - R4	R5 - R6
Days after Emergence*											
0	7	21	32	38	44	49	56	63	70 77 84	91 98 105	112 119 160
Germination and emergence. Planting depth 5-8 cm.	Plant population established. Growth point 20-25 mm below surface. 5 Leaf – cob and tassel initiation.	Cob development.	Active growth – leaves and cob development. Brace root development. 12 Leaf – cob size determined.	Pollination. 5-10 Days.	Kernel development.	Grain filling. Nutrients are transported to cob.	Physiological maturity. End of mass gain.	Ready for harvest. 14% Moisture.			
Vegetative Growth Stages							Reproductive Development Stages				

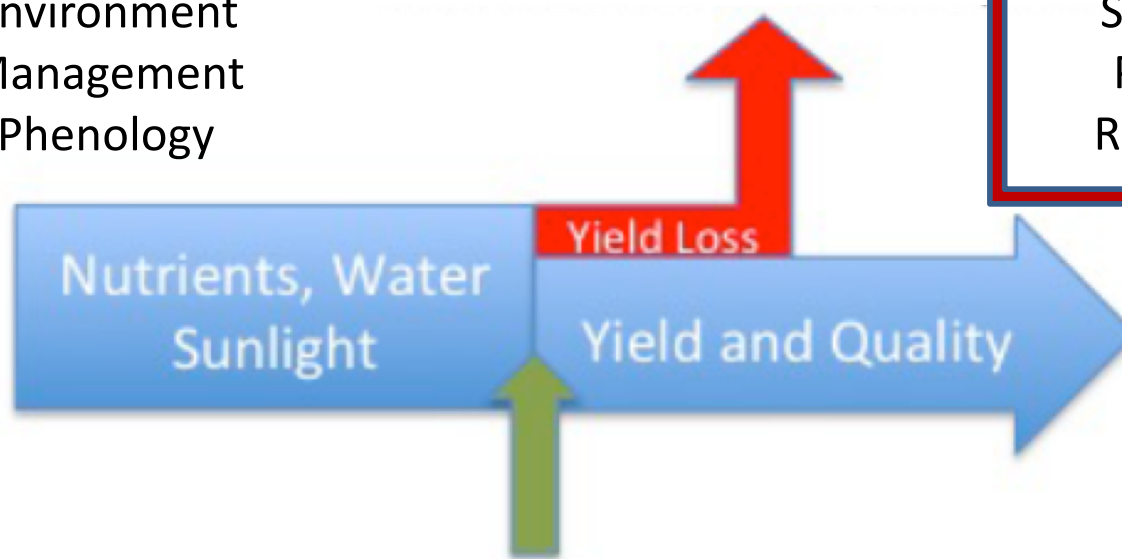
* The number of days varies between different growth classes and environments.

