Phenotyping and remote sensing to facilitate minimum data set requirements for crop simulation modelling

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Phenotyping and remote sensing to facilitate minimum data set requirements for crop simulation modelling

- Crop models require extensive and/or intensive data sets to drive simulations
- Some data require significant resources such as green area index, light interception and water and nitrogen availability in the soil.
- As a result, the vast majority of field data sets are not 'model friendly'
- Discuss how high throughput phenotyping can supplement or potentially serve as proxies for some of the harder to phenotype traits required, in different modelling contexts.

BREEDER FRIENDLY PHENOTYPING

1. Low resolution stereoscopic spectral radiometer (eyes) + supercomputer (brain).

Trait class / Approach:

Handy-visual

Application / Traits:

Phenology, canopy architecture, disease, pests

2. Greenseeker for NDVI.
3. IR thermometer for canopy temperature.

Trait class / Approach:

Handy-physiological

- NDVI/SPAD
- IR thermometer

Application / Traits:

Ground cover, green area, biomass, leaf greenness

Canopy temp: fitness, root depth/capacity

4. Drone for IR and spectral images.
5. Phenocart.

Trait class / Approach:

High throughput

Application / Traits:

Spectral indices, thermal (IR) images

6. Root growth analysis.
7. Canopy growth analysis.

Trait class / Approach:

Precision

Application / Traits:

Growth analysis, above and below ground

- Radiation use efficiency, tiller dynamics
- Partitioning of N and C to different organs
- Root dry weight, depth, architecture

Direct measurement (not shown in photos)

- Energy use efficiency (photosynhtesis/respiration)
- Transpiration
- Chorophyll fluorescence
- Leaf water potential

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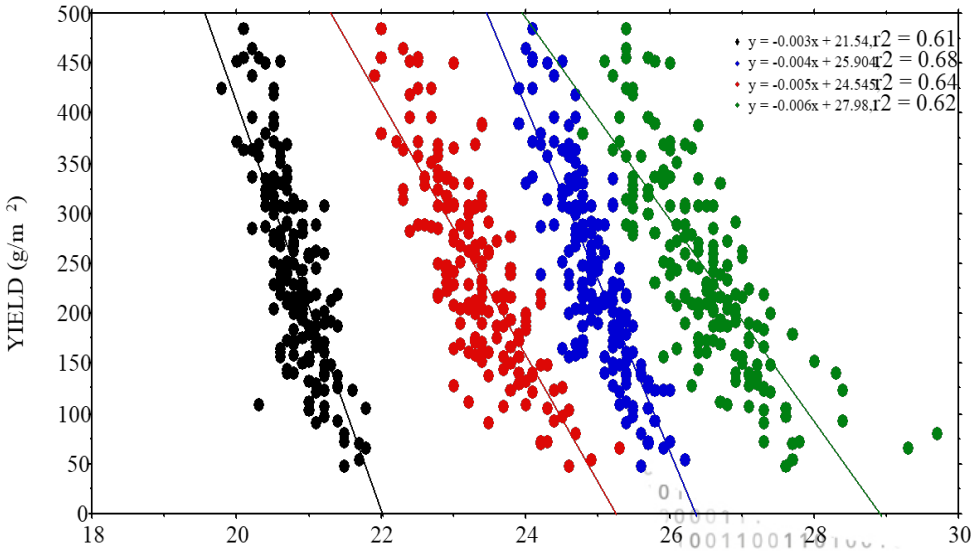
Canopy temperature (CT)
correlated with yield under drought & heat stress

