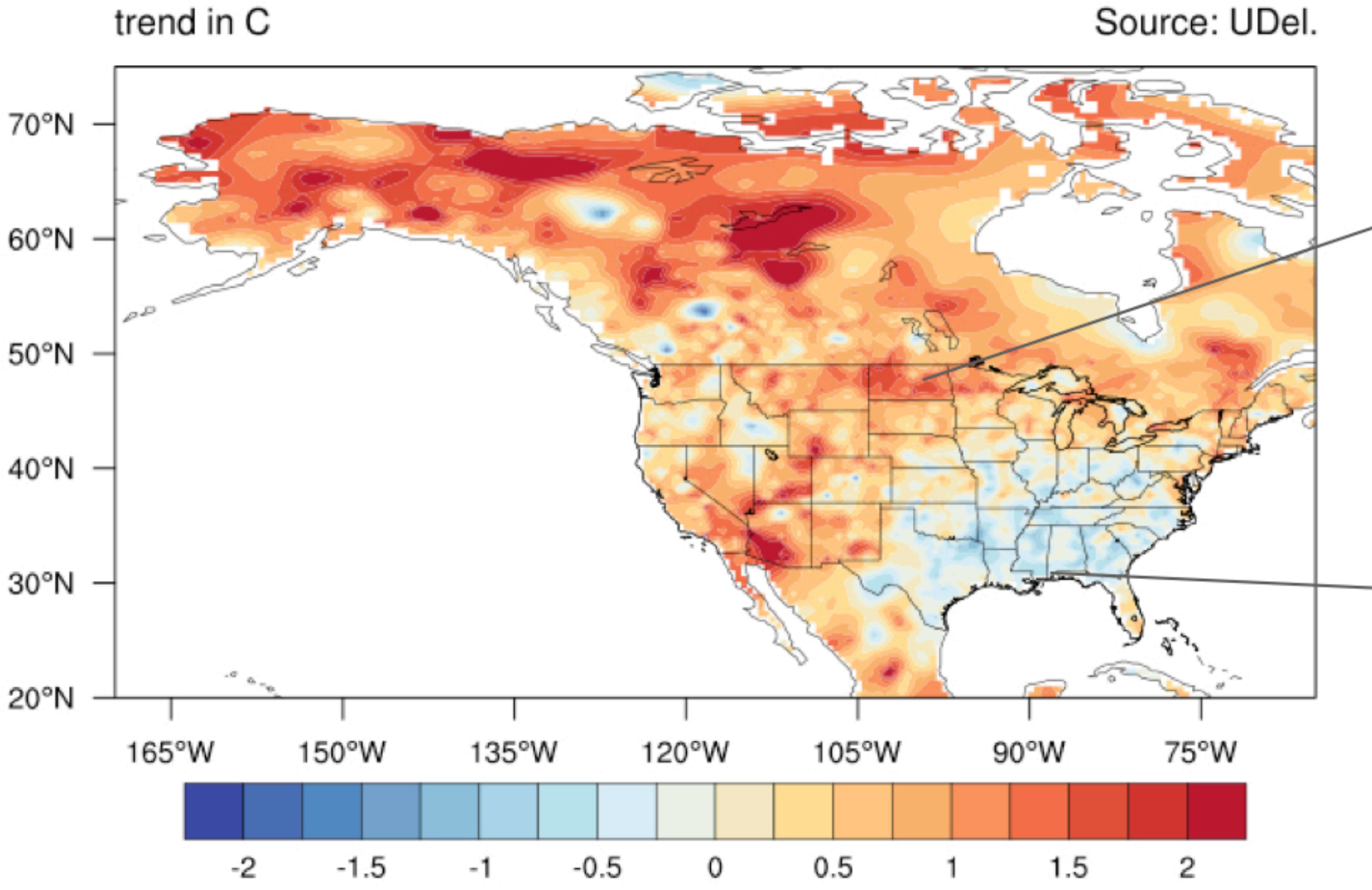
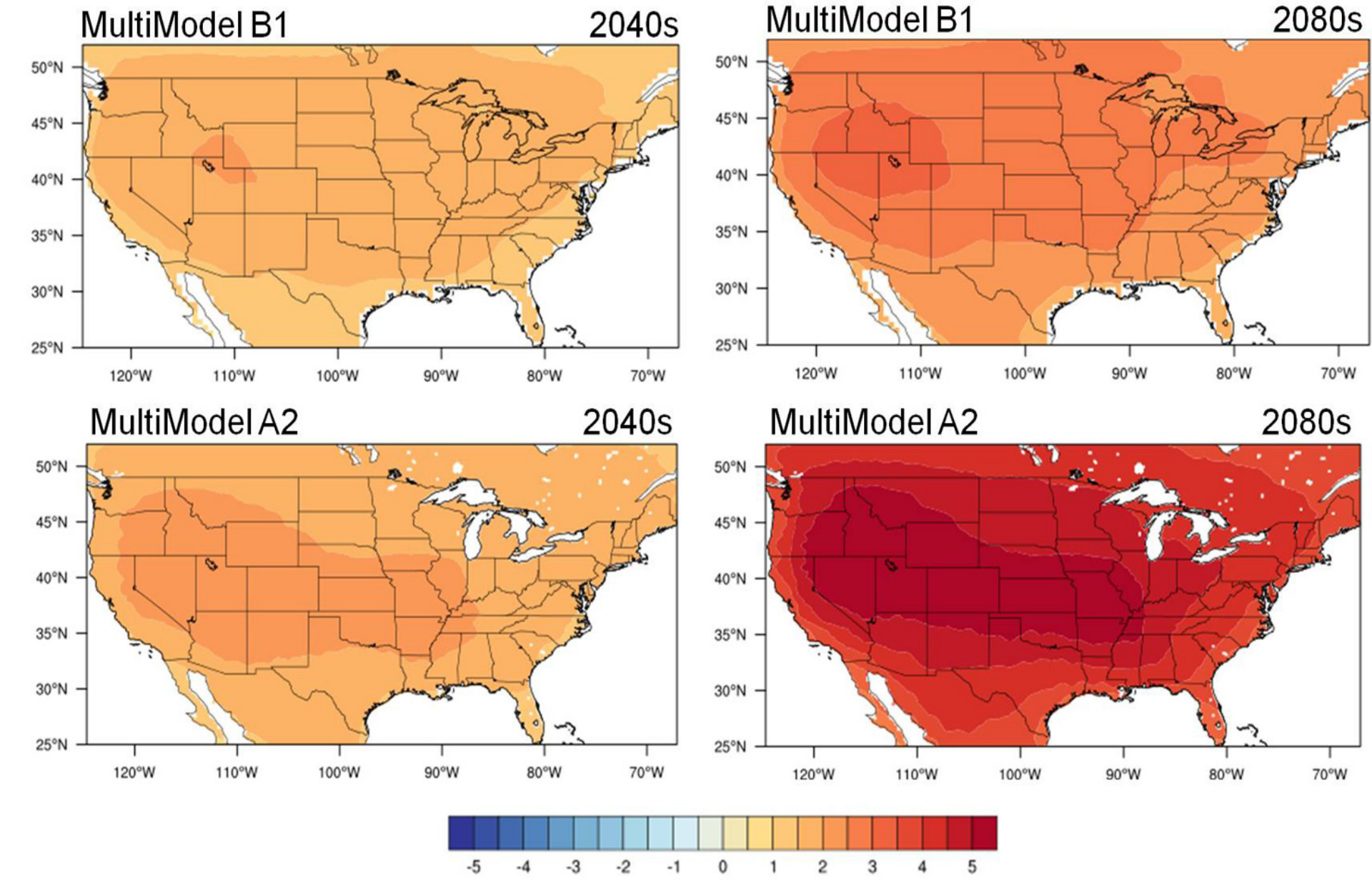
U.S. Global Change Research Program