Yield Potential

Genetics
Environment
Management
Phenology

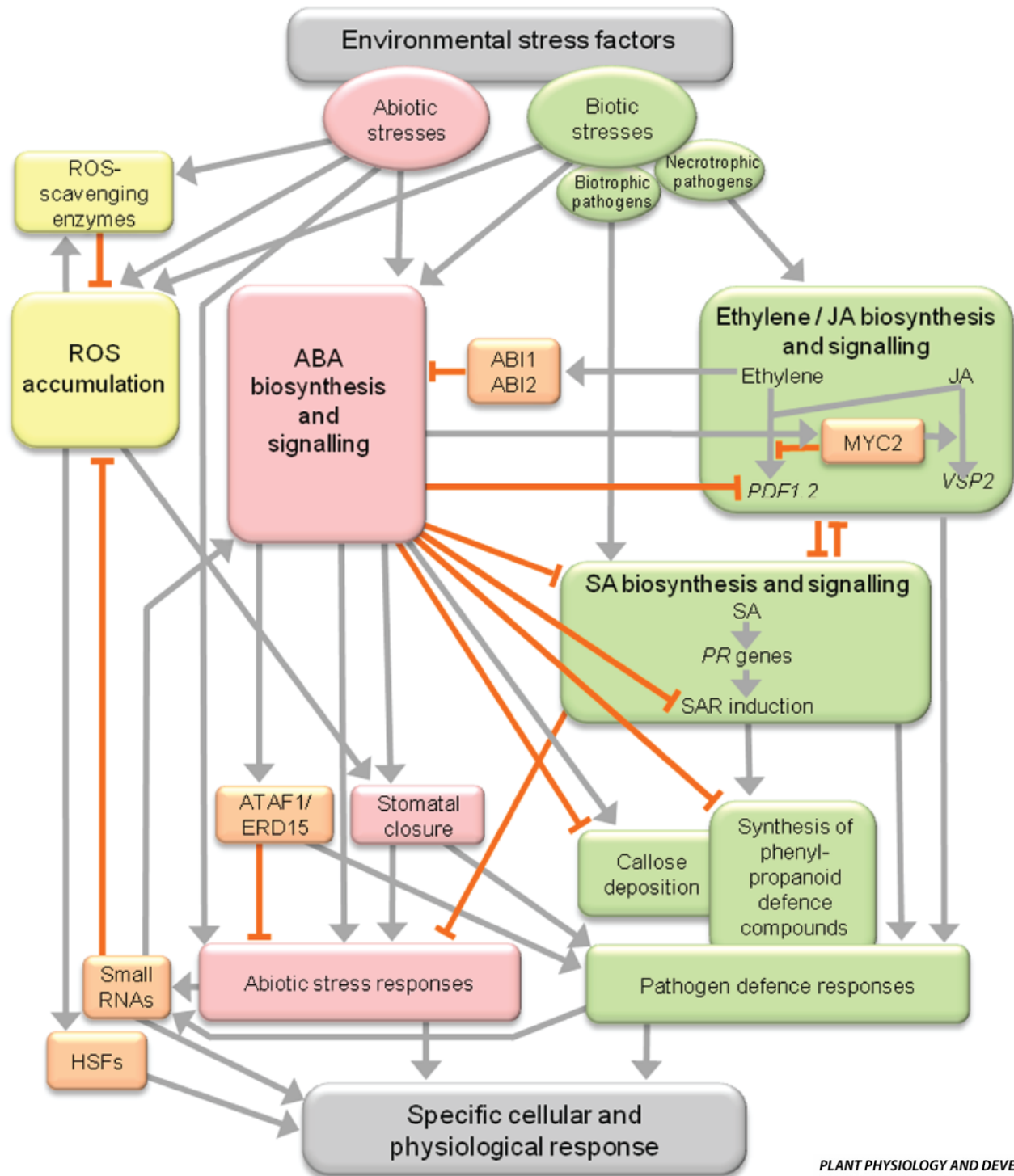
Plant Stress

Perception
Signaling
Priming
Response



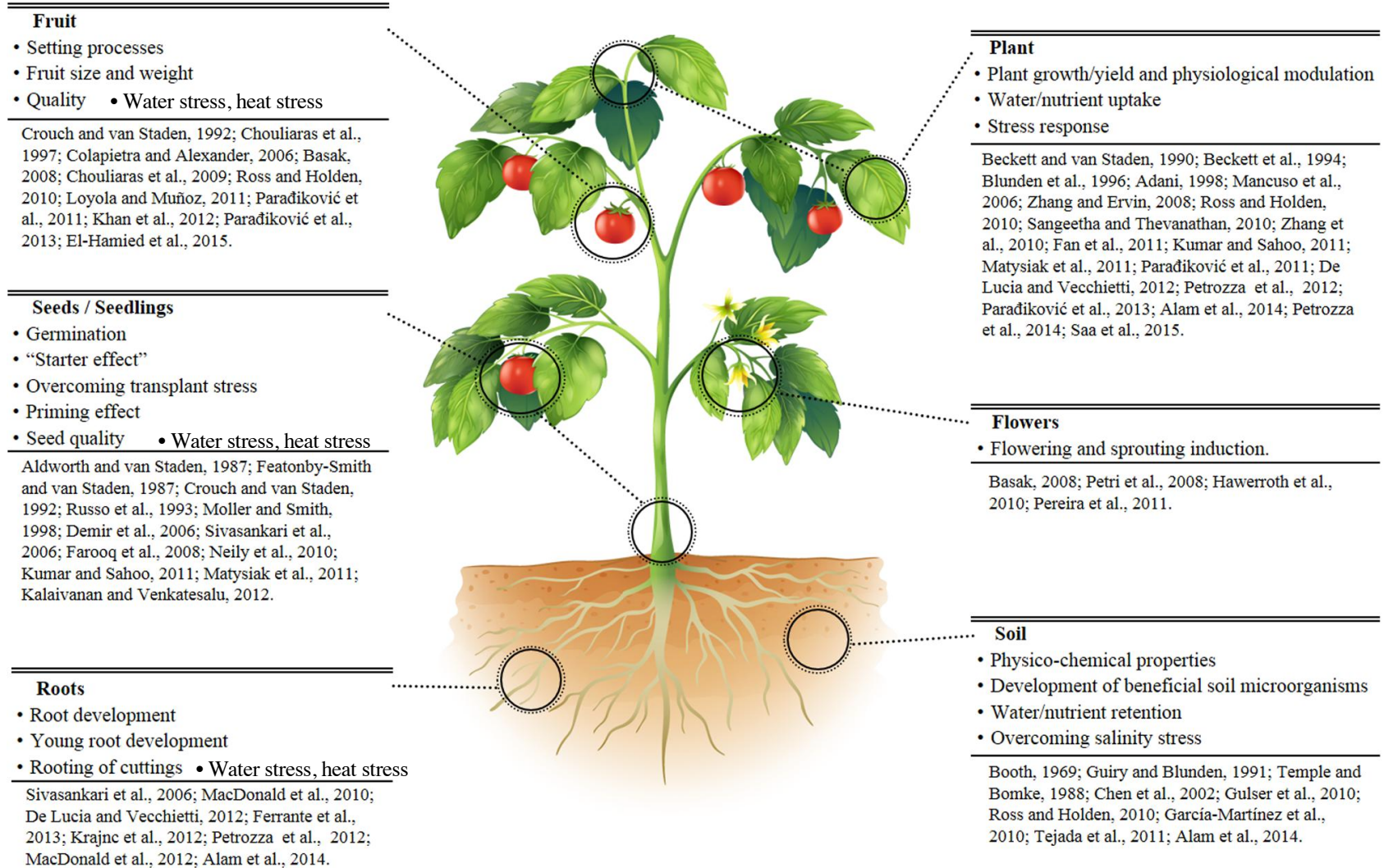
Biostimulants

Discovery
Mode of Action
Verification



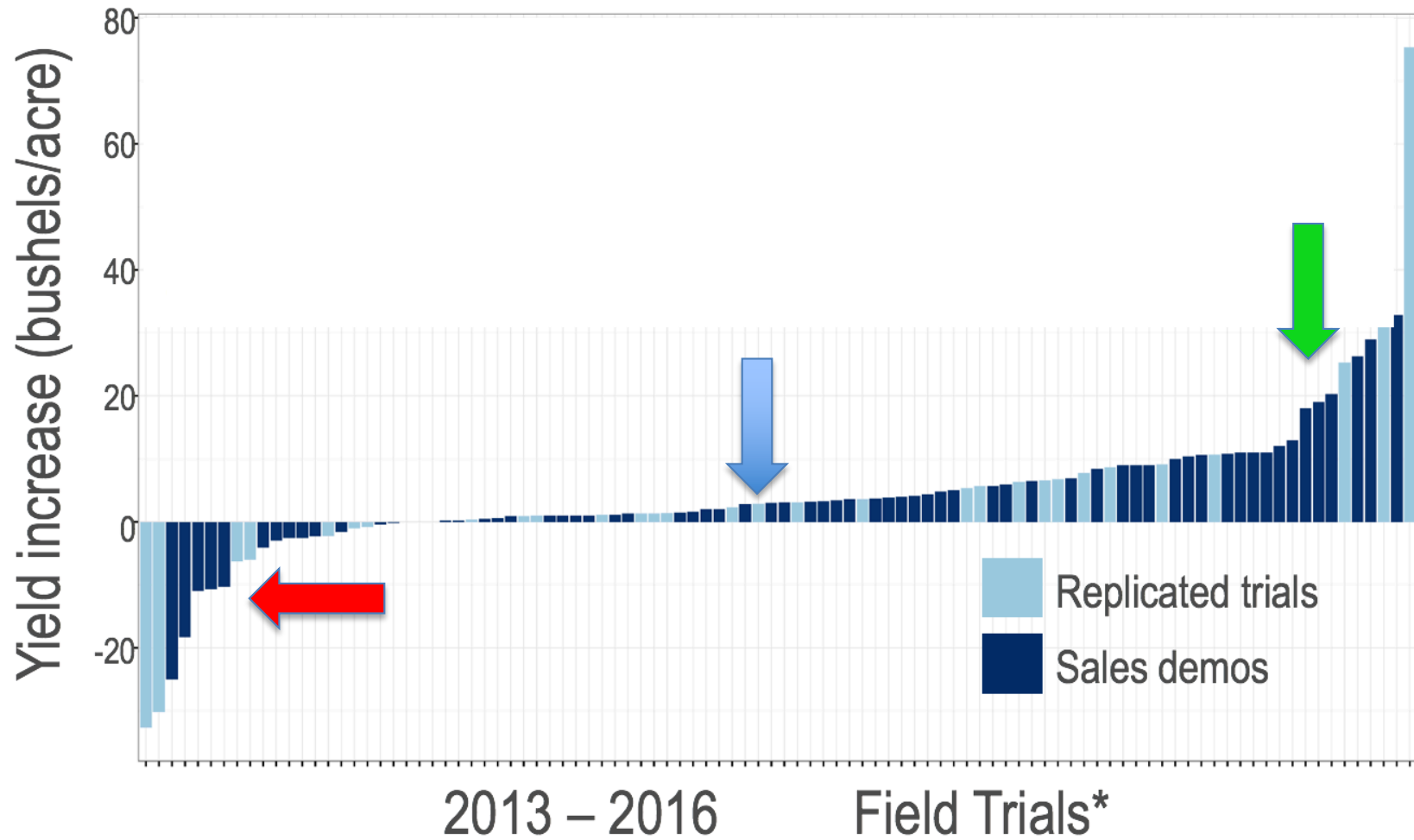
Is it possible for a biostimulant to positively influence plant response to stress?

Many examples of biostimulant responses. Mostly in pot trials, frequently highly variable response.

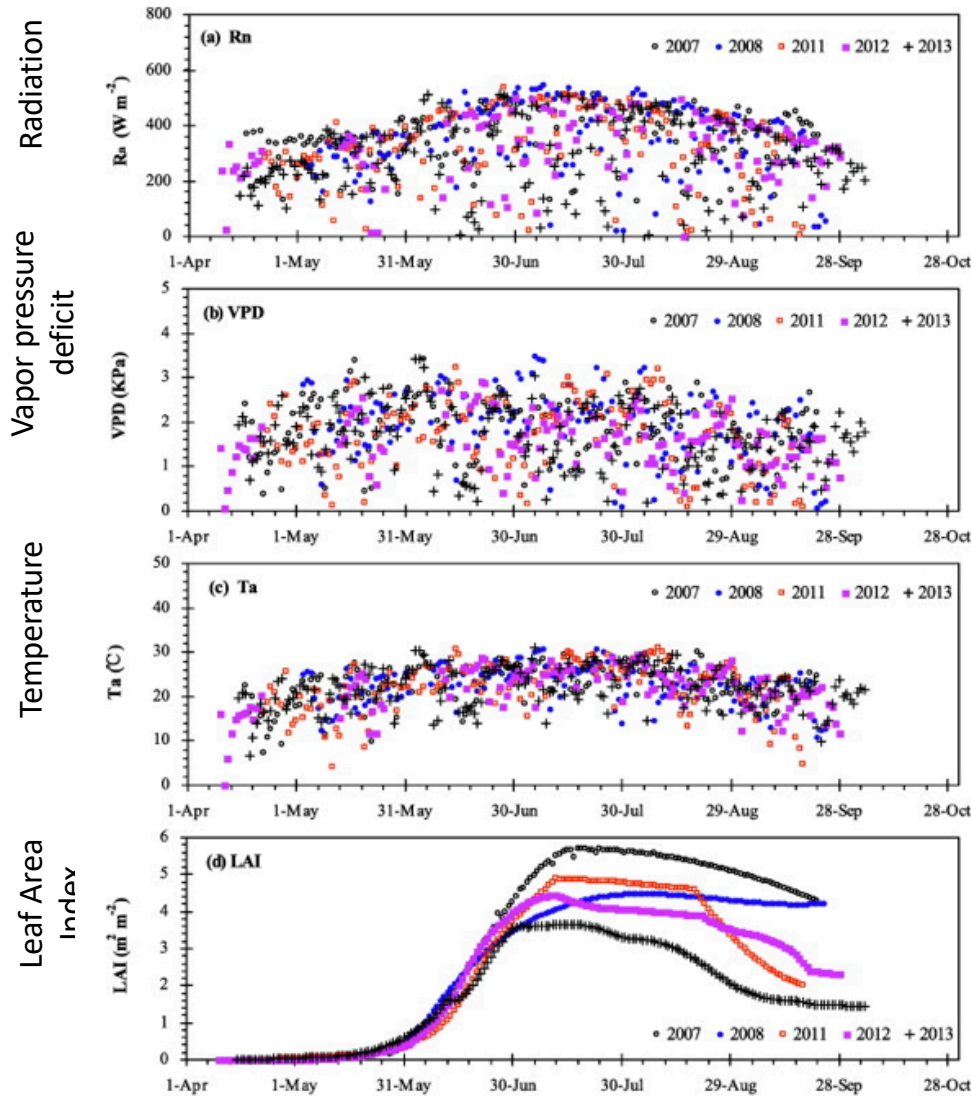


Testing Biostimulants

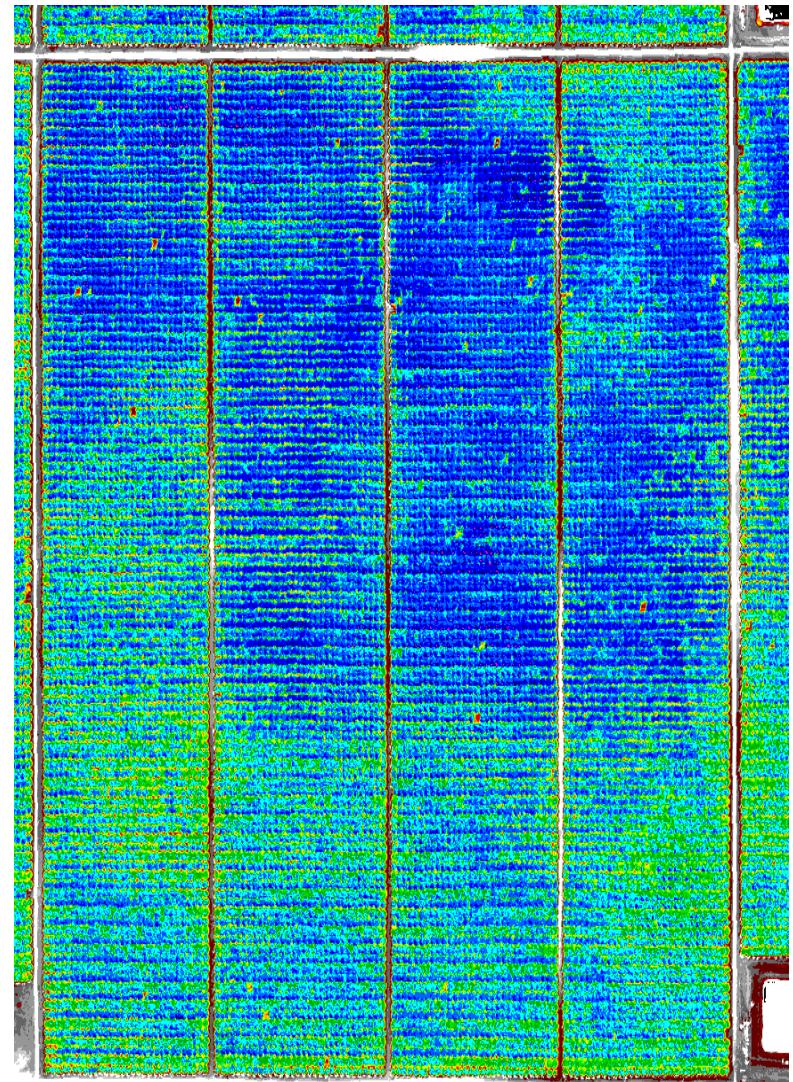
150 Trials and Demos



Stress varies with season and location. Precision Ag and biostimulants clearly intersect.



Seasonal Variability in Environment



Spatial Variability in Environment
(RGB image of leaf Area)

Stress Hypothesis:

- Abiotic stress limits crop productivity and select biostimulants have been shown to mitigate this stress
- Rarely is a single stress present, more commonly multiple stress occurs together (Drought and heat, salinity and water stress...)
- The pathways involved in stress perception and response are complex and poorly understood- results WILL be unpredictable

Questions: If biostimulants help plants 'protect' themselves against stress, how do we predict if and when a stress will occur?

Can a single biostimulant work against multiple stresses?

If a biostimulant is applied but no stress occurs, do we lose yield?

UC DAVIS BIOSTIMULANT FIELD SCREENING TRIAL

2018 (10 acre) and 2019 (5 acre)

Each plot 3 rows x 100 foot (8 replicates each)

Treatments:

- 12 Biostimulants applied at commercial timings and rates
- Full irrigation then: 30%ETa and 70% ETa after day 66

Measurements:

- Every environmental and plant data-point you can imagine!
- Yield, Brix

(70% Eta plots yielded 79 and 70 ton)

Environmental Monitoring

Tule Tower



Weather Station



Flow Meters



Plant Monitoring





Days After Transplant: 1 - 66

Control - 100% ET

Control - 100% ET

Control - 100% ET

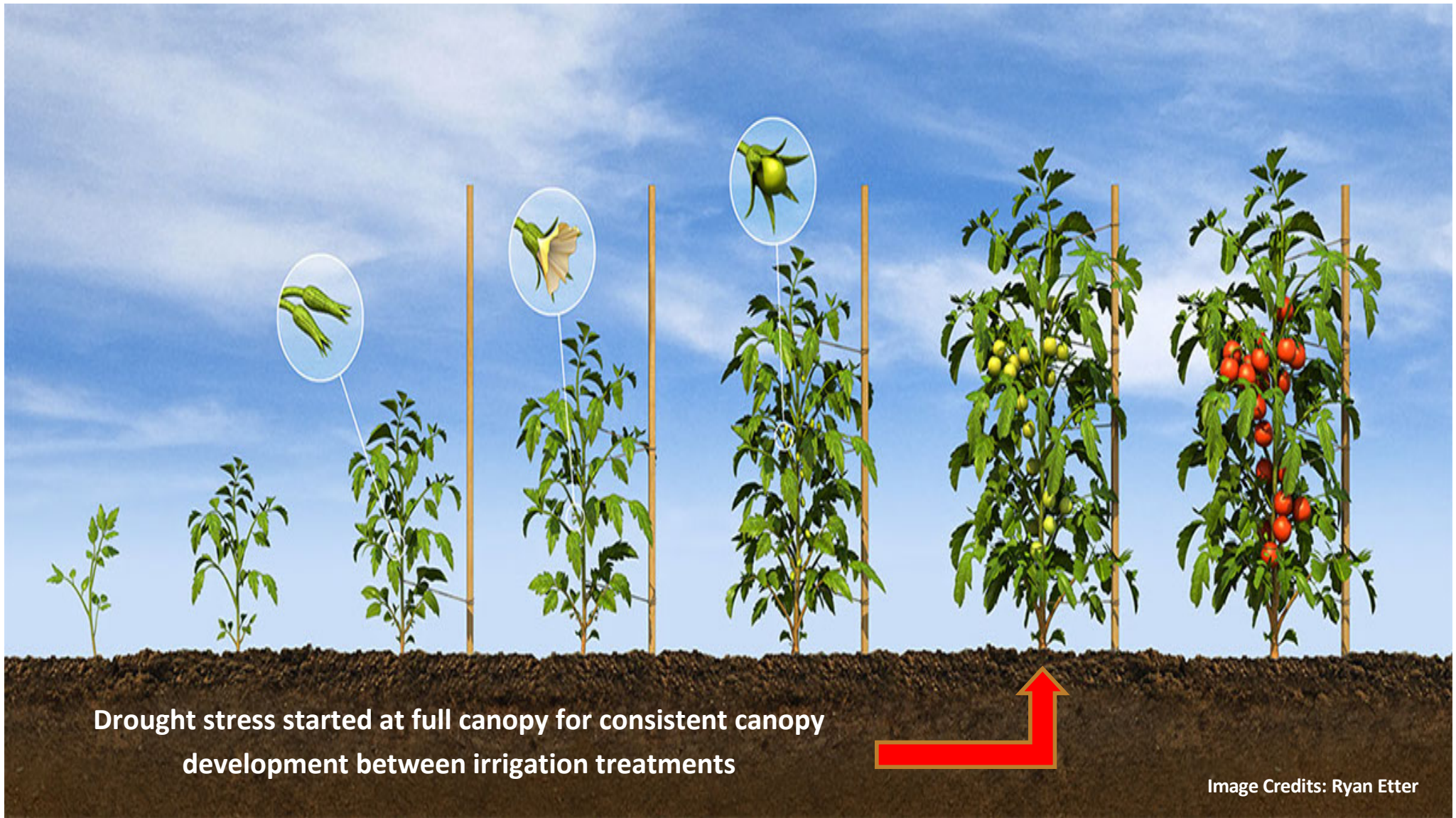
Control - 100% ET

Control - 100% ET

Control - 100% ET

Control - 100% ET

Control - 100% ET



Drought stress started at full canopy for consistent canopy development between irrigation treatments

Image Credits: Ryan Etter

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Days After Transplant: 67 - 113