Seri/Babax RILs



CT under drought, at different growth stages and times of day

Using NDVI (Greenseeker) to improve NUE

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Aerial remote sensing

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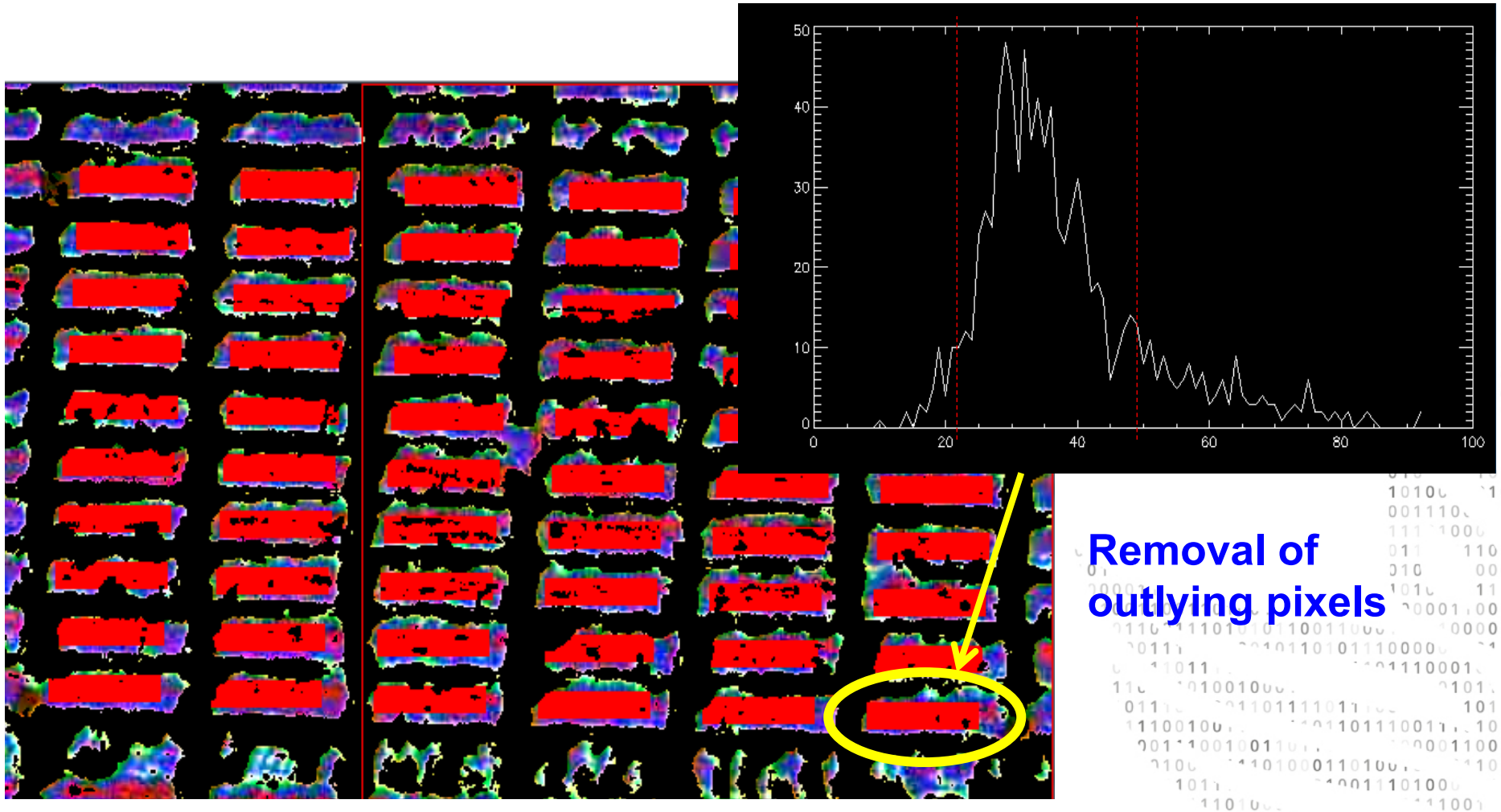
Tattaris M, Reynolds MP, Chapman SC, 2016.
A direct comparison of remote sensing approaches for high-throughput phenotyping in plant breeding.
Front. Plant Sci. 7: 1131.