National Climate Assessment

Linear trend of Surface Air Temperature 1901-2008



Summer Temperature Change



Projected impact of climate change on apple production in the US.

- For the NE- 2010-2039
  - 5-10 day increase in number of July heat stress days.
  - Short term droughts will occur annually
  - 1000 or more chill hours met only 50% of the time
  - High precipitation events will increase 8%

Projected impact of climate change on apple production in the US.

- For the PNW- 2010-2039
  - 3% reduction to 9% increase in production
  - Flowering will occur 3-4 days earlier
  - Codling moth flights will begin 9 days earlier and egg hatch will accelerate 8-14 days resulting in a consistent third generation.
  - Snow water equivalents will decrease 50-58%
  - Peak runoff is moved to early March.

Stress detection in plants

D. Michael Glenn and James Kim

USDA-ARS-Appalachian Fruit Research Station

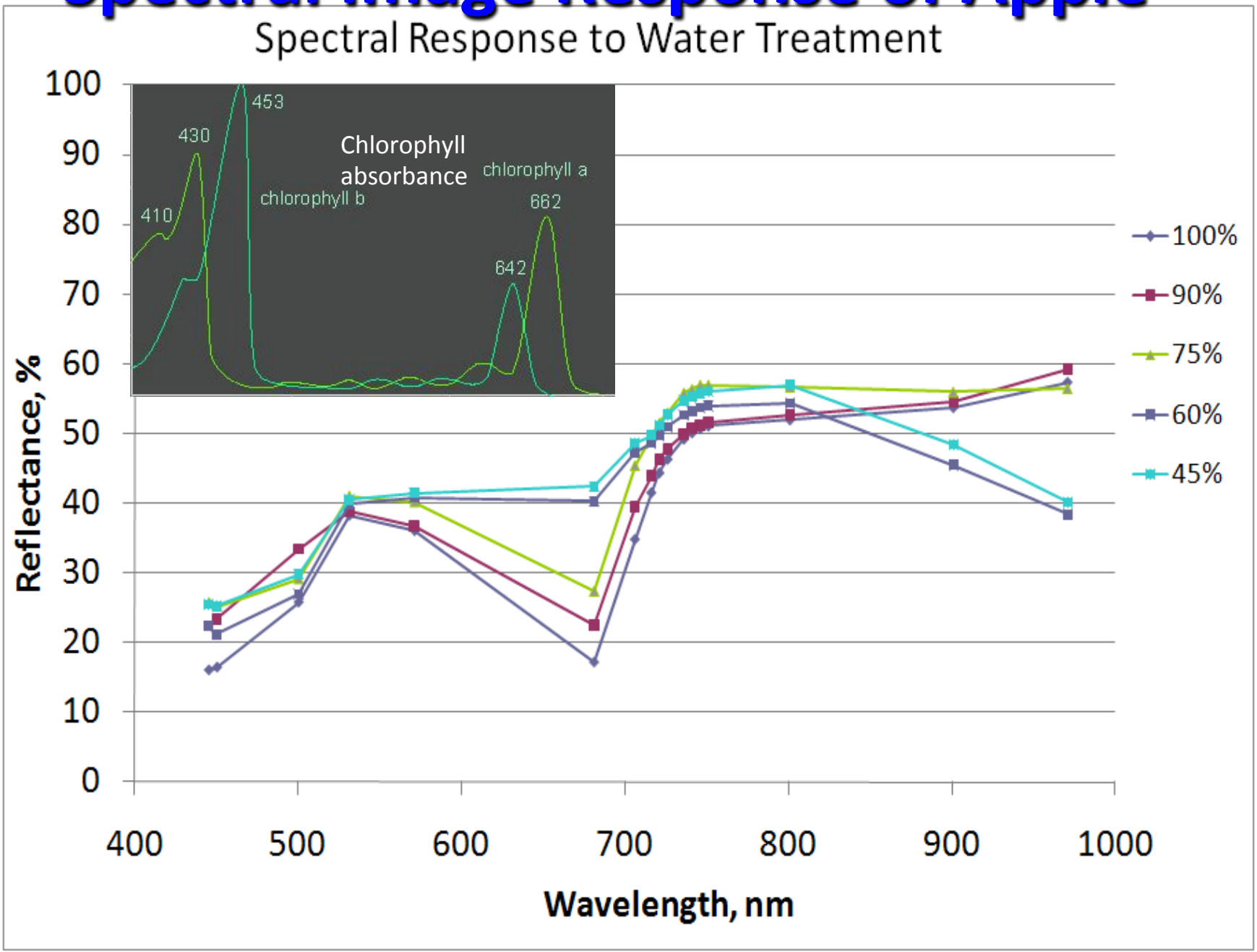
Kearneysville, WV

Problem: How can the status of plant stress be measured rapidly and accurately?

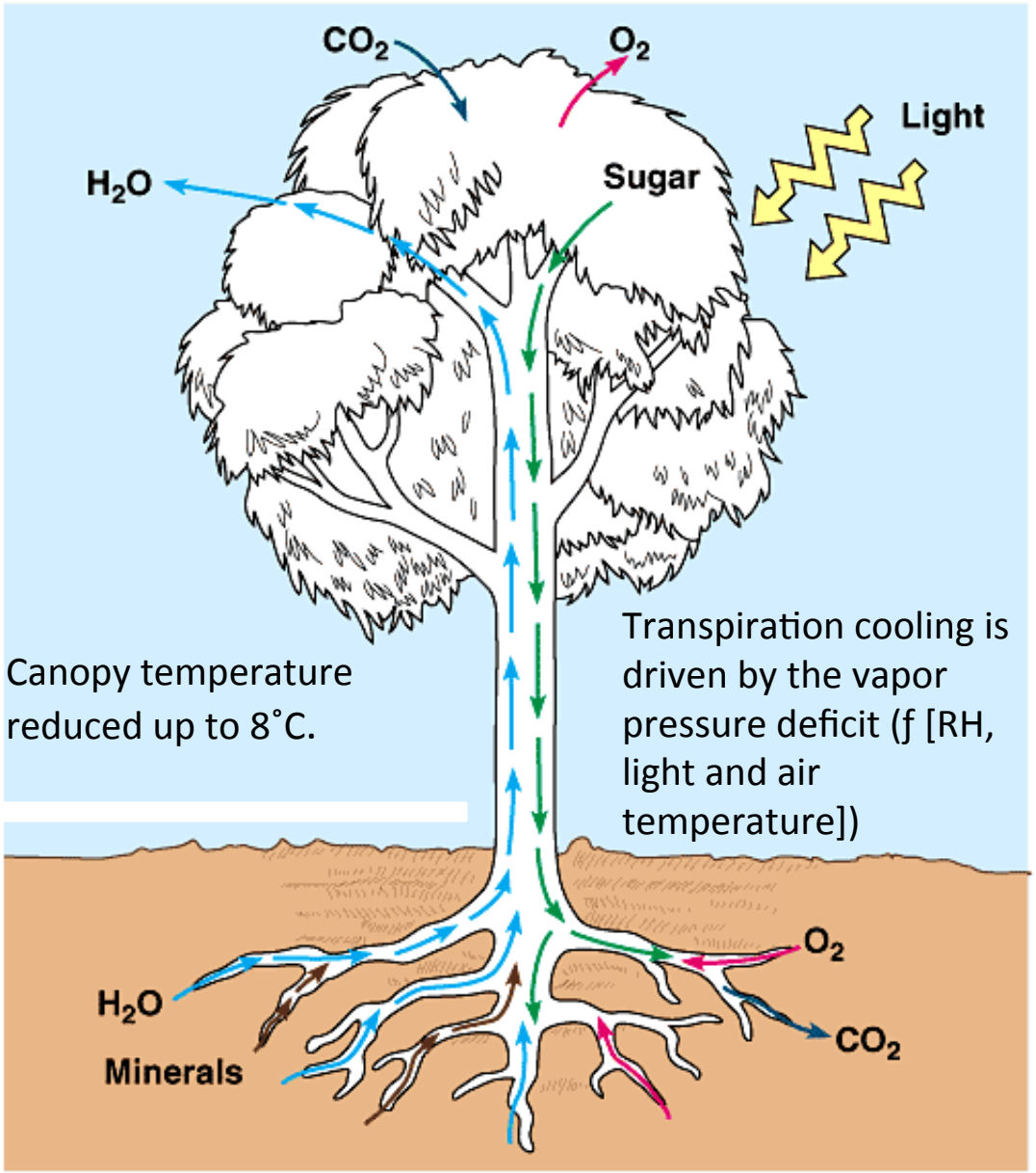
Technology to measuring plant stress:

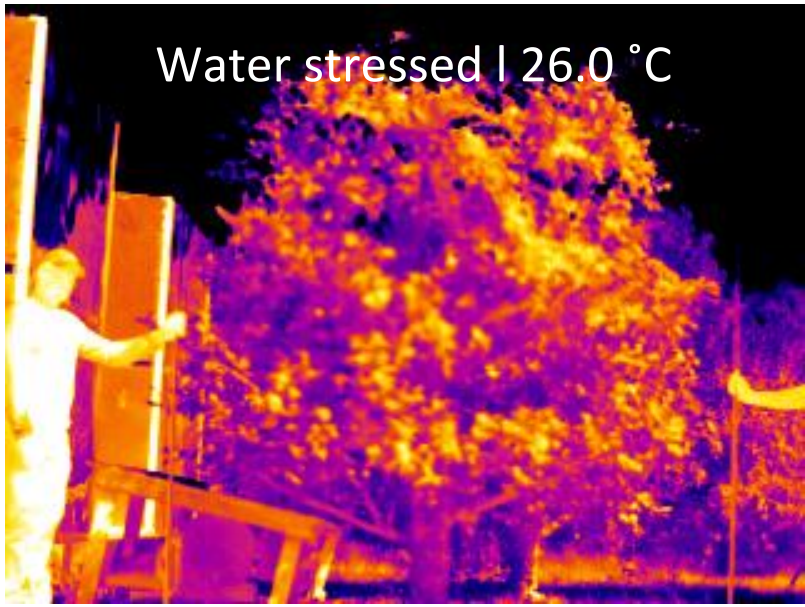
- Reflectance of radiation (visible, NIR)
  - A measure of photosynthesis efficiency
- Plant temperature (absorbance of IR)
  - A measure of transpiration supply to meet environmental demand for water