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

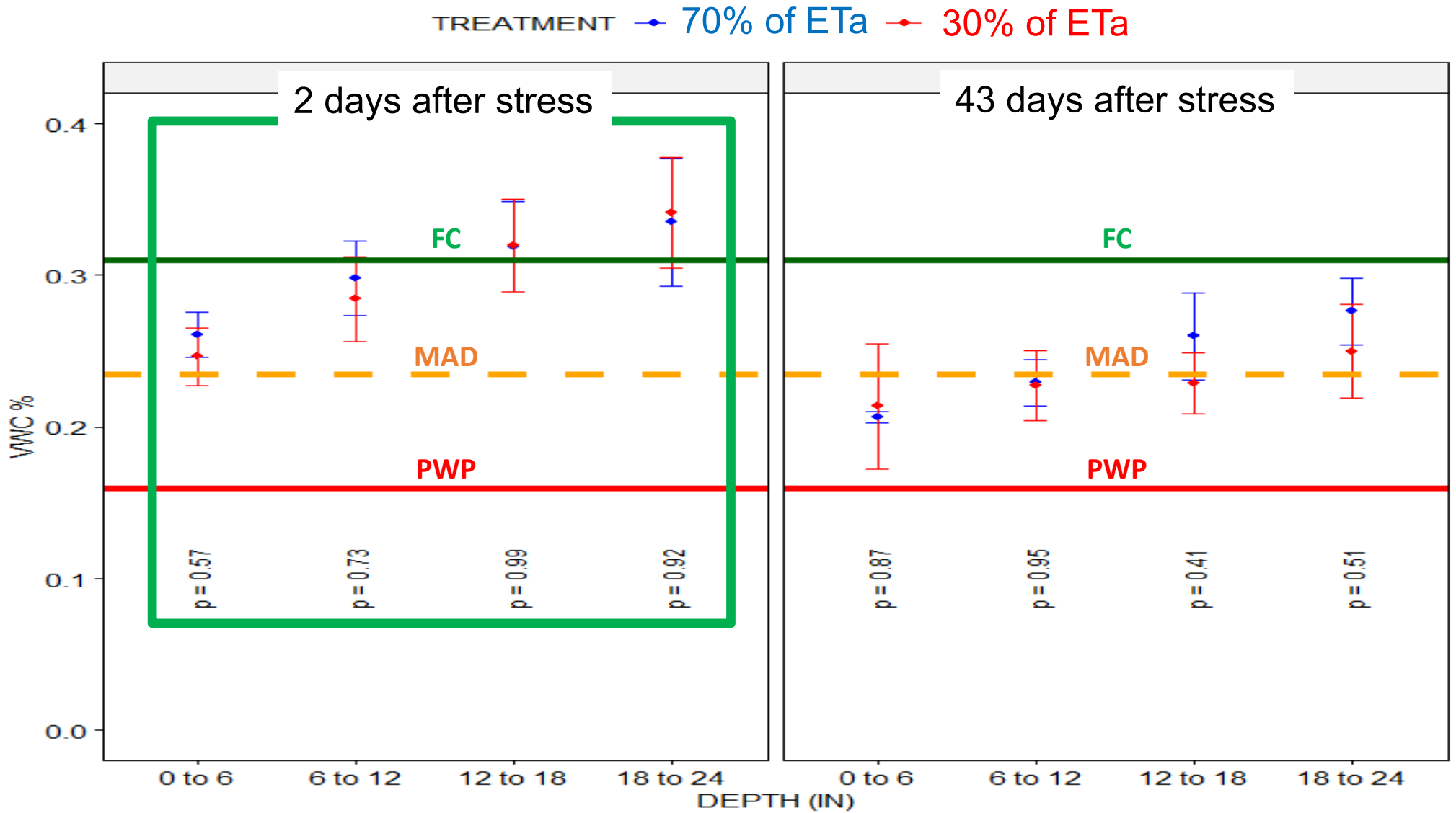
Biostim - 30% ET
Biostim - 70% ET

Control - 30% ET
Control - 70% ET

Biostim - 30% ET
Biostim - 70% ET

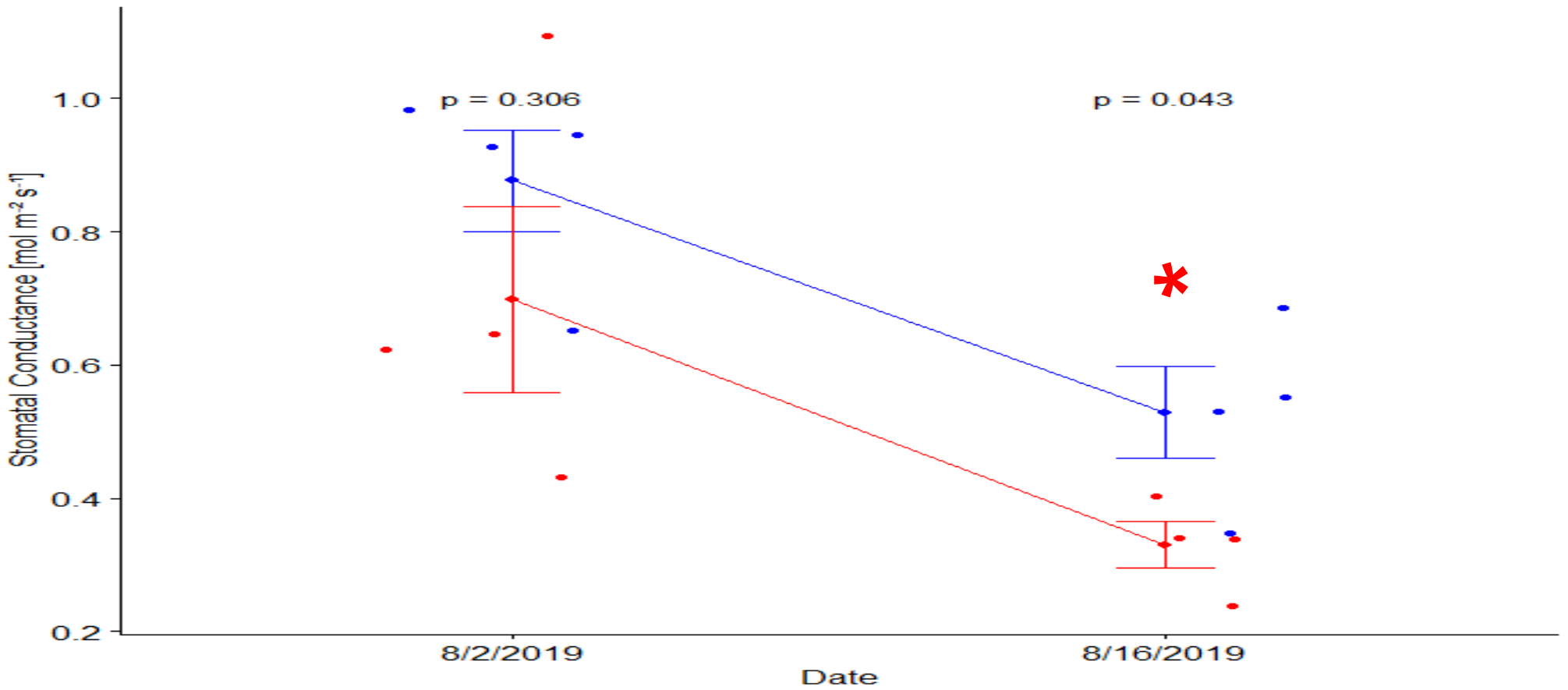
Soil Volumetric Water Content

Irrigation Reduction at Day 66 clearly depleted soil water by 12 days after stress treatment

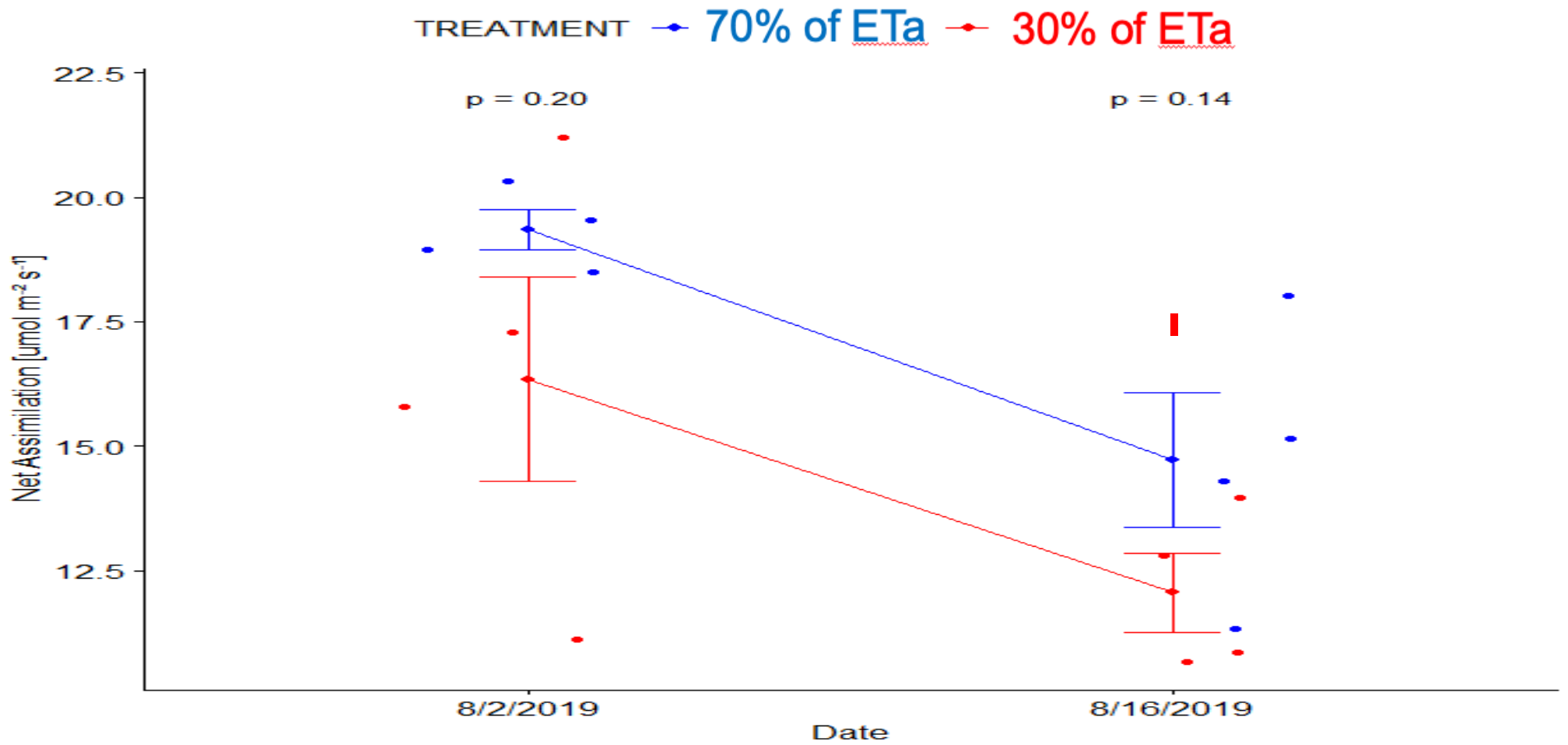


STOMATAL CONDUCTANCE:

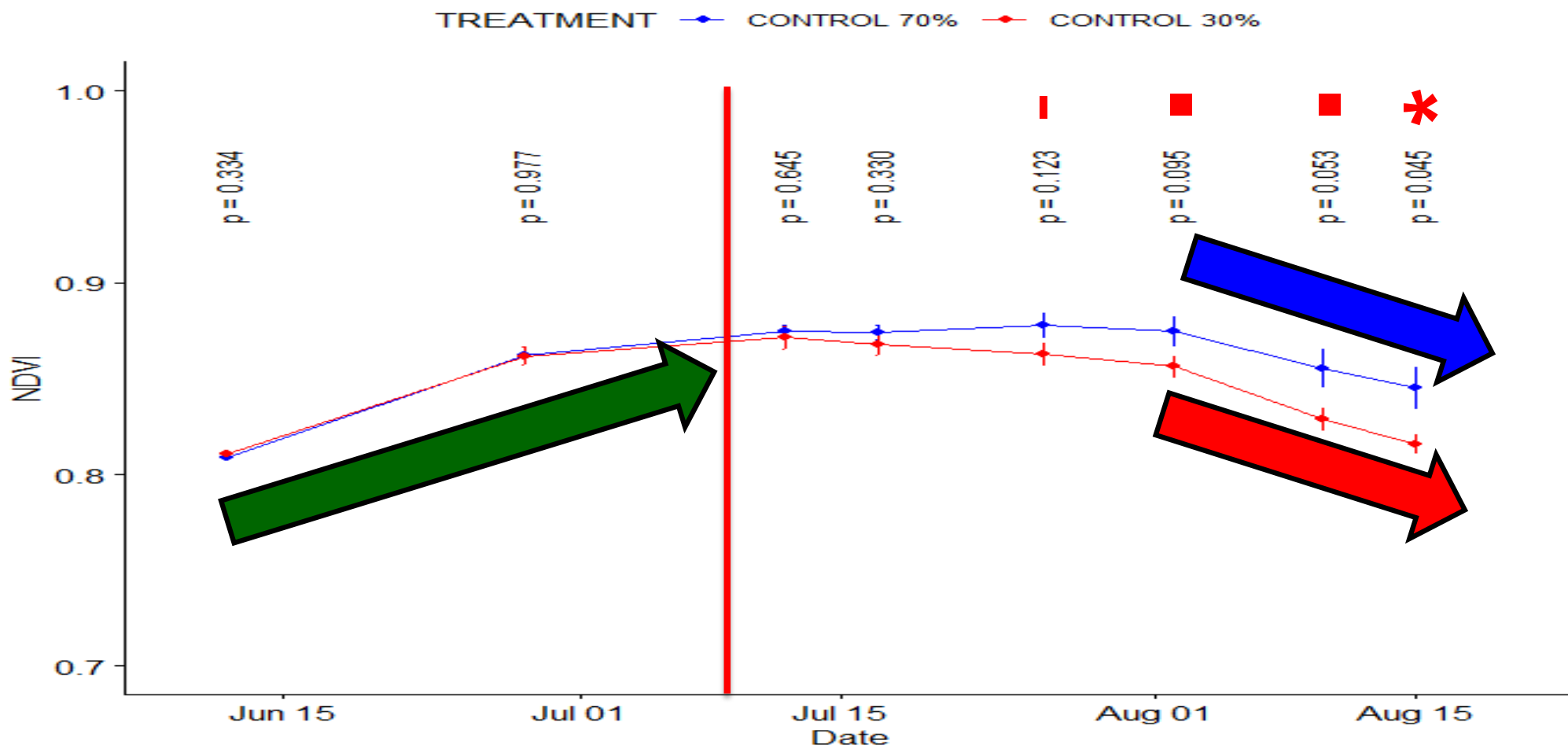
TREATMENT —●— 70% of ETa —●— 30% of ETa



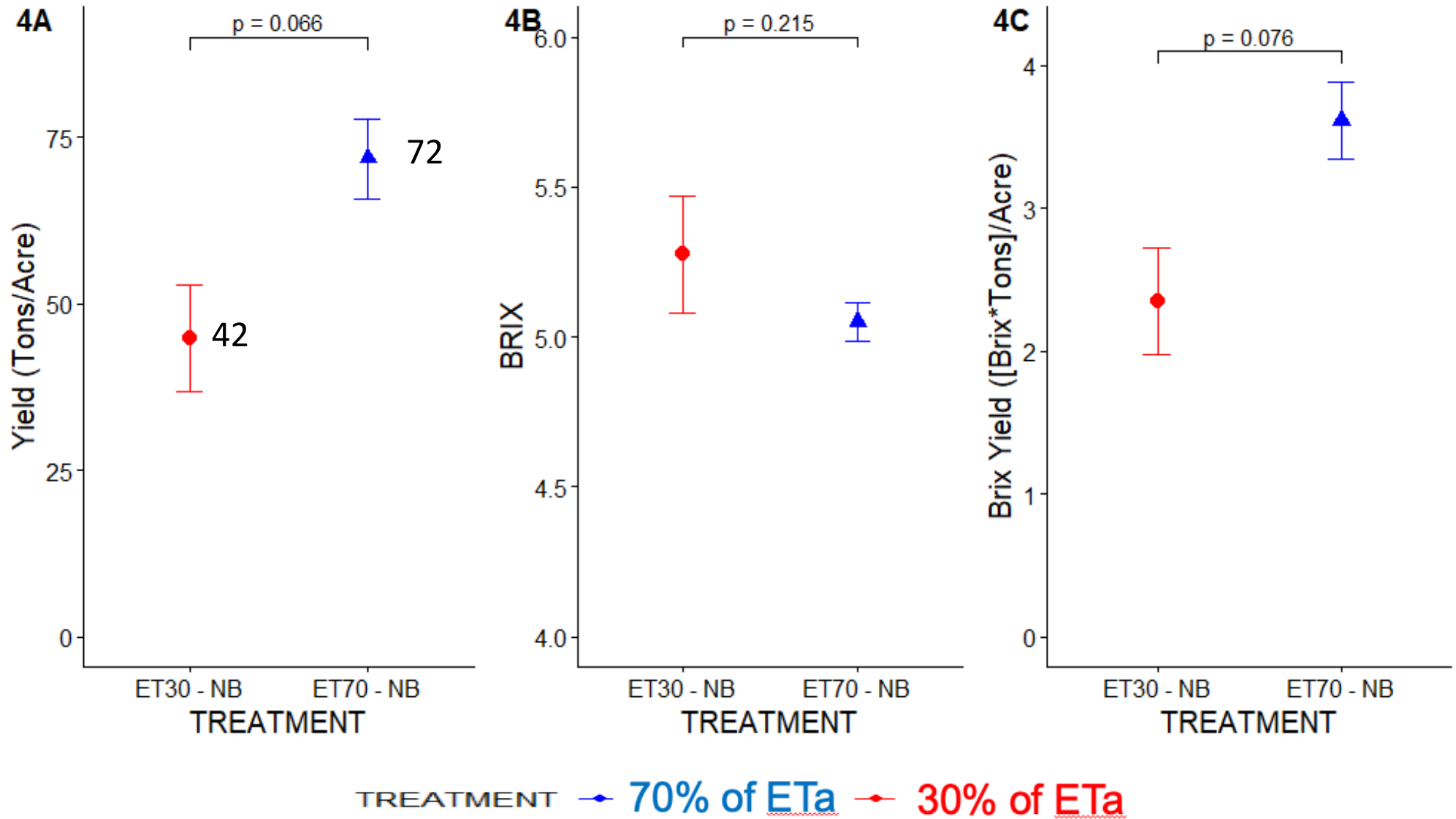
PHOTOSYNTHESIS:



NDVI BY DRONE: (canopy cover /canopy 'health')



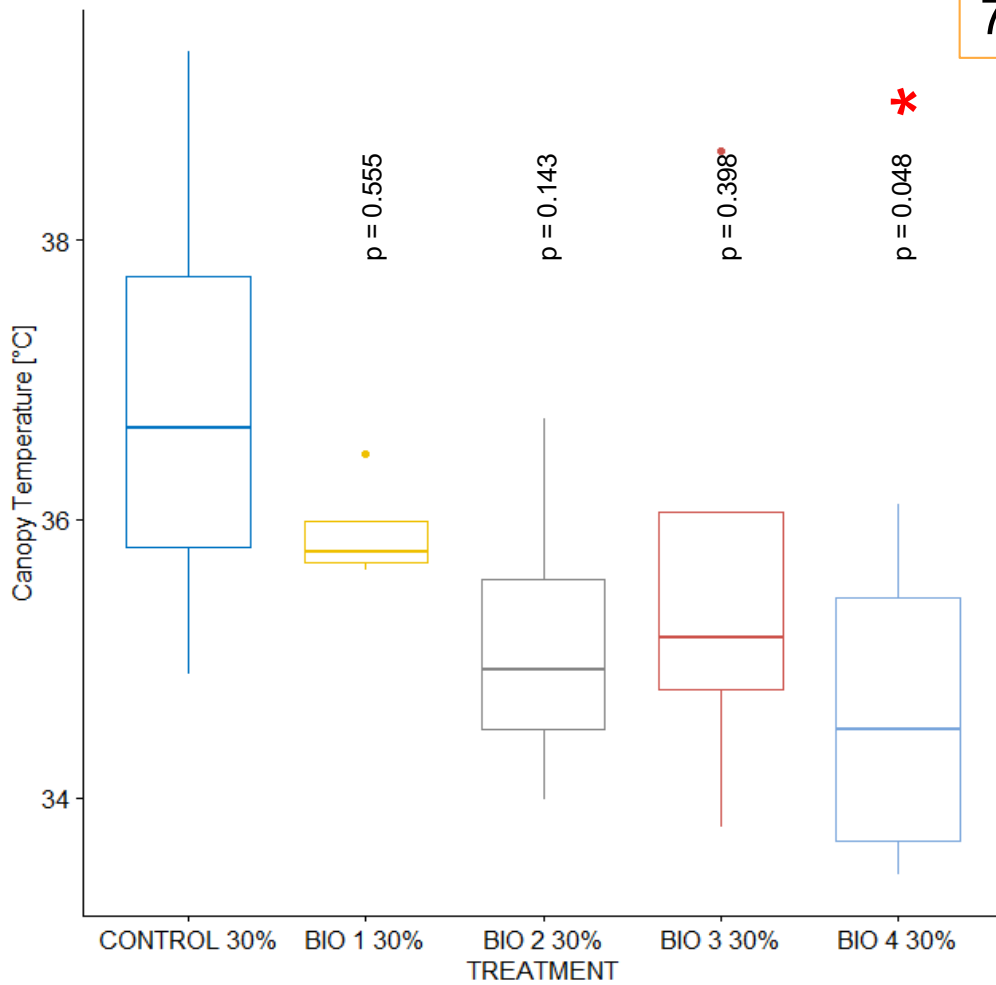
Water Stress and High Late Season Canopy Temperature Compromise Yield