Thermal imagery: Data processing



Removal of outlying pixels

Tattaris, Reynolds, Chapman, 2016. A direct comparison of remote sensing approaches for high-throughput phenotyping in plant breeding. Front. Plant Sci. 7: 1131

Not so ‘breeder friendly’ phenotyping

Deep root profiles under drought stress

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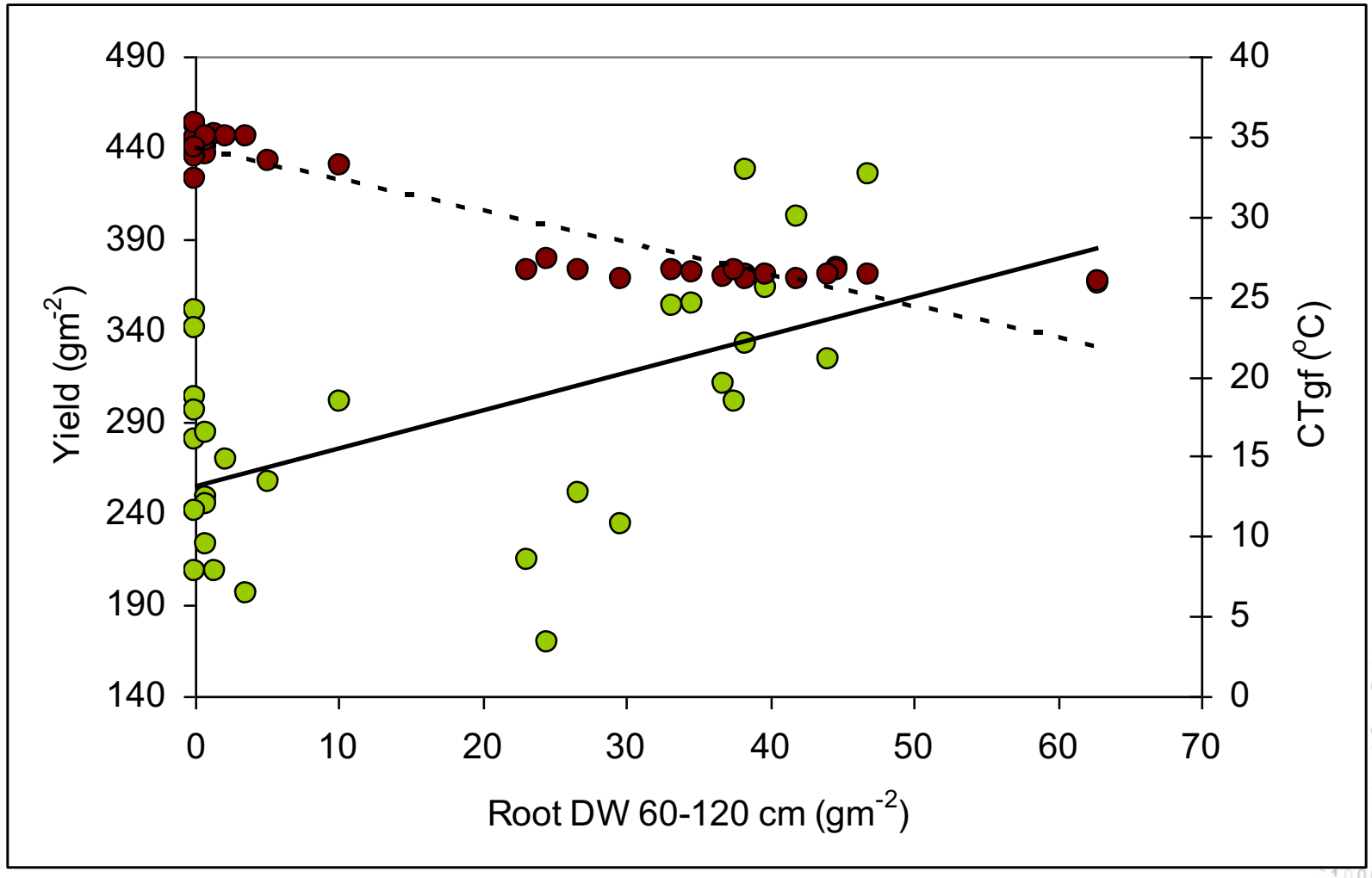

Lopes MS and Reynolds MP, 2010. Partitioning of assimilates to deeper roots is associated with cooler canopies and increased yield under drought in wheat. *Functional Plant Biology* 37:147-156

Remote sensing estimates of Canopy N

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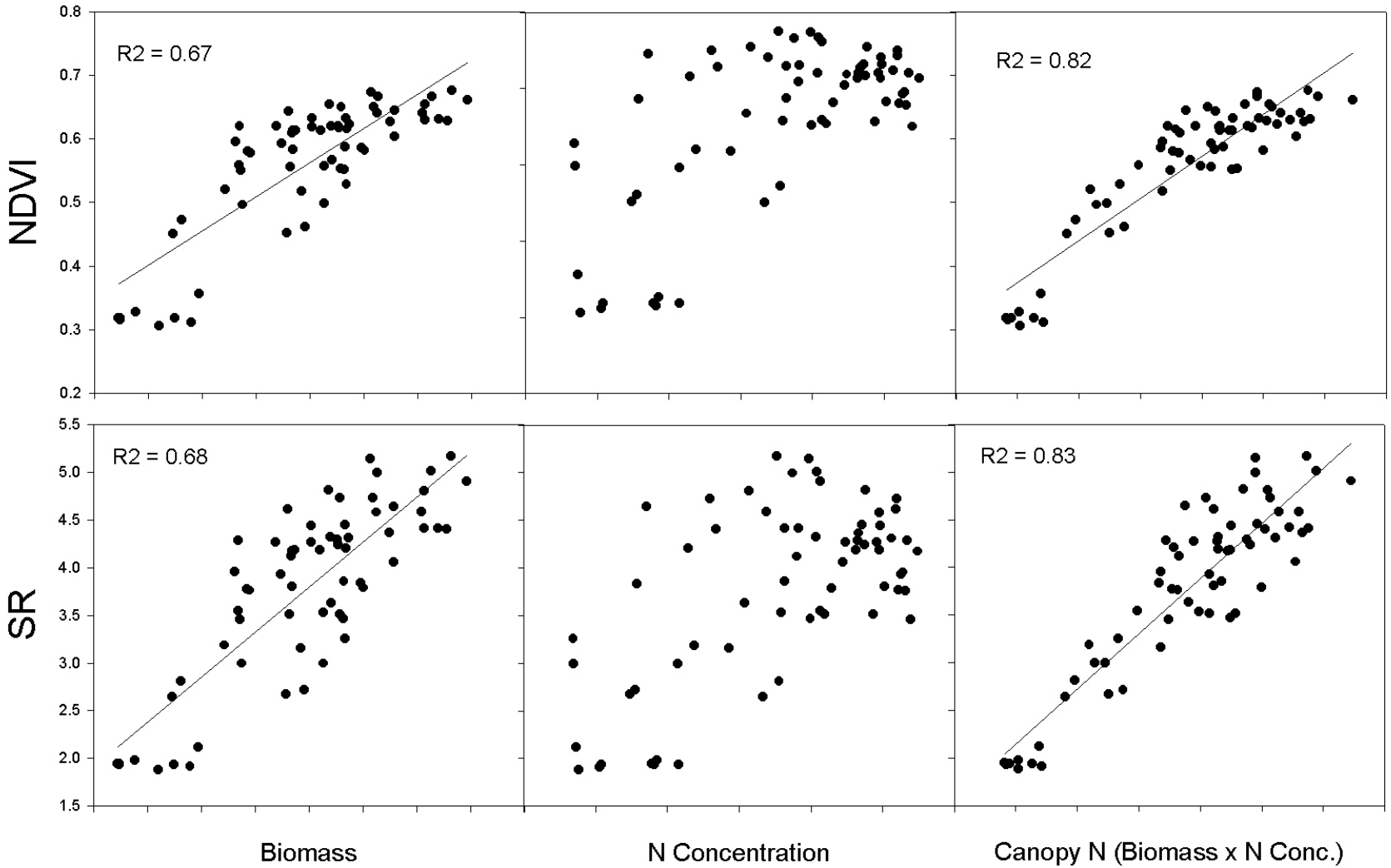

Data from Ivan Ortiz-Monasterio

New research program

- Testing remote-sensed data in crop simulations with the view to increase general availability and accessibility of inputs to crop models and boost scale-out

- CONACYT, Purdue, CIMMYT/FFAR funded PhD Program for Luis Vargas

THANK YOU

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