Disease and Weed Detection with RGB Type Drones

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Research & Extension

Summary:

- Different Kinds of Camera Drones
- Imagery Indices
- Measurement of Disease Severity in Crops with RGB Drones
- Weed and Close-Up Detection

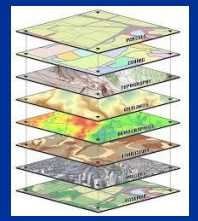
Different Types of Remote Sensing Drones:

- 1) Retail Store Type Drones:
  - RGB, visible wavelength
  - Easy to fly and use
  - Record RGB imagery in easy-to-use file types
  - Low-cost ($500 to $7000)
- 2) Dedicated Units:
  - Example: Wingtra
    - Special high-end cameras;
      - Usually Multispectral, lidar, thermal, etc.
    - Very expensive (> $20,000)
  - Heavy data loads

Future Drone Field Inspection System:

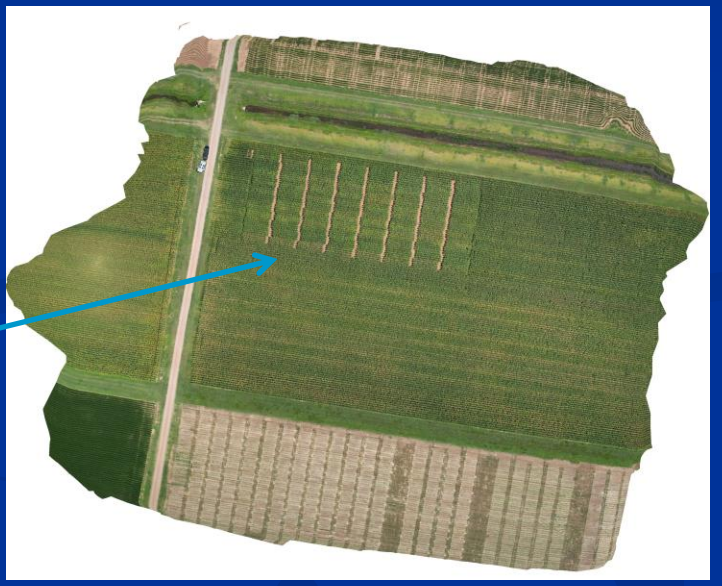
- Drone located near multiple fields
- Drone flies field every day, twice per week, weekly, etc.
- Data sent to computer automatically
- Daily maps (layers) created
- Multiple maps analyzed for crop health (damage areas, etc.
- Drone flown to specific areas to obtain close-up for reason of disease or damage, etc.
- System also allows farmer to have manual control to real-time visually inspect fields, or monitor conditions and farming operations, etc.

Data and Evaluation Computer / Center



Drone Stationed in Field with Recharging / Launching Station

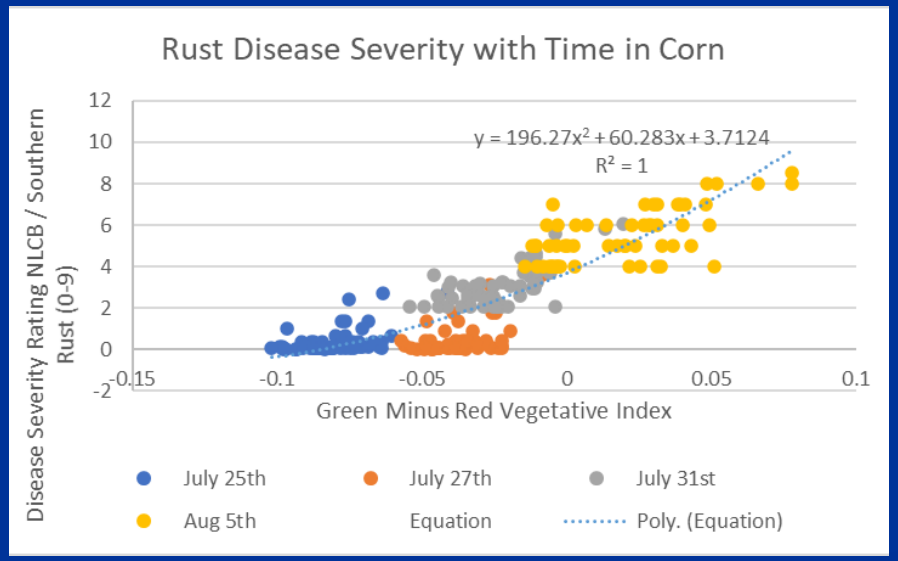
Field Data Recorded Daily, Weekly, Hourly, Etc.



1) Fly high for large area mapping
2) Fly low to specific trouble spots to determine actual disease or pest and cause

The Need for High Frequency/High Resolution Data:

- High Frequency Data:
  - Example: monitoring NCLB or Rust propagation in corn field (< 10 days from zero to full severity)
  - In a producer's field it maybe even harder to recognize as the whole field may be changing color at the same time!!!
- High Resolution Data => Drone can be brought down to the top of the crop for high resolution photos that will be needed for A.I. and disease analysis
  - < 15 ft or so
  - Some newer drones rated at 100 Megapixels resolution or more

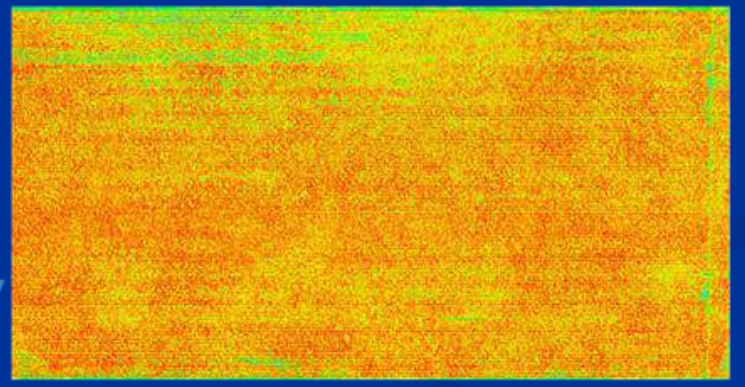


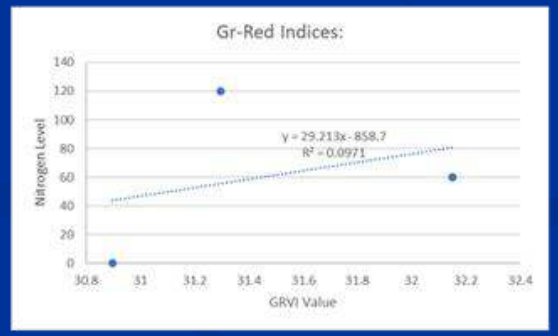
Indices:

- Imagery is changed from three numbers (RGB) to one number with an index (calculation of the colors) that represent a property you are trying to detect:
- Examples VARI, NDVI, CLI, etc.
- We use GR (Green – Red)

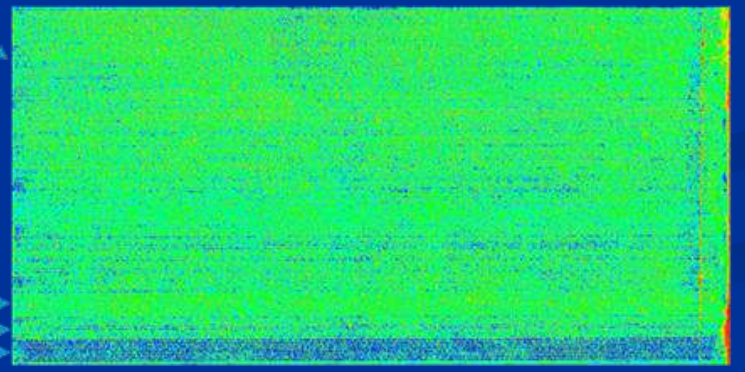
Raw RGB Image of Cotton Field:

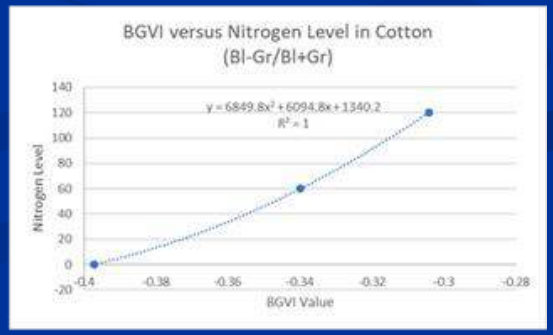
GR Image – General Crop Variability





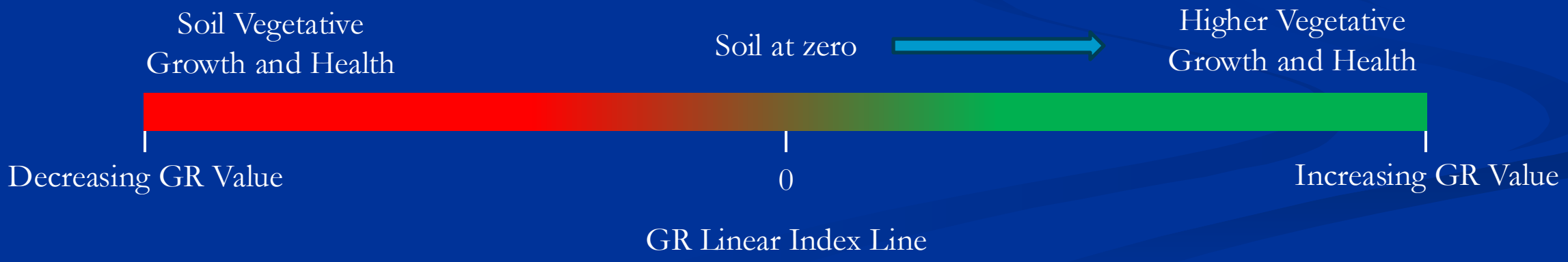
BGVI Image - Nitrogen Detection:





GR Index:

- GR (G minus R) is related to crop vegetative health and stand quality
- GR is the top part of VARI index => (G - R) / (G + R - B)
- The GR index creates a linear number line where:
  - Higher GR values indicate higher vegetation and plant health
  - Lower GR values indicate lower healthy plants and vegetation
  - Soil typically breaks at 0 (+/- 5 GR values, etc.):

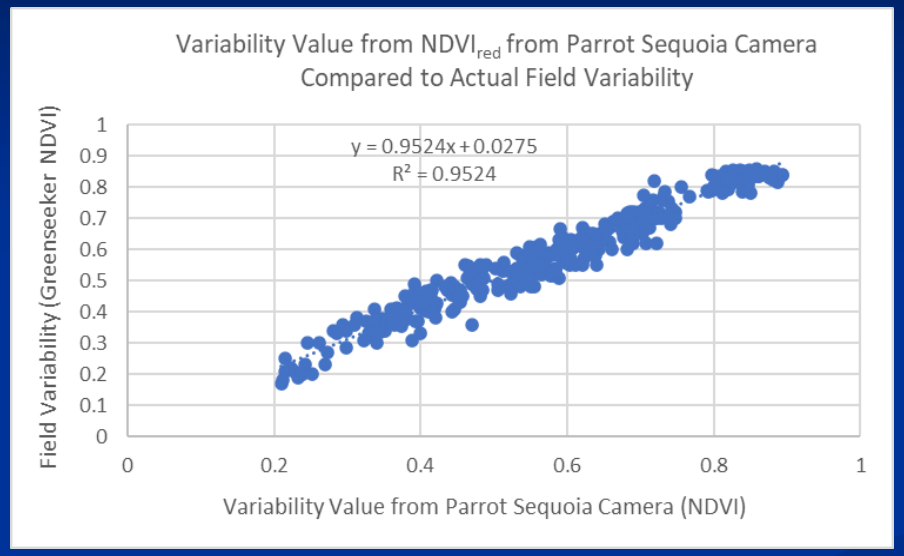


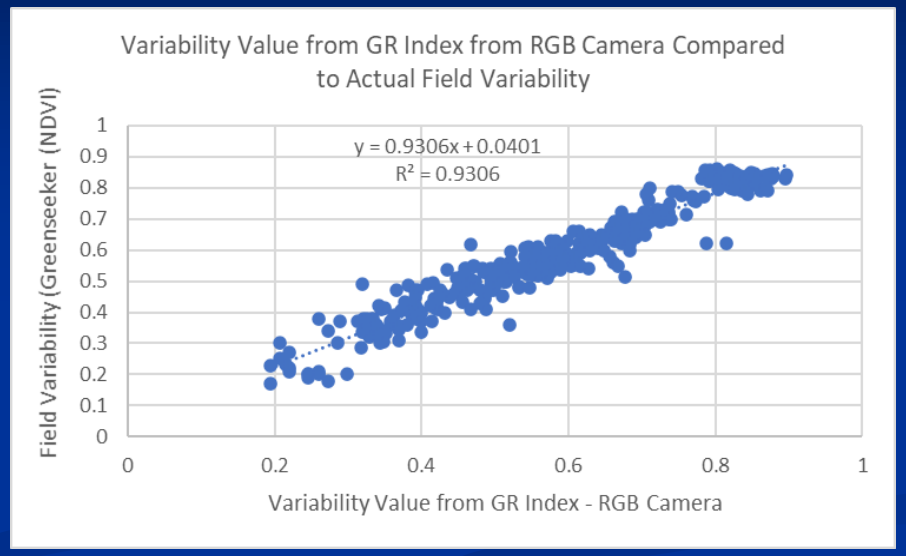
GR Index Compared to Different NDVI Values:

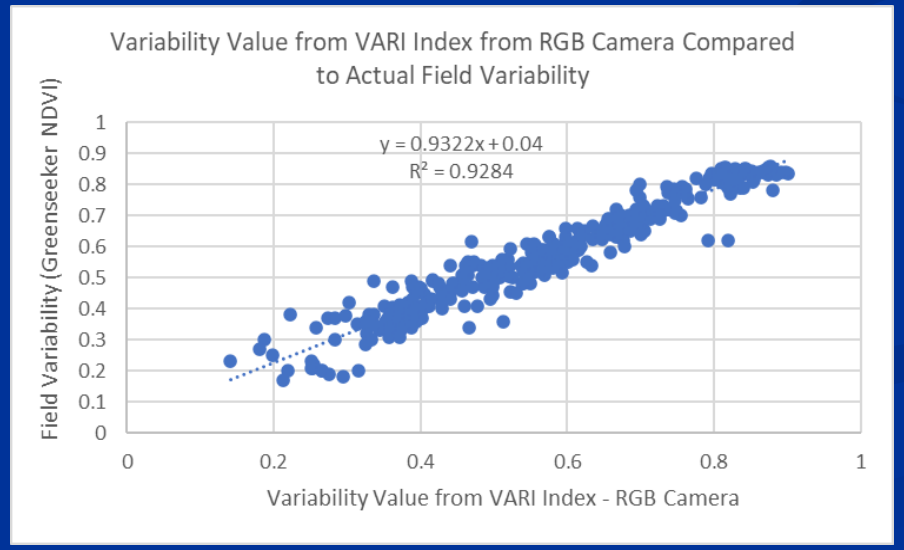
- Comparison of Parrot Sequoia Multispectral camera and standard RGB camera on drones
- 700 readings taken in 17 different fields over a three-year period

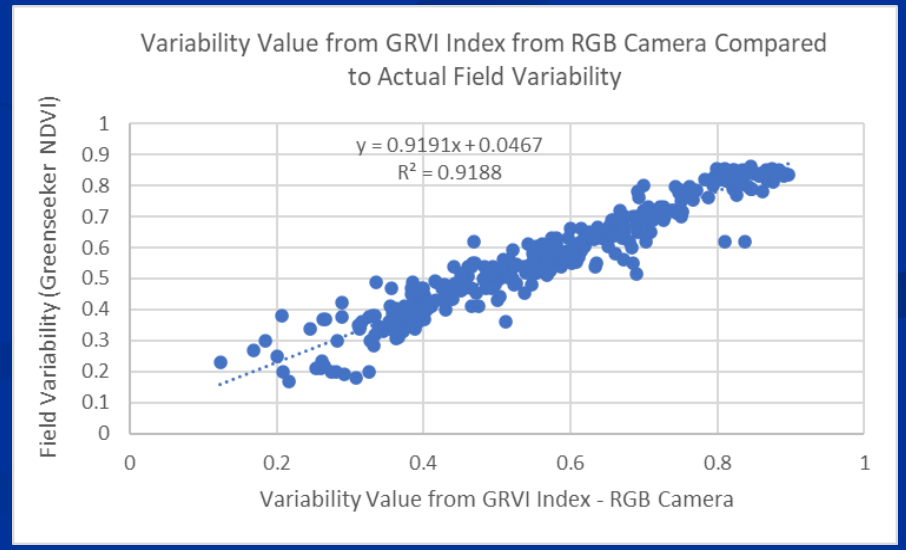
Standard RGB Camera

Multi-Spectral NIR Camera









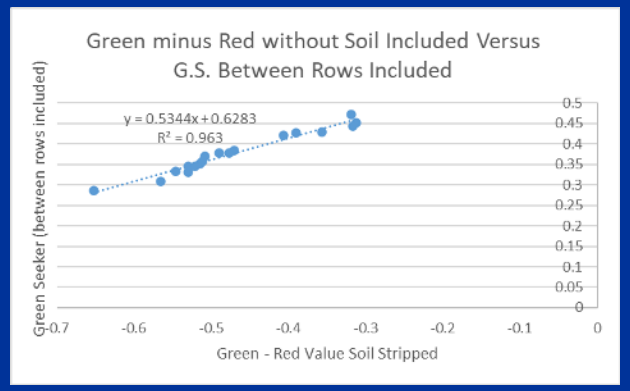
Example of GR Indices Related to Field Differences Versus NDVI:

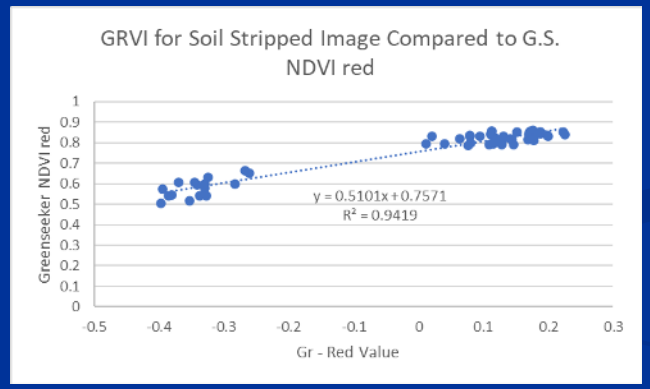
- Low-cost RGB drones in many cases indicate field variances as well as higher priced NIR-type (NDVI) cameras:

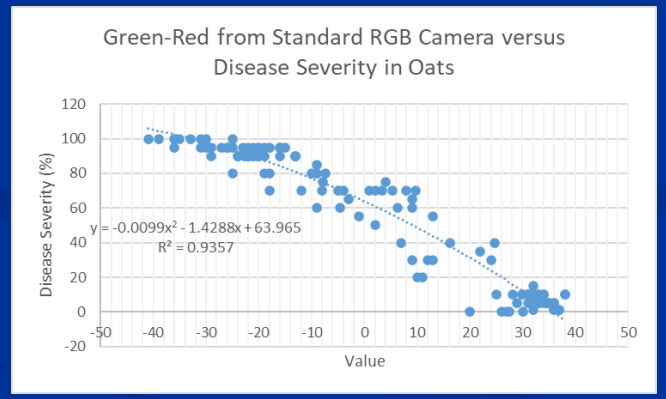
Early Season Soybean Plots

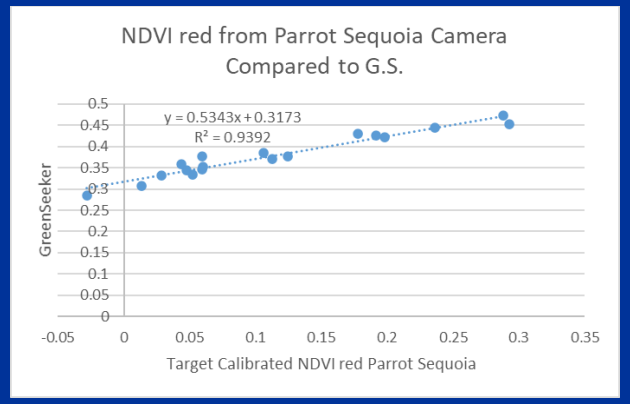
Early and Mid-Season Soybean Plots

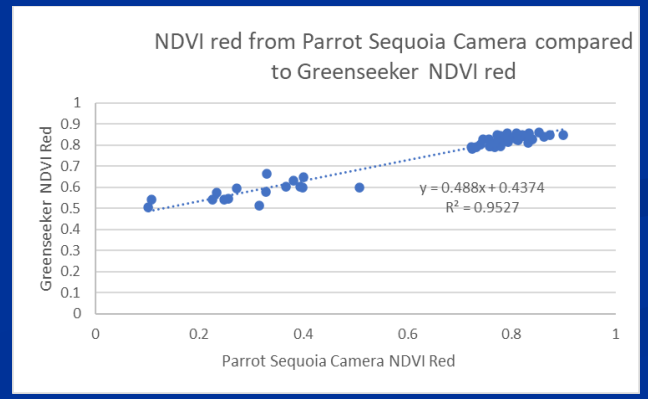
Oats Disease Plots

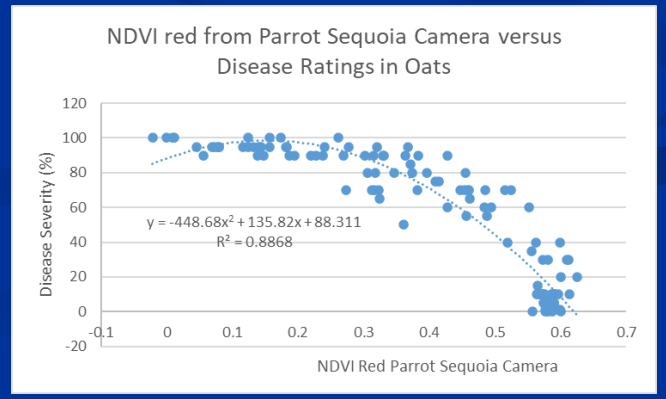








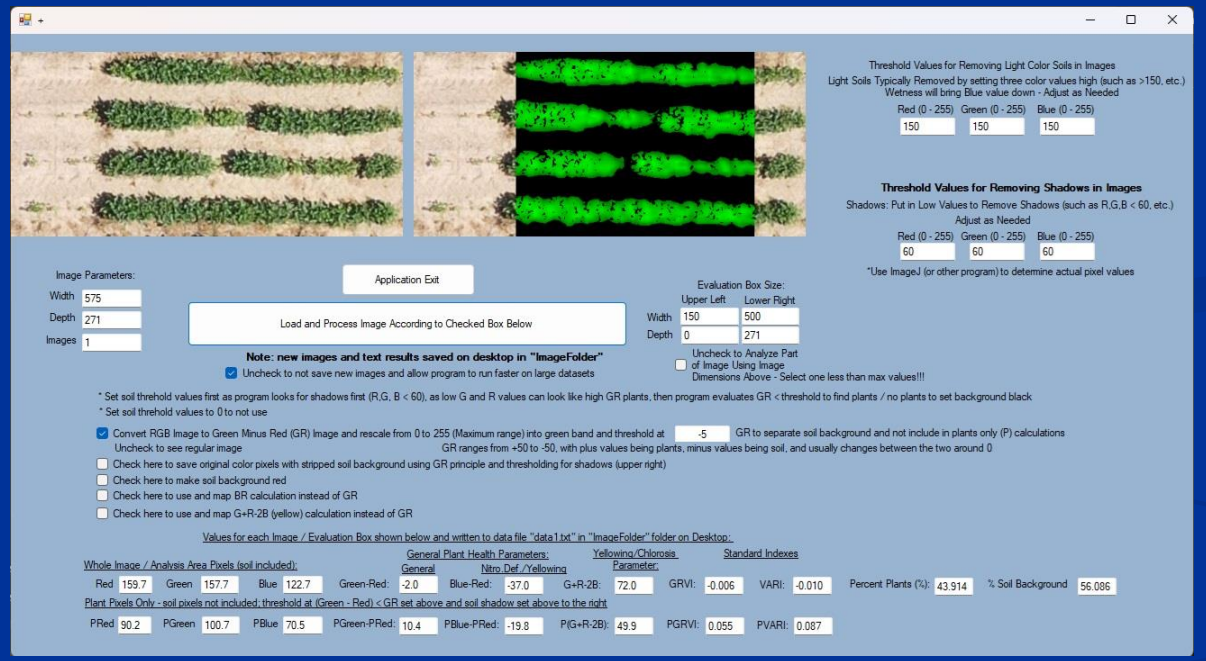


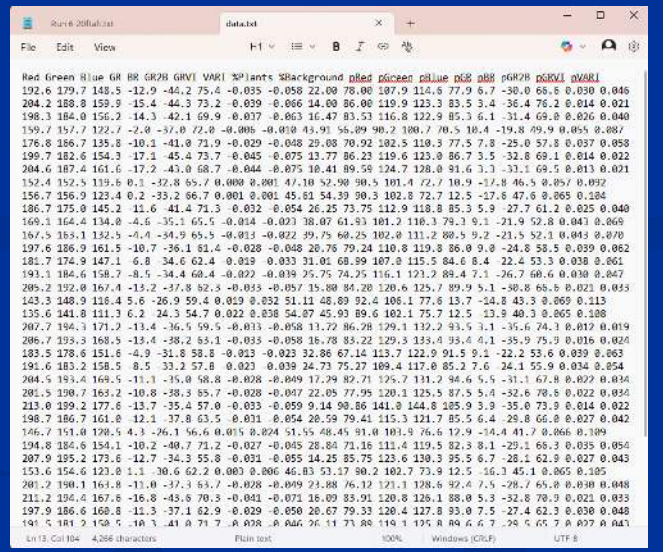


Programs to Calculate GR and Assiciated Indices:

- Analyze up to 1200 to 1500 plots in 12-15 minutes

Rotate, Straighten, Crop, and Slice Image Into Equal Segments (Image to Stacks)

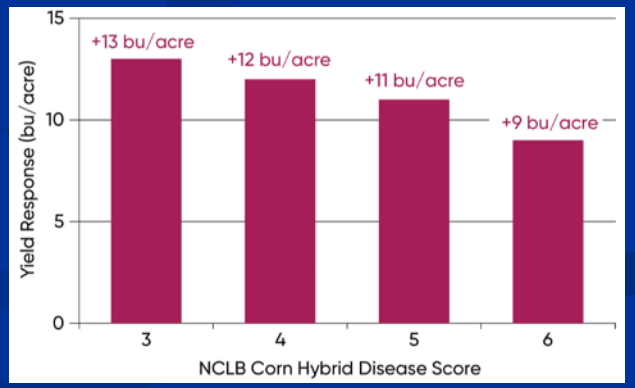




Using RGB Cameras to Indicate Disease Severity in Crops:

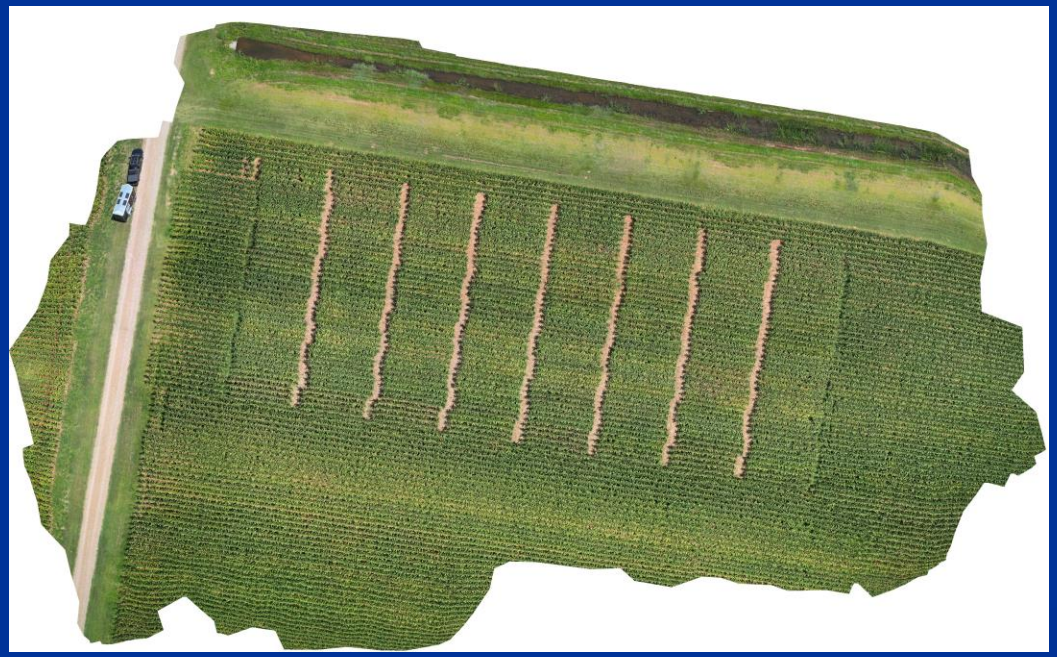
- Disease severity a standard damage estimator in fields for insurance, area assessment, and yield loss/gain.
- Ratings usually done on a rating system of 0 to 9
- Published tables on yield losses from these values in corn
- Drones a good way to measure this parameter
  - Could be flown in the field while consultant is in the field providing ground truthing

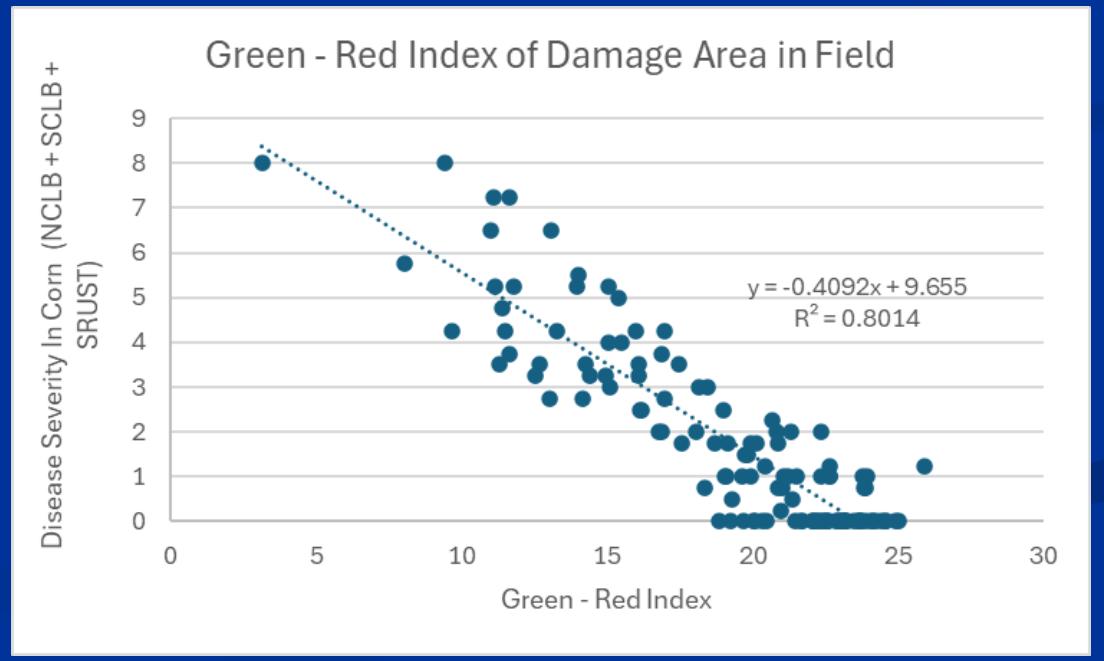
Pix4Dfields



GR Index Related to NCLB, SCLB, and Rust in Corn (2024):

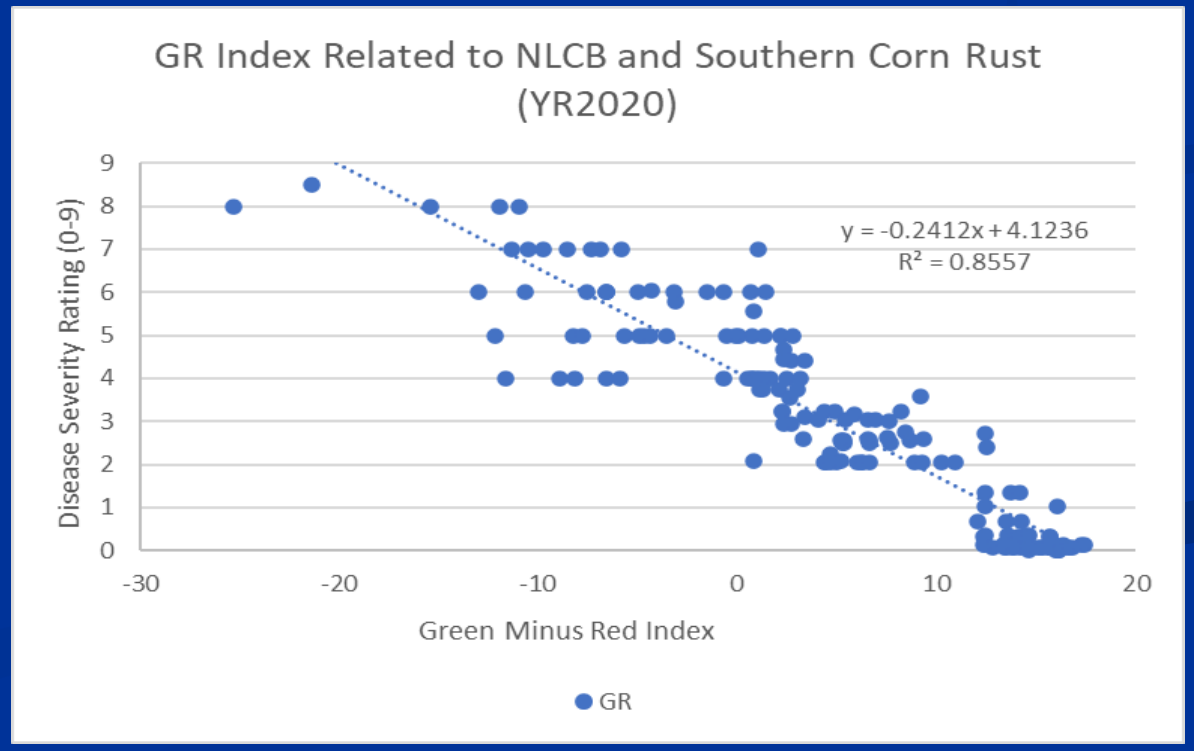
- NCLB and Rust in Corn Plots
- 652 plots / 153 values (when averaged)
- Data taken YR2024 @ 5/29, 6/10, 6/17, 7/1 => 4-week period
- Results: $R^2 = 0.80$





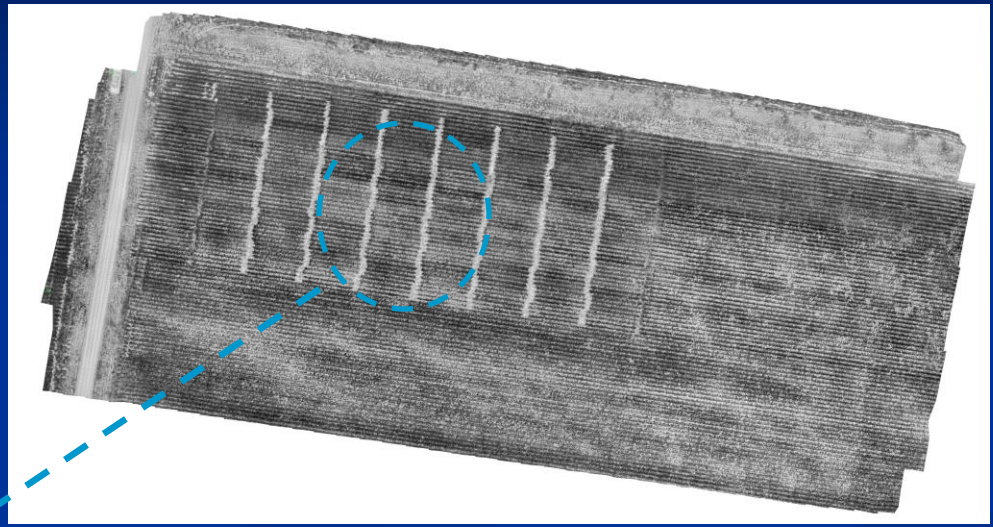
RGB Imagery Related to NCLB, SCLB, and Rust in Corn (2020):

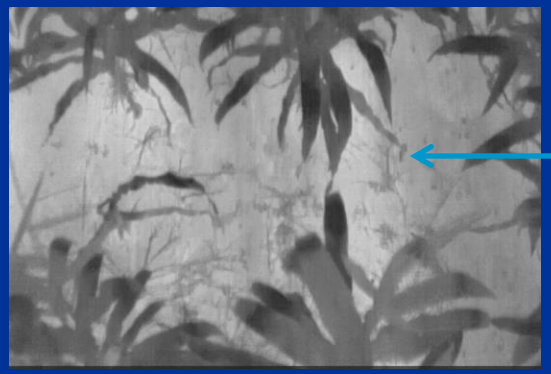
- 225 plots / values
- Data taken YR2020 over a five-day period (7/28 to 8/03) as disease progressed through field
- Results:
  - GR index related to disease severity with an $R^2 = 0.86$

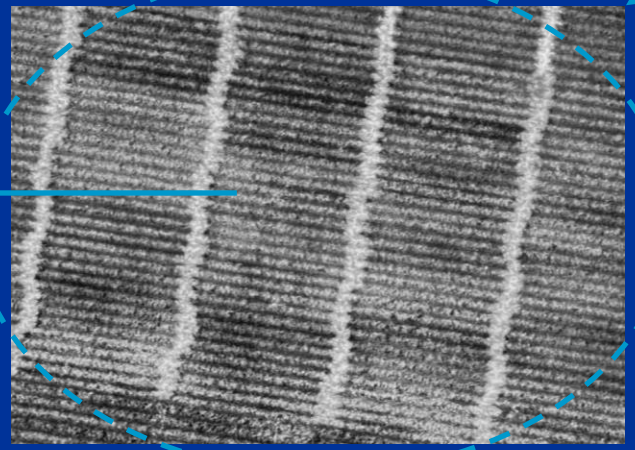


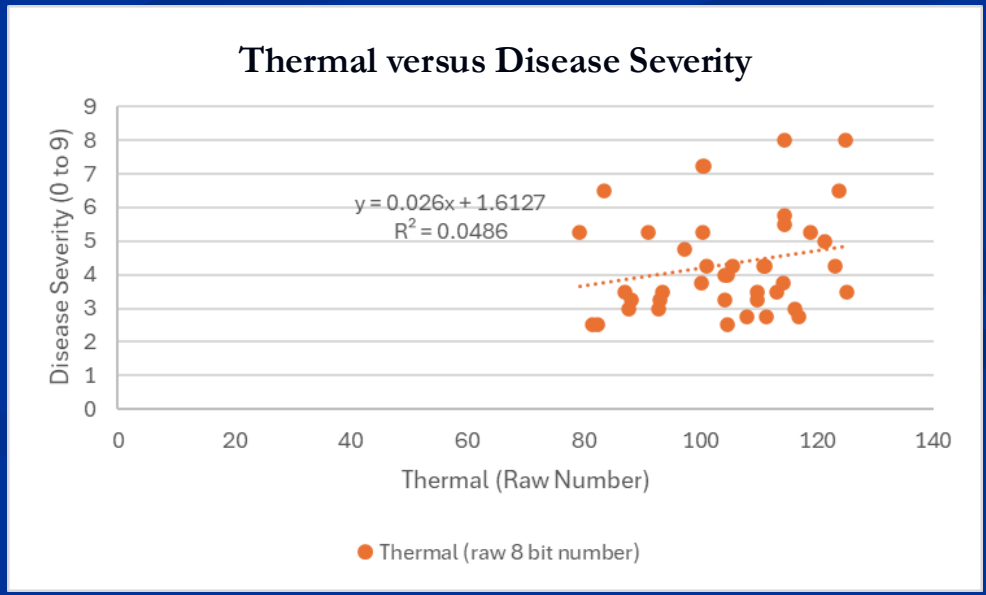
Other Cameras Tested (Corn 2024 Data):

- Thermal => did not work well!!!
  - Always looks good, but never pans out
  - Too many other variances???
  - Thermal hard to work with because of background temps and when you should record it (high noon, midnight, etc.)



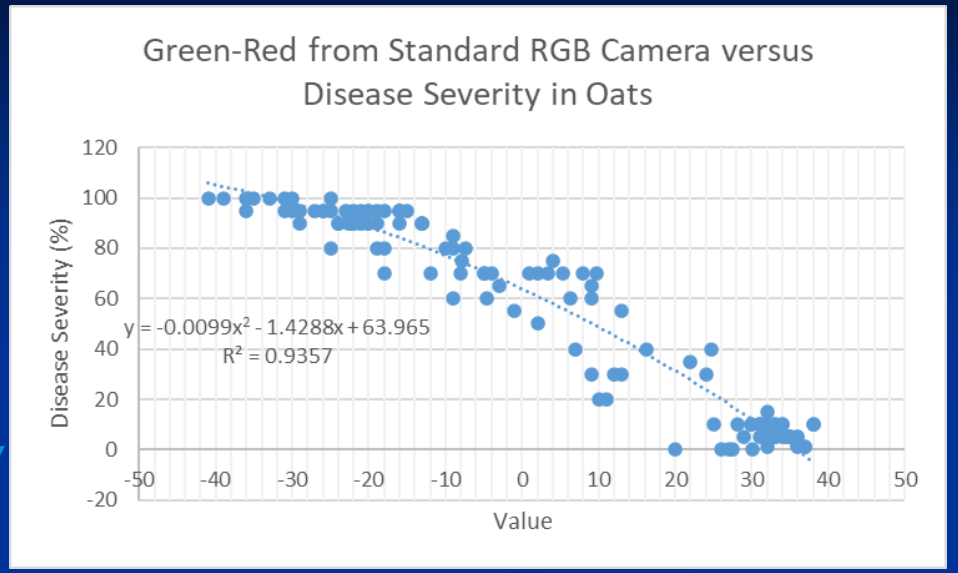


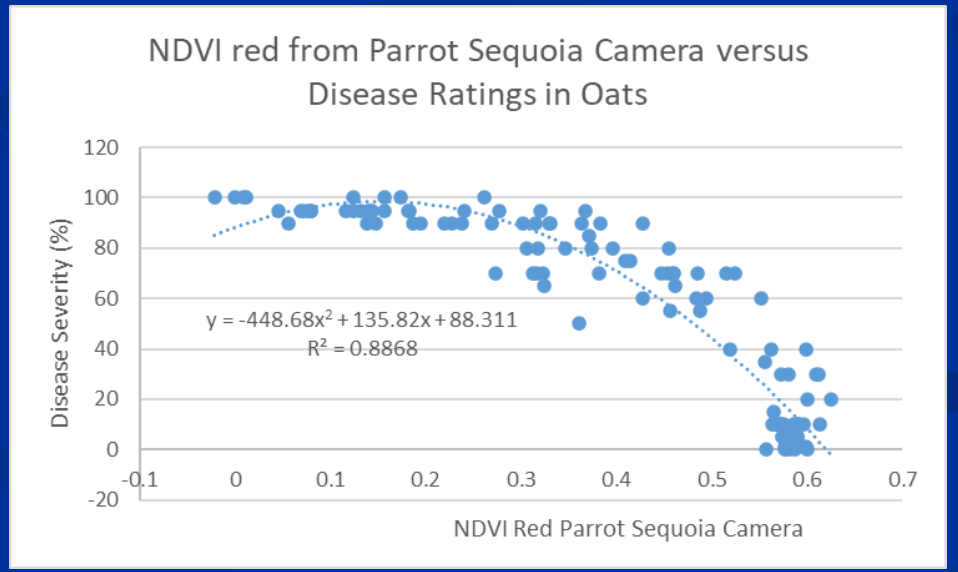




Crown Leaf Rust in Oats:

- Crown Leaf Rust
- Data taken over 4-to-6 week period
- GR index performed better than $NDVI_{red}$
  - GR: $R^2 = 0.94$
  - NDVI: $R^2 = 0.89$





Insect Damage Detection in Soybeans
Wire Worm Damage

GR values for Different Areas:

- Wire Worm damage in field with time:

9/9/20 **=> 3 days =>** 9/11/20 **=> 4 days =>** 9/15/20

Stripe (Yellow) Rust in Wheat:

Close-Ups with Drones Needed for Identification of Type of Disease Detection

- Can detect damage well, but don't know what type of damage without ground truthing
- Close ups needed to have complete answer
- Can fly 2 to 15 ft. off crop
- Drone camera increasing in resolution (100 Megapixels, etc.)

Oblique Image flown 15 ft (4 m) above crop (12 Meg. Pixel)

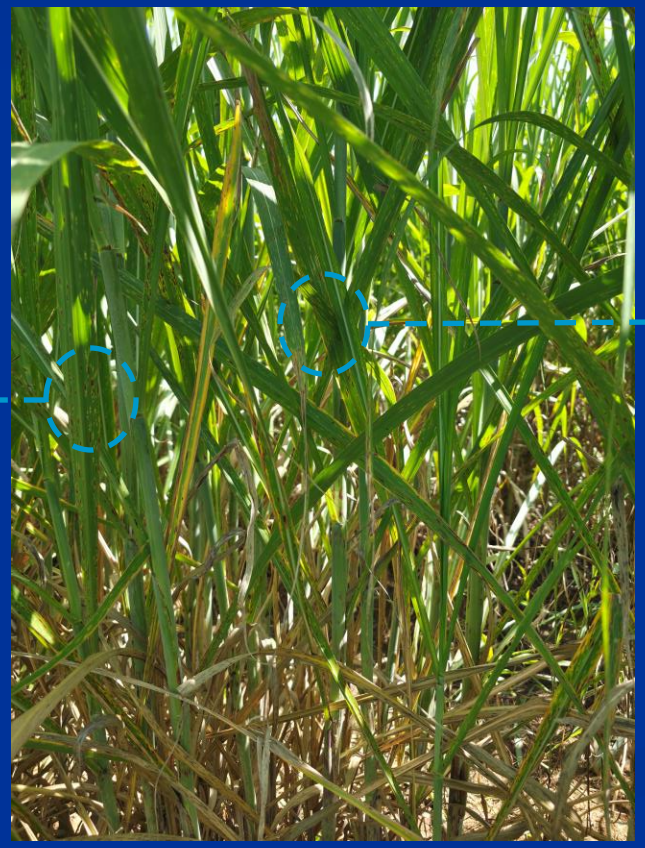
48 Meg. Pixel:

Brown Stripe in Sugarcane:

- 20 Megapixels
  - Not enough to clearly identify feature of Disease

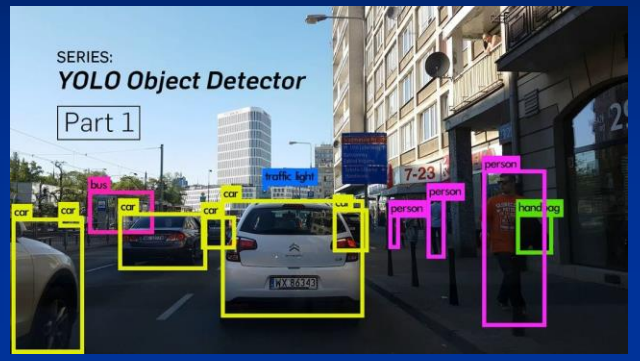
Brown Stripe in Sugarcane:

- 200 Megapixel Imagery:



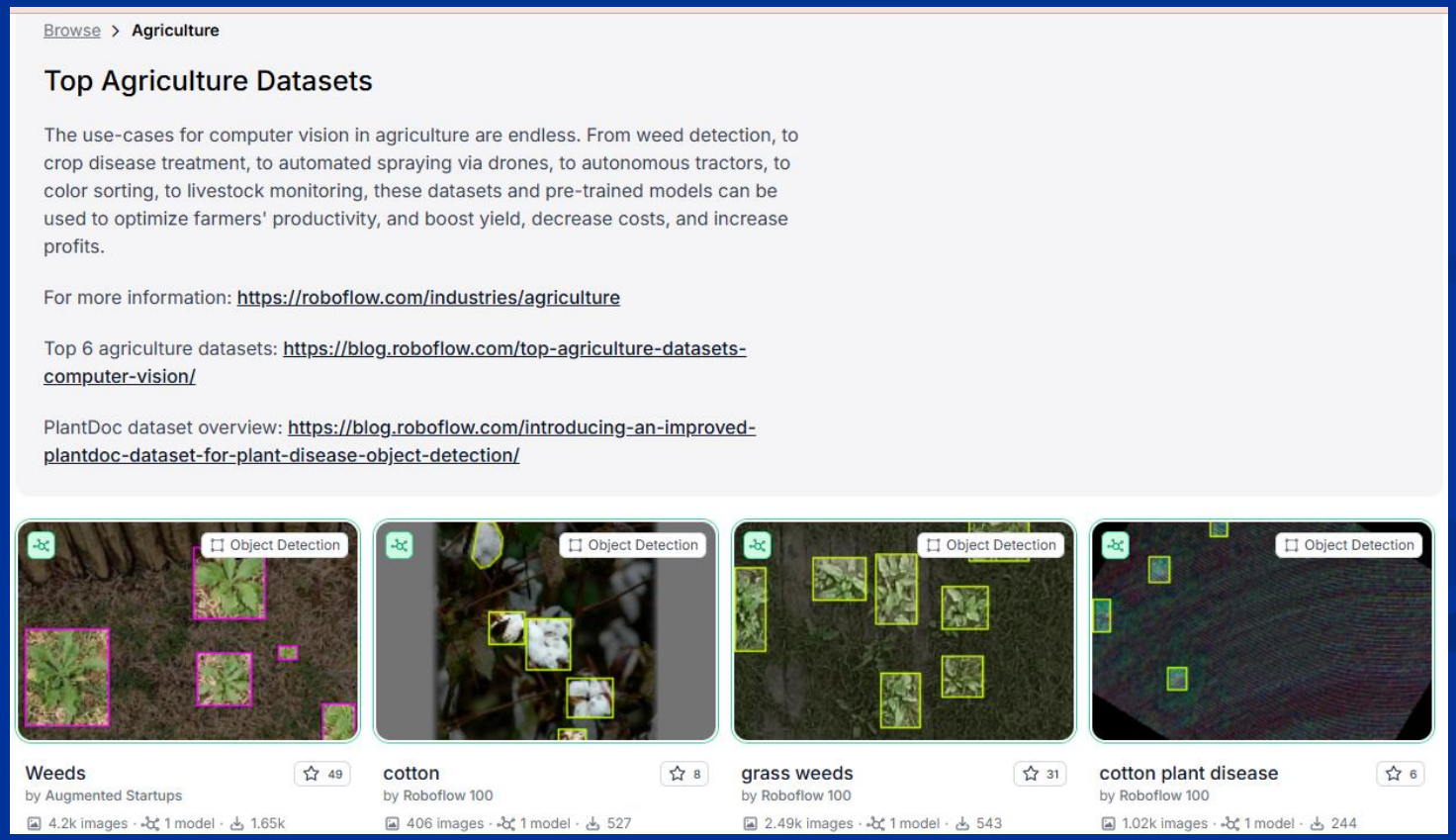
YOLO Stuff:

- A.I. Object Identification
  - YOLO - "You Only Look Once"
  - YOLO1,2,3,4, …. 28
- Training set to find and identify objects in images
- Very fast – 45 fps
- Needs Large Training Sets:
  - 3,000 to 30,000 images



Roboflow:

- Object and feature detection
- Based on model like YOLO (“You Only Look Once”) - SAM3, etc.
- Agricultural datasets



coffee leaf rust

Search By **Subject** | Has a Model | Project Type | Model Type | Advanced Filters | 50 results per page

Related Objects of Interest: red_spider_mite, ferrugem, rust, leaf_miner, brown_eye_spot, leaf_rust, ferrugemw, bicho_mineiro, leaf miner, healthy

Showing 1 - 50 of 300

Instance Segmentation

Yolov8
by Yolov8
105 images
rust cosp phom

Object Detection

tflite
by 864953792@qq.com
2847 images
brown_eye_spot leaf_miner leaf_rus

Object Detection

CoffeeLeafDisease
by AGROCTOR
2847 images
brown_eye_spot leaf_miner leaf_rus

Object Detection

liscie_rust_2
by Rafix
542 images
rust leaf miner

YOLOv11: How to Train for Obje | Roboflow Rapid: Build a Vision | Gemini

rapid.roboflow.com/randy-56ypo/build/review

YouTube | Maps | News | Yahoo | Mic works but I cant... | Spotify | Gmail

roboflow RAPID

Public

Build — Review — Use

How's your experience? Talk with our Team

Files 5

Smaller serction for Yolo.jpg Draft

Reset

How is your model looking?

You can adjust the slider to show more or less objects before taking your next action.

Test on More Files

Adjust Objects

Objects 133

Relabel Objects

Publish and Use Model

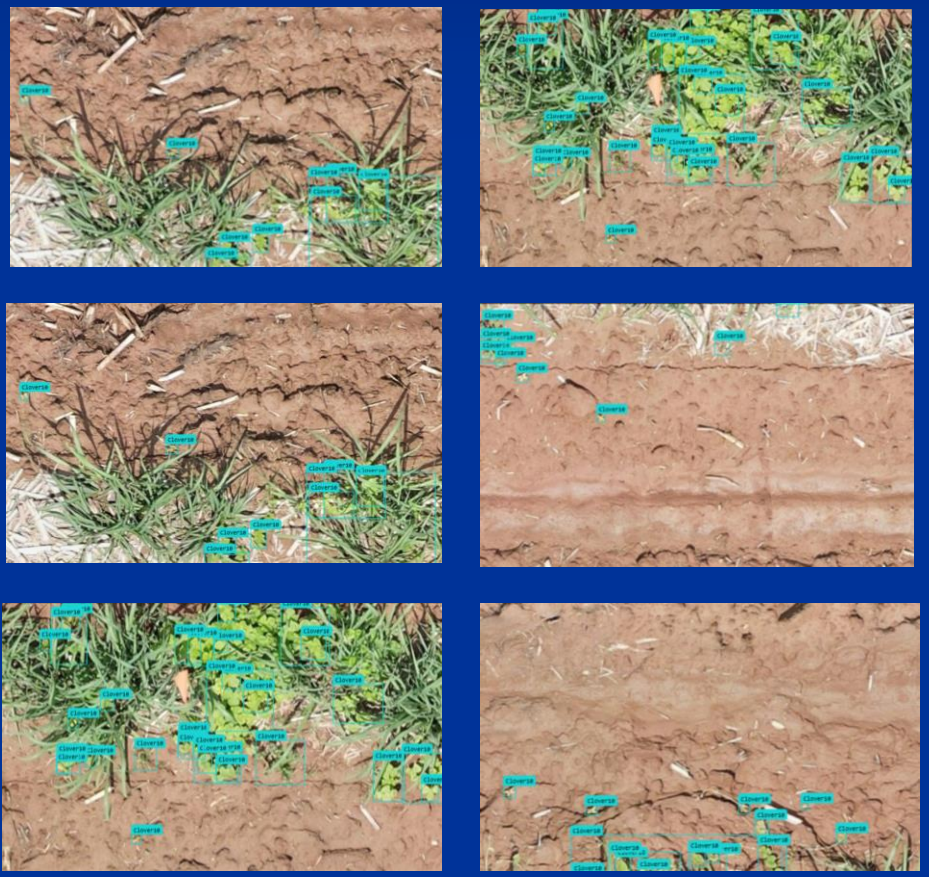
Search

7:55 PM
1/13/2026

Weed Identification in Sugarcane Plot:

Example (SAM3):

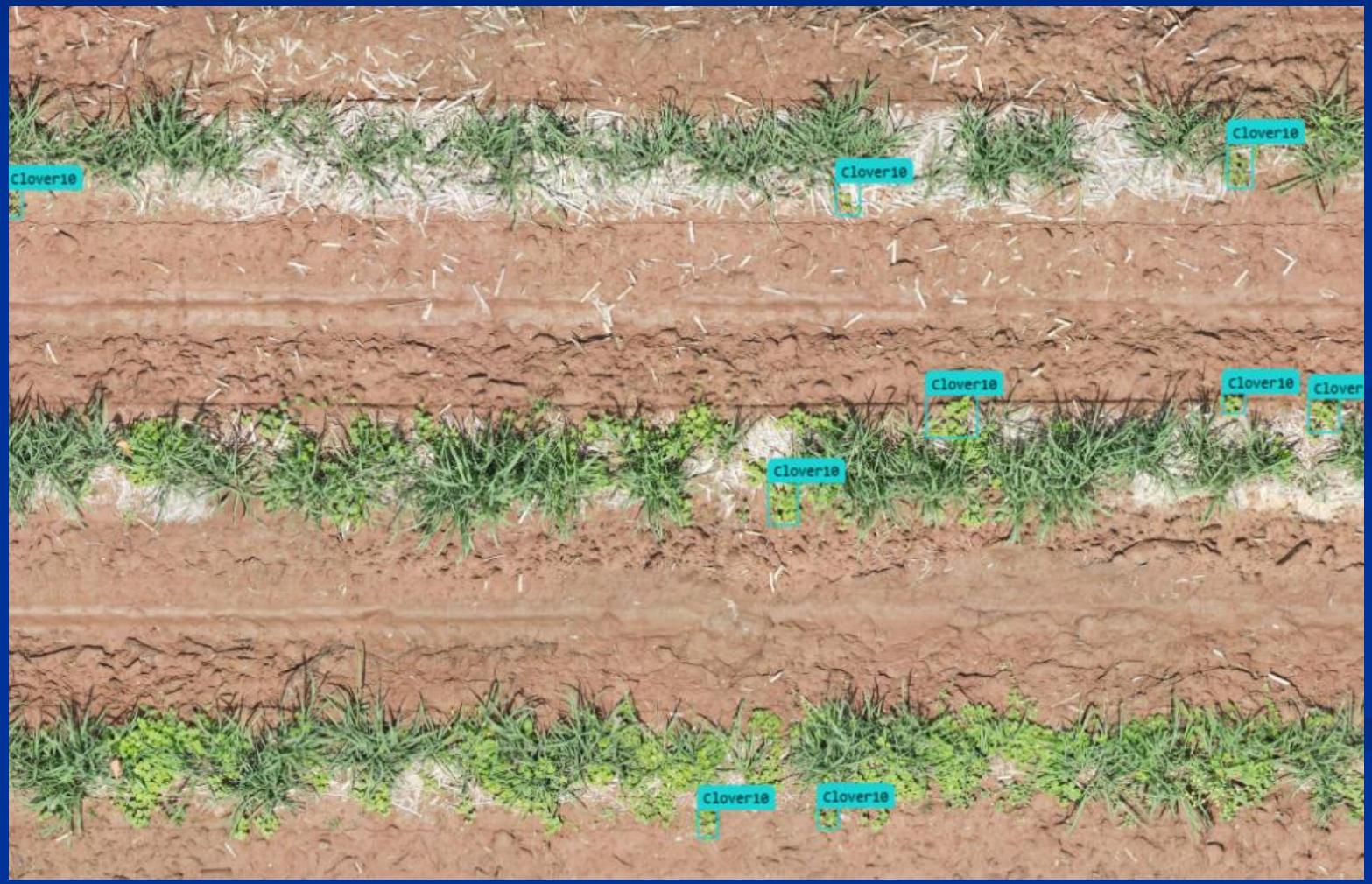
- Training Images:



- Test Images:

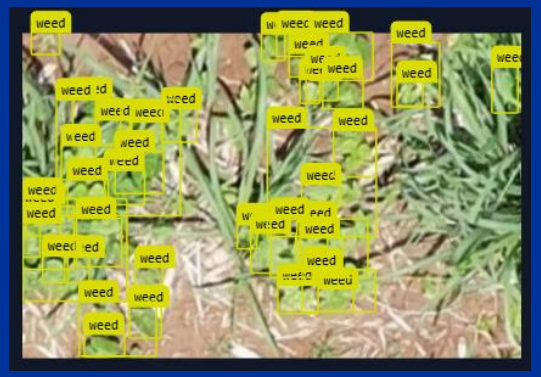
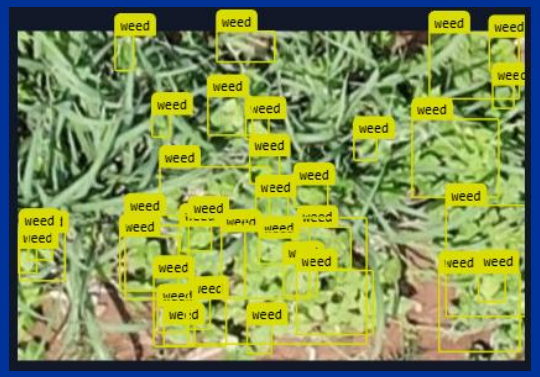
Larger Image Section:

- Did not work as well in larger images:



Results:

- Tried to train it to see smaller, each clover plant

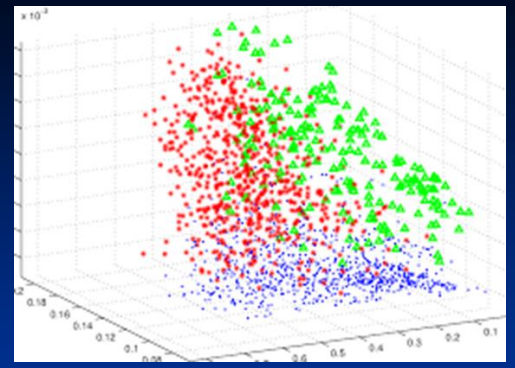





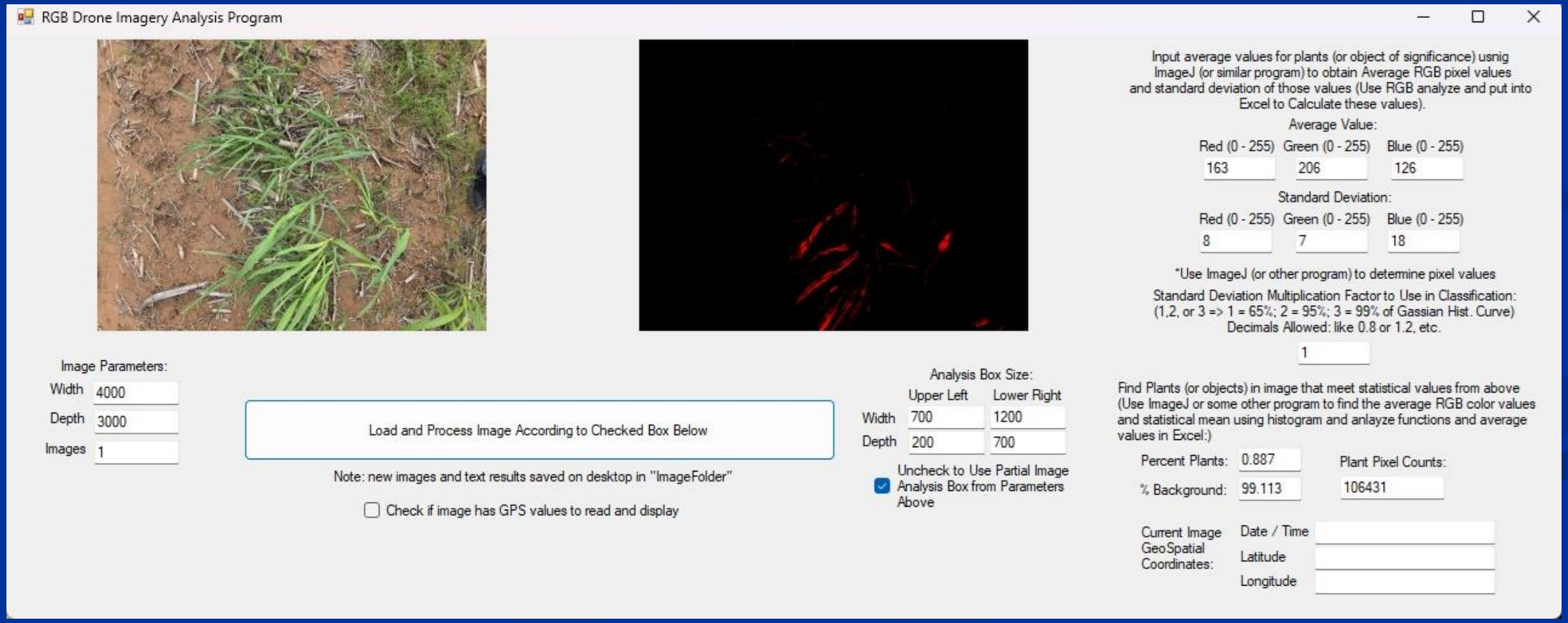


Larger Area Images:

Classifier Method:
Detecting Johnson Grass from Sugarcane:

