

# Controlled Environment Agriculture

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<https://www.purdue.edu/hla/sites/cea/>

- Controlled Environment Agriculture utilized both science and engineering based approach to grow plants and optimize resource use
- CEA is high intense farming system
- In my lab, we are developing reliable technologies to remotely monitor plant growth, fertilizer, irrigation, light and temperature needs
- These technologies will be made available to growers in an affordable form (ex: Smartphones)

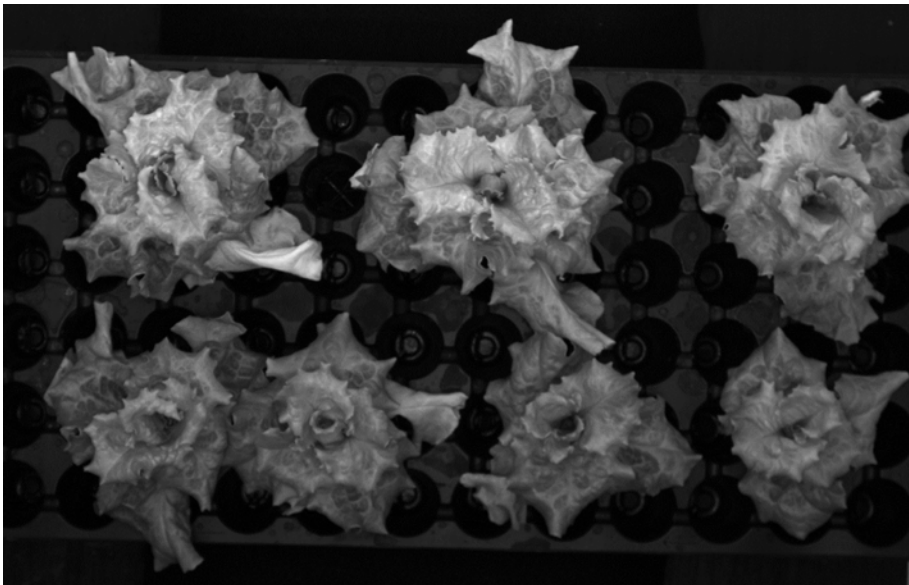
- We use both spectral reflectance and imaging based approaches
- Spectral reflectance is measured using spectroradiometers connected to automated logging devices
- Imaging is done using Aris TopView image station by exposing plants to 465, 521, 593, 625, 634, 660 and 870 nm



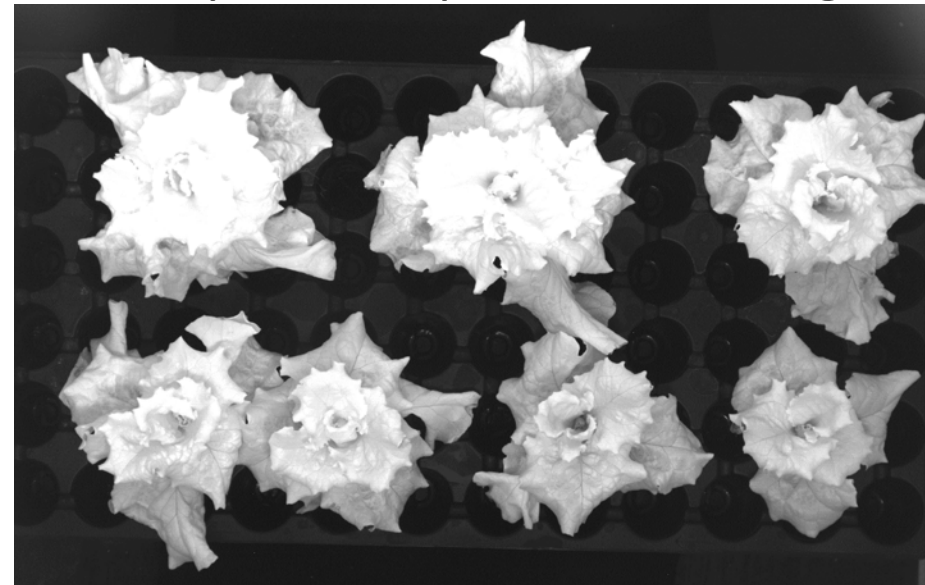
Image Station

- TopView image station uses a monochromatic camera
- Images collected from red, green, and blue exposures are combined to make a visual image
- Pixels on images collected by TopView station only have intensity information, i.e., these are grayscale images
- Darker the image, higher light absorption and lower grayscale value

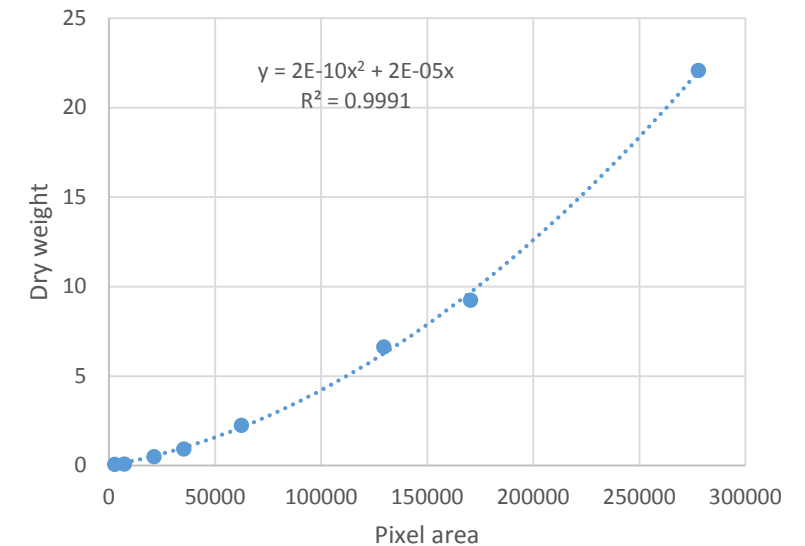
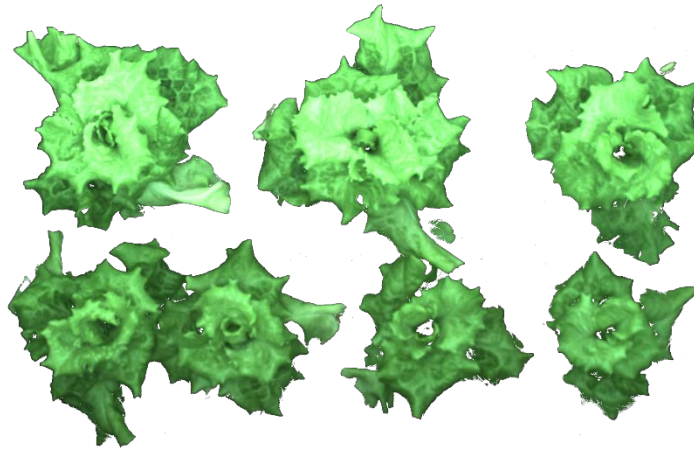
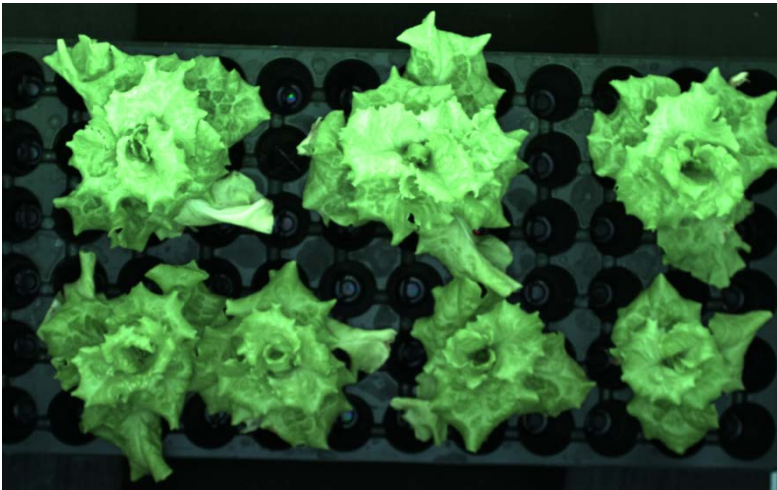
Lettuce plants exposed to red light



Lettuce plants exposed to NIR light



- We have been successful with plant growth analysis using TopView imaging
- System uses fluorescence from plants to mask the image or detect edges, then automatically measures pixel area of plants
- Pixel area can be correlated to dry weight/leaf area of plants

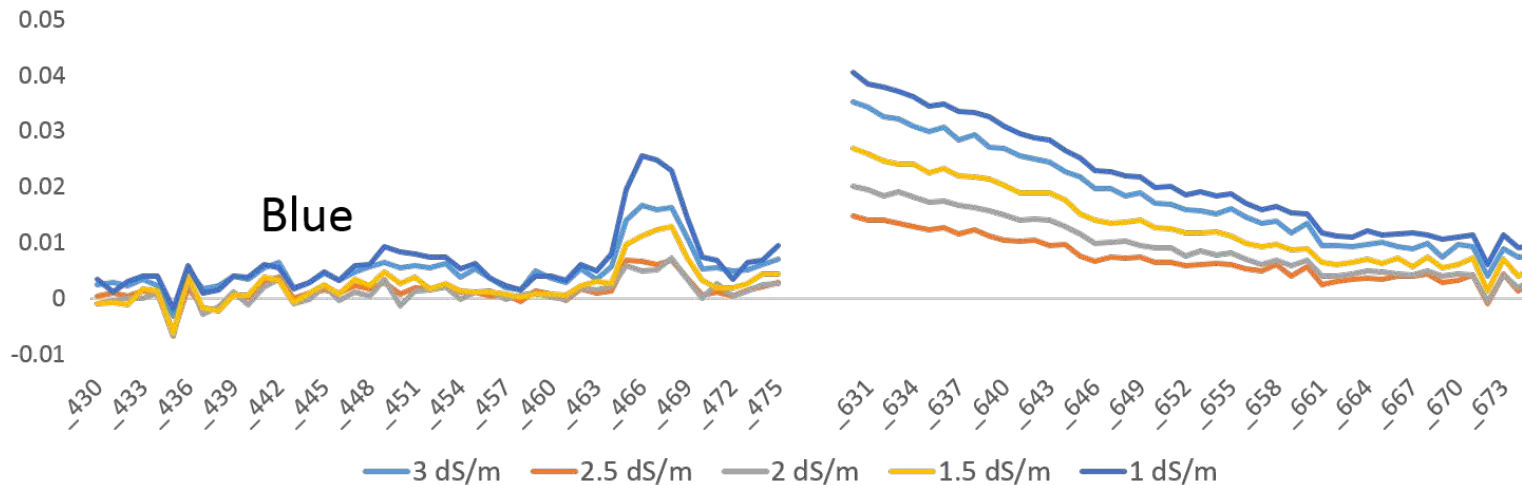


# We are currently looking at different ratios to detect crop N status



Lettuce was fertilized with EC levels of 1.0, 1.8, 2.0, 2.5, and 3.0 dS/m every alternate day using sub-irrigation. An EC level of 1.8 – 2.0 dS/m was found optimal

## Spectral reflectance ( $\text{W/m}^2/\text{nm}$ )

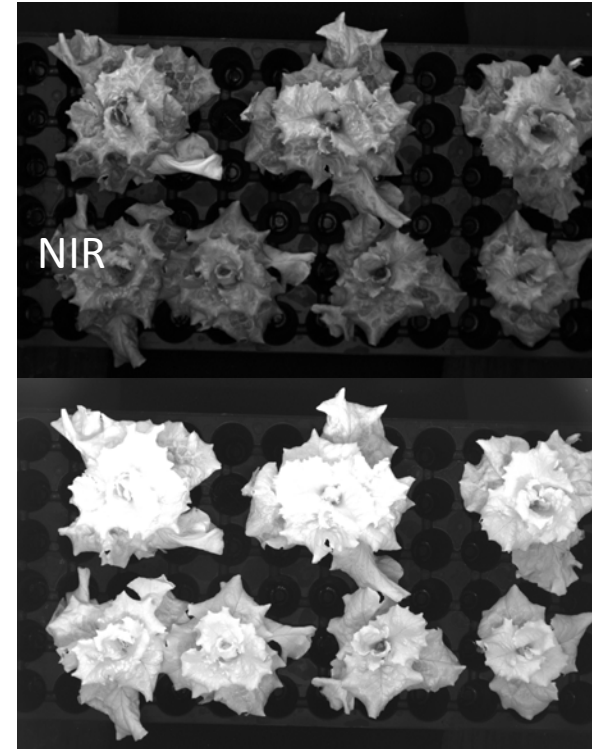
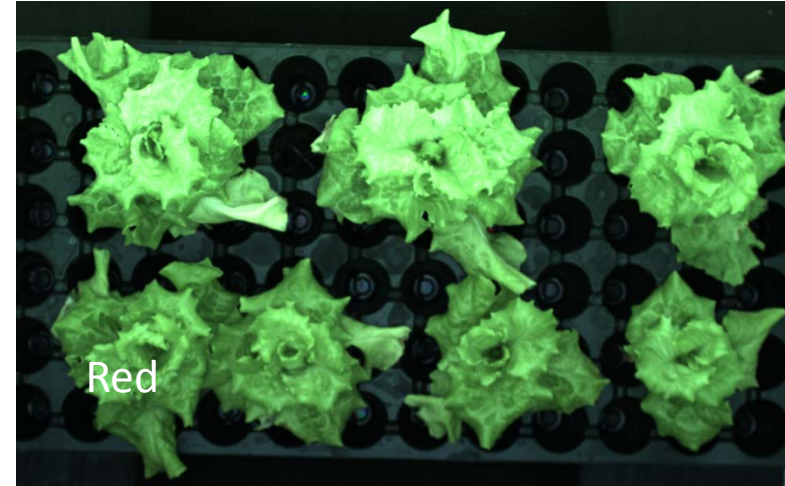




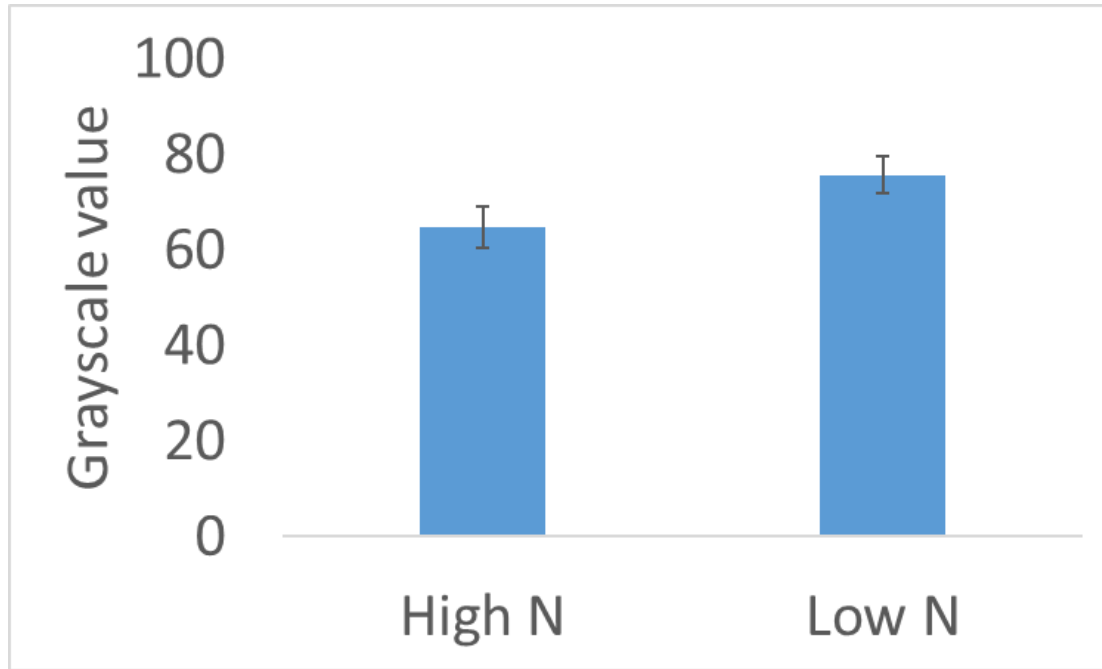
# Nitrogen analysis using reflectance in the red and NIR wave bands

Images of lettuce plants were taken before and after supplying N and normalized reflectance in red band was measured. Lower  $R_{660}/R_{870}$  in the table below indicates more red light was absorbed by 24 h after adding N

Trt	R_660 nm	R_870 nm	R_660/870
Before N	36.5	72.5	0.503448276
After N	45.1	94.1	0.479277365



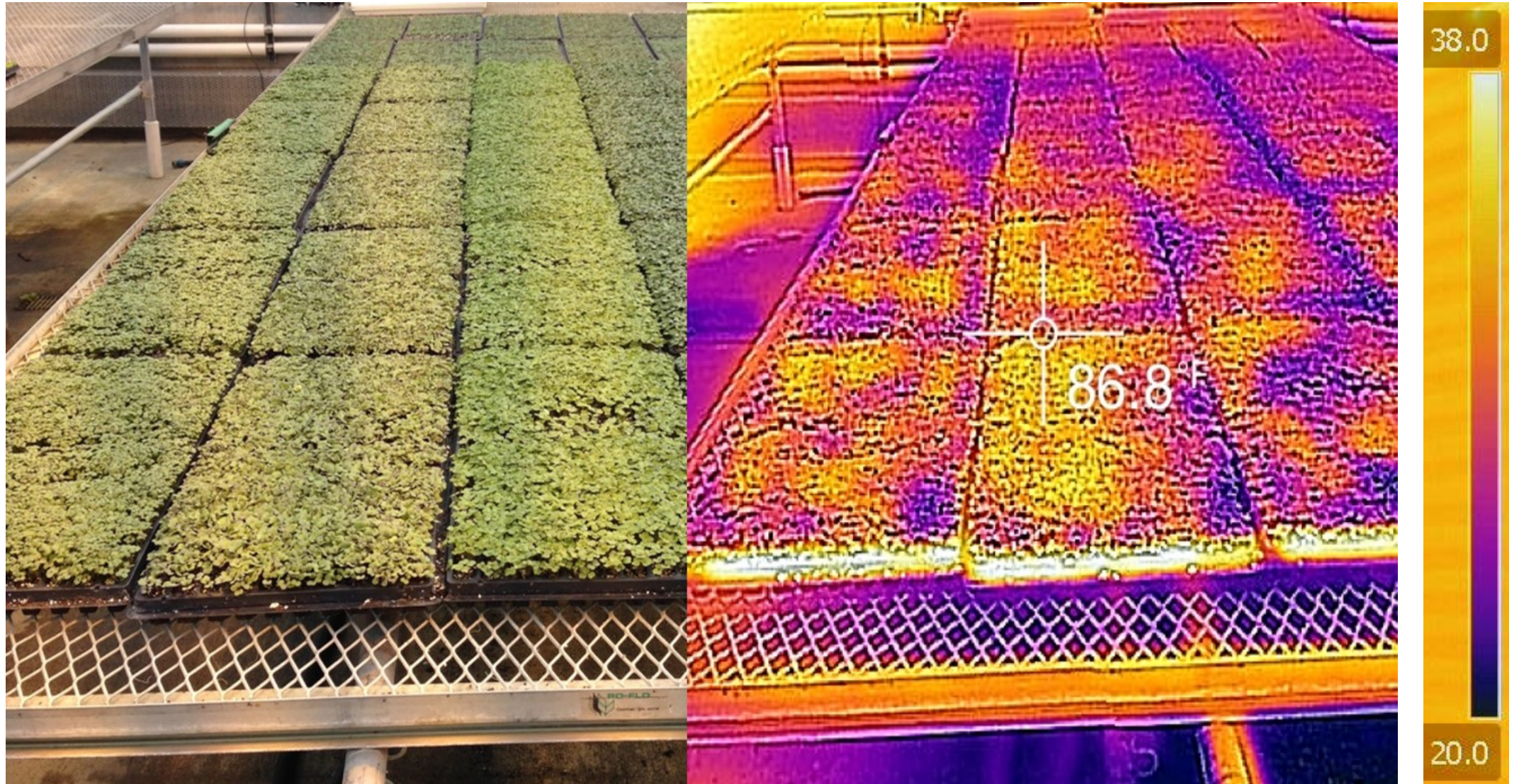
# Relative greenness as a measure of N status in plants



Higher grayscale value indicates relatively less greenness in poinsettia plants



# Thermal Imaging of microgreens for irrigation needs





# Smartphone based Apps to detect crop input needs

Currently, we are using off-the-shelf camera to measure water and possibly N status of plants using Smartphones