Spectral Image Response of Apple

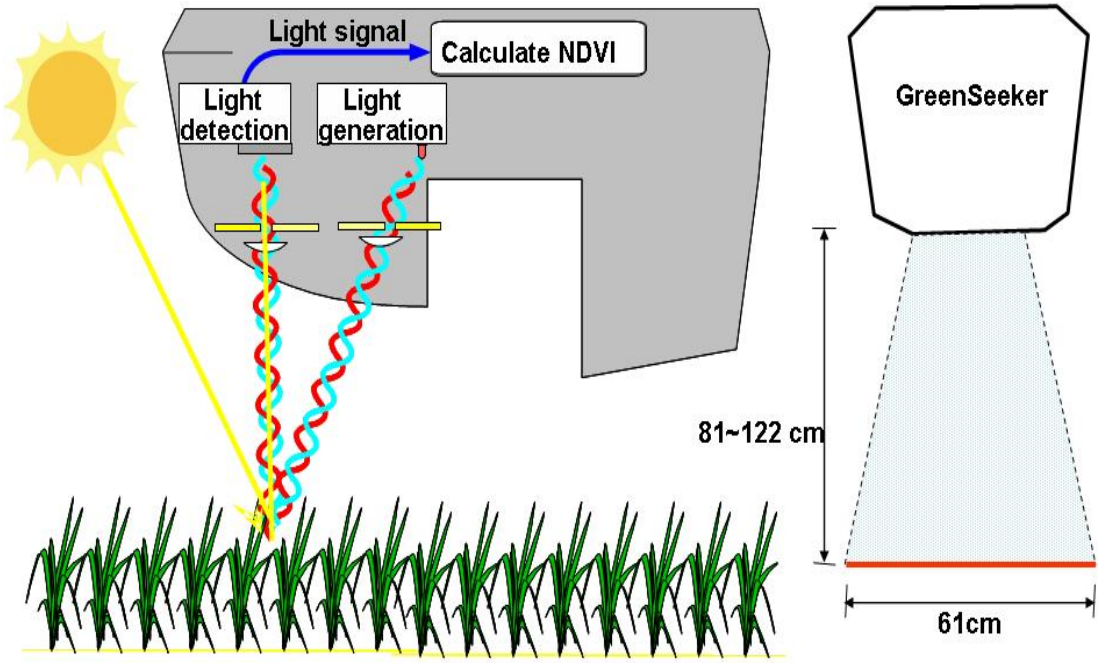


Transpiration cooling-the evaporation of water from a surface reduces the surface temperature

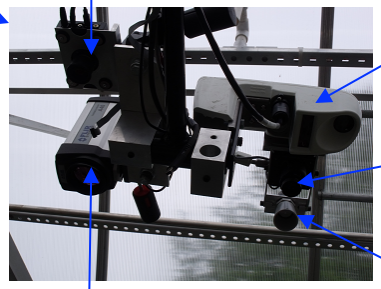


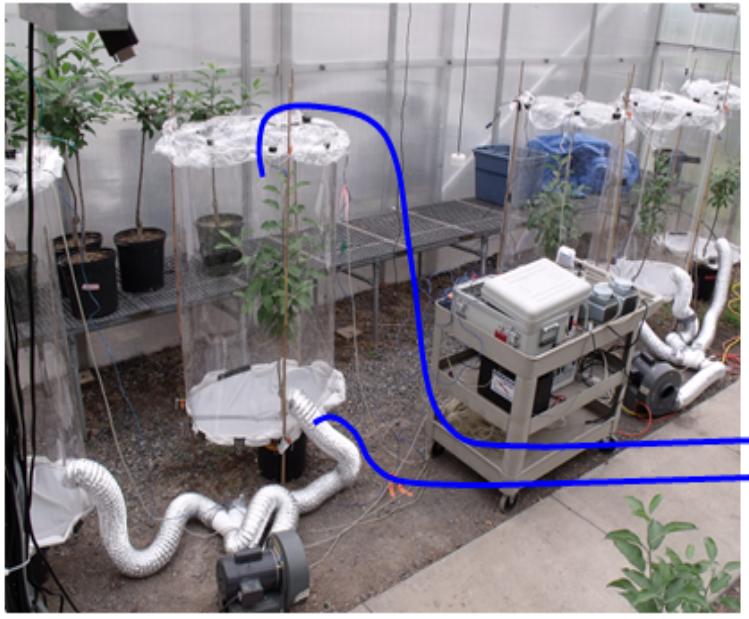


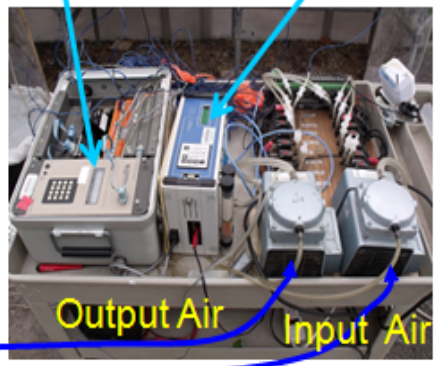
Trimble's GreenSeeker-an 'active' NDVI sensor

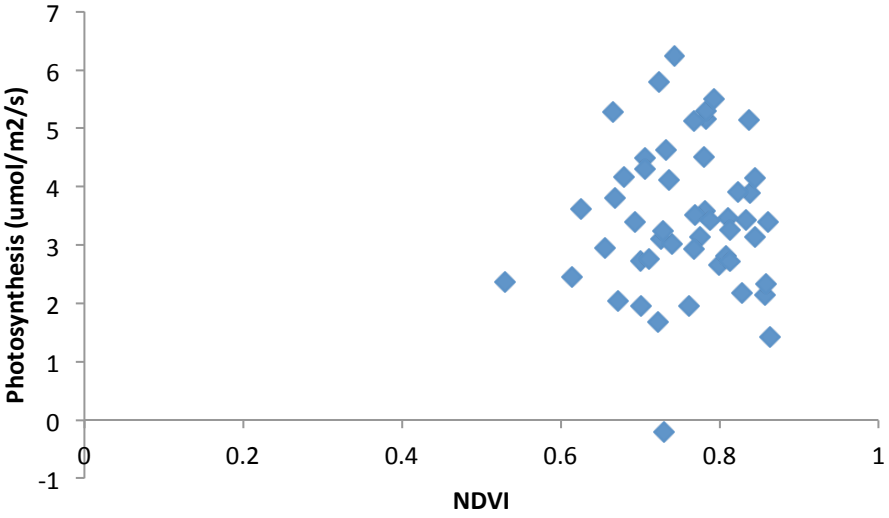


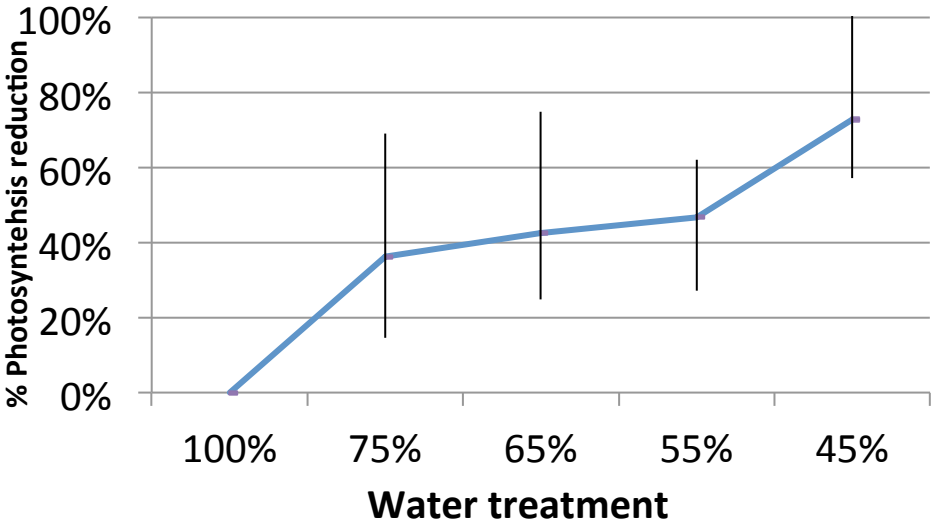
Plant Stress Detection (Greenhouse Test)