Effect of Biostimulants on Canopy Temperature and Yield

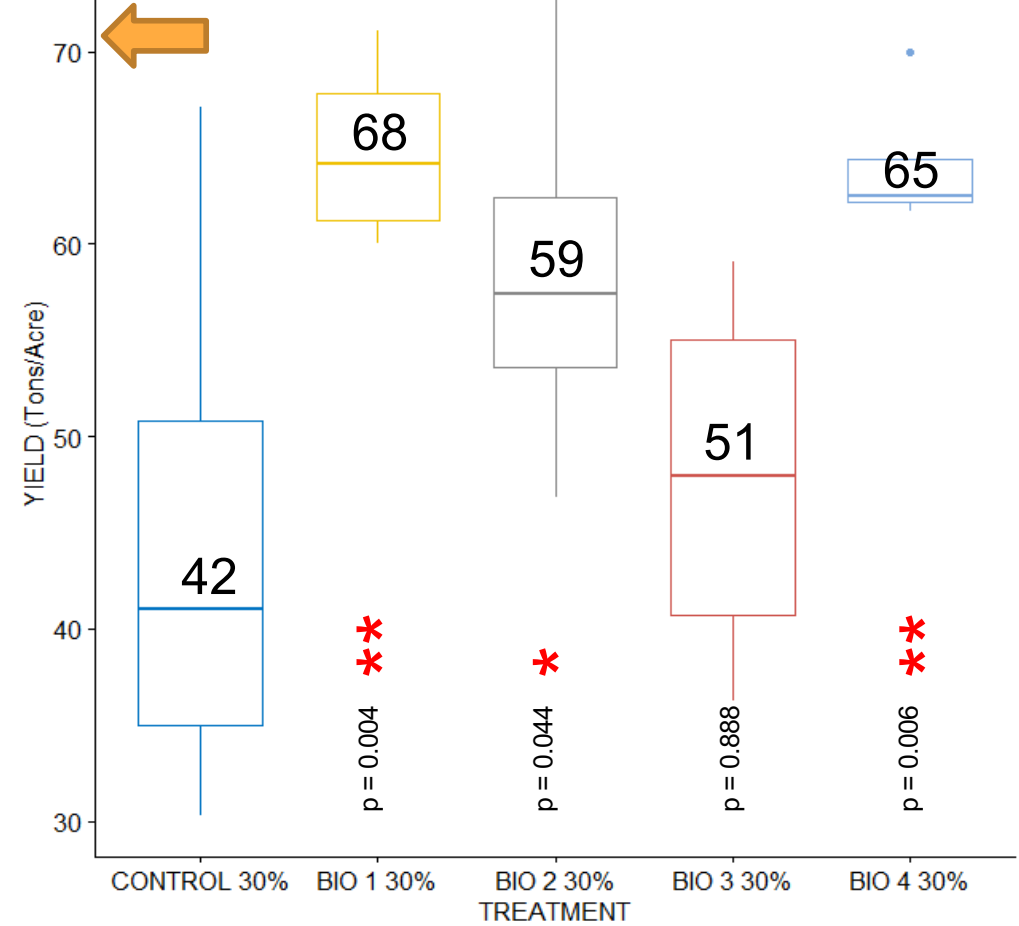
38 Days after Stress

CANOPY TEMPERATURES BY TREATMENT

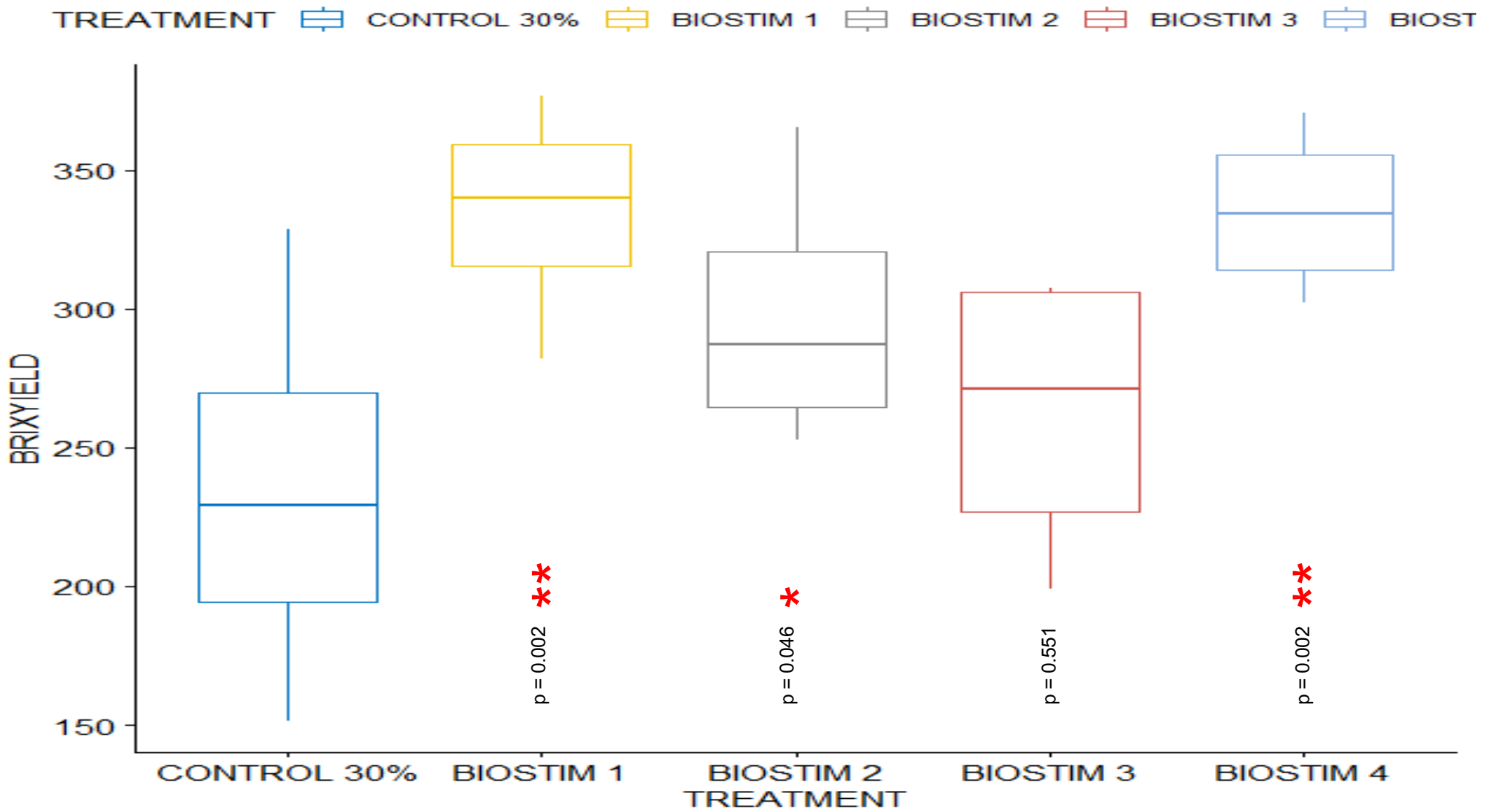


YIELD BY TREATMENT (ton)

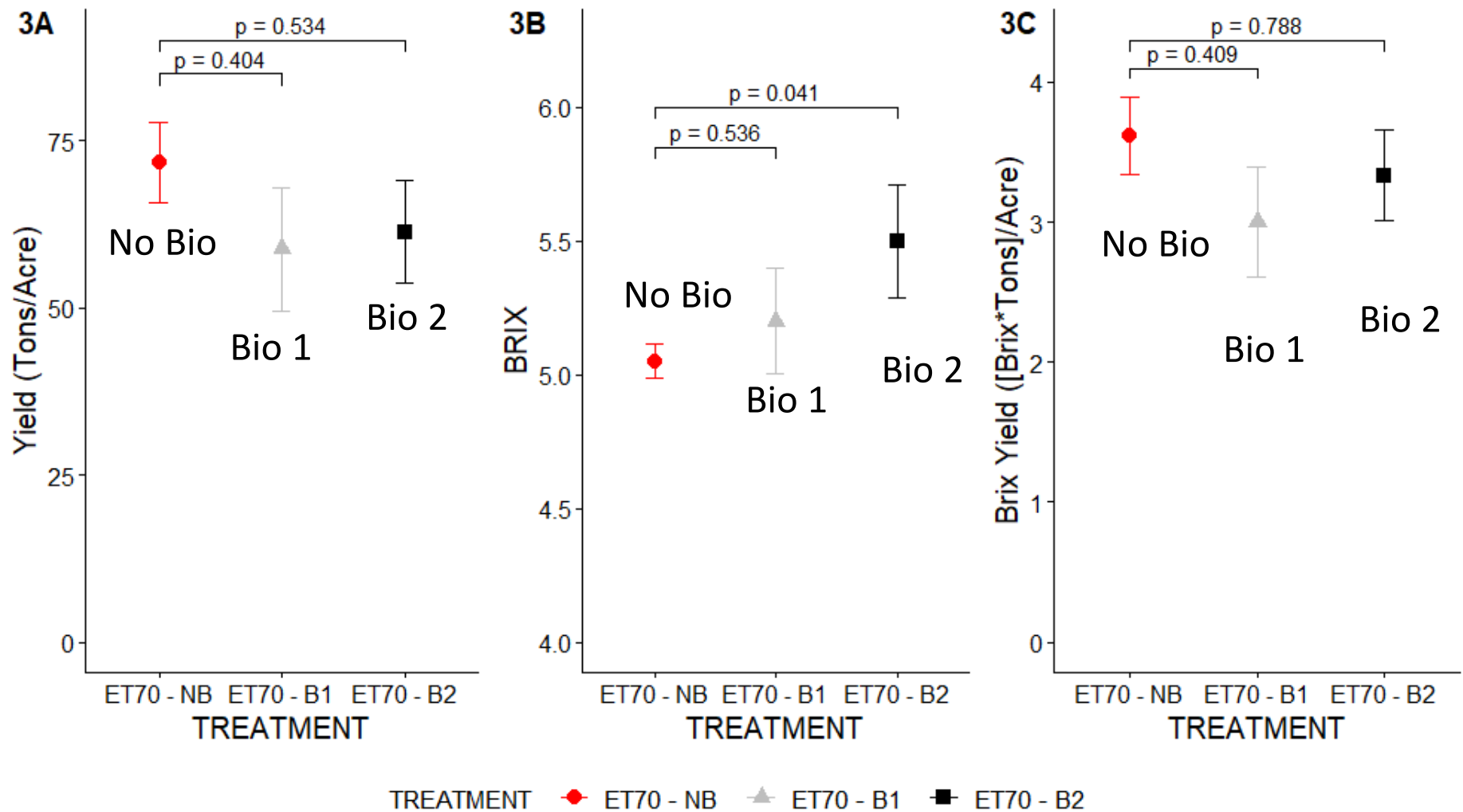
72 (yield at 70% ET)



Effect of Biostimulants on Brix Yield



No Effect of Biostimulants on Yield @ 70% ETa (day 66 onwards)



Summary

- Abiotic stress limits crop productivity and select biostimulants have been shown to mitigate this stress
- In the absence of a stress, no benefit was seen.
- The physiological explanation for the effect is still under investigation.
- There is some evidence for a negative effect of biostimulant use when no stress occurs
- Very few biostimulants have been tested rigorously, but the best show promise.



Thank You



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