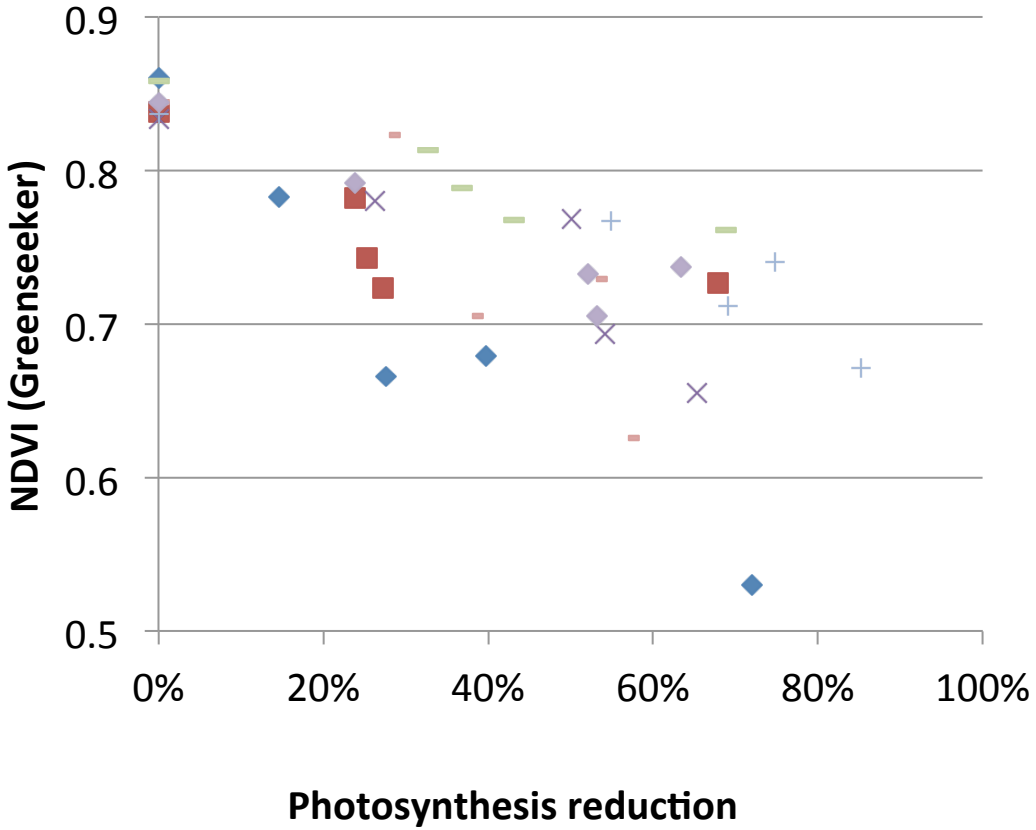






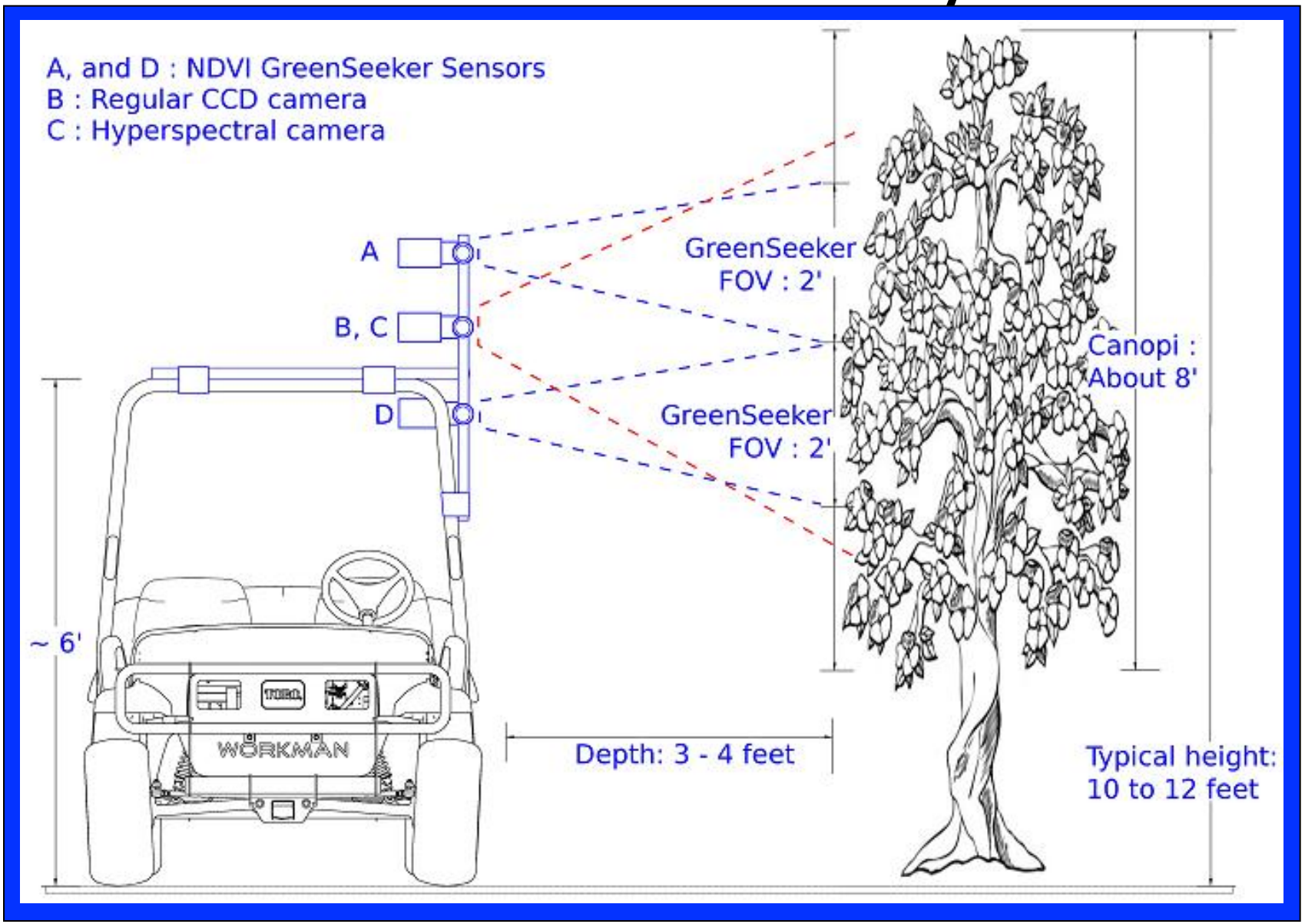


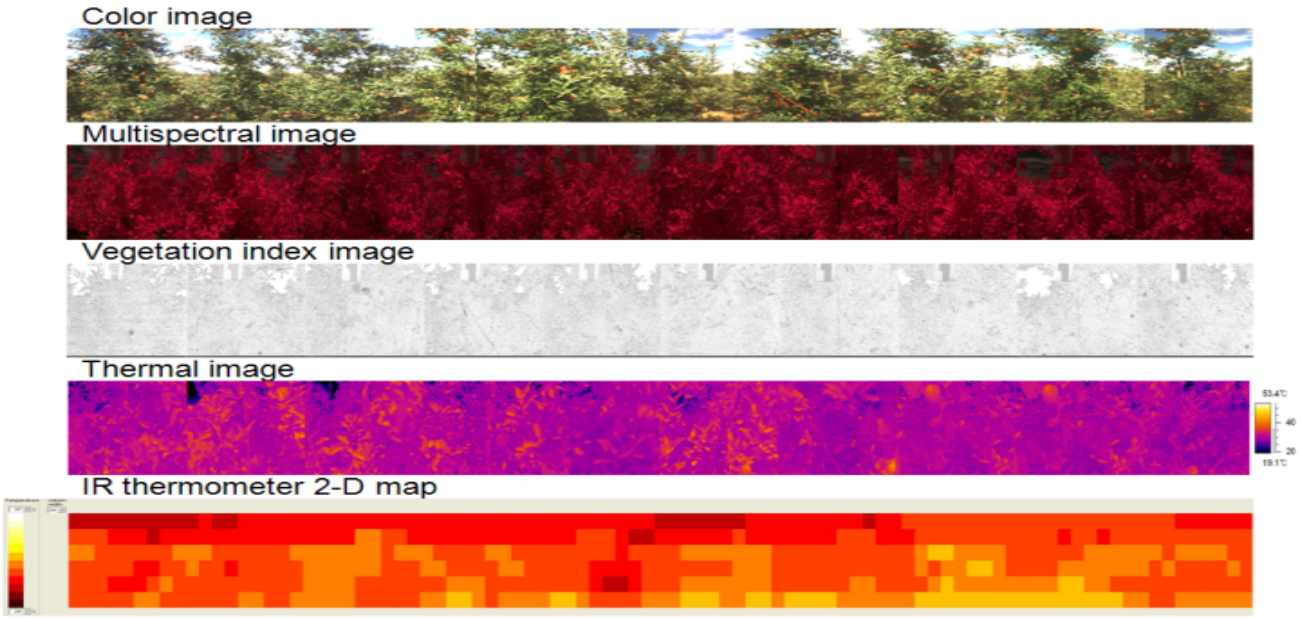




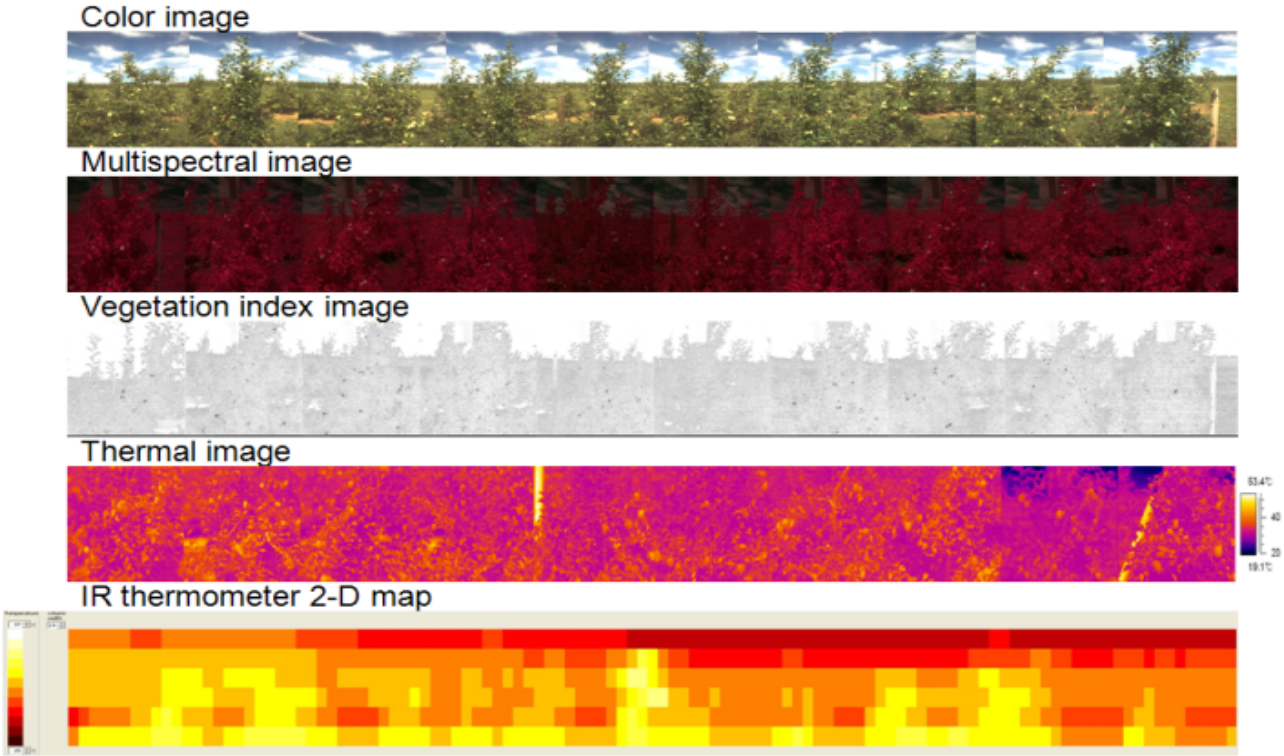
- NDVI values alone do not reflect the photosynthetic rate
- Expressing the photosynthetic rate as a % of maximum does not overcome sampling date variation
- However, variation diminishes in NDVI as stress is reduced.
- Growers are most concerned about identifying initial stress where NDVI >0.8

Multi-modal Sensor System





Irrigated



Non-Irrigated

The next step?

Integrate spectral and thermal data with whole tree photosynthesis to develop an absolute measurement of plant stress status

Summary

- What we know:
  - Environmental conditions change diurnally
  - Varying degrees of plant stress can be identified with NDVI and canopy temperature
  - Neither NDVI or canopy temperature provide an absolute measurement of plant stress
  - NDVI and canopy temperature both provide independent information on plant stress but have not been integrated.
- What we need:
  - Reliable, non-contact, sensor array to measure absolute plant stress status
  - A sensor system that will integrate environment, NDVI, and canopy temperature with photosynthesis data measured in short time frames and integrated into a daily response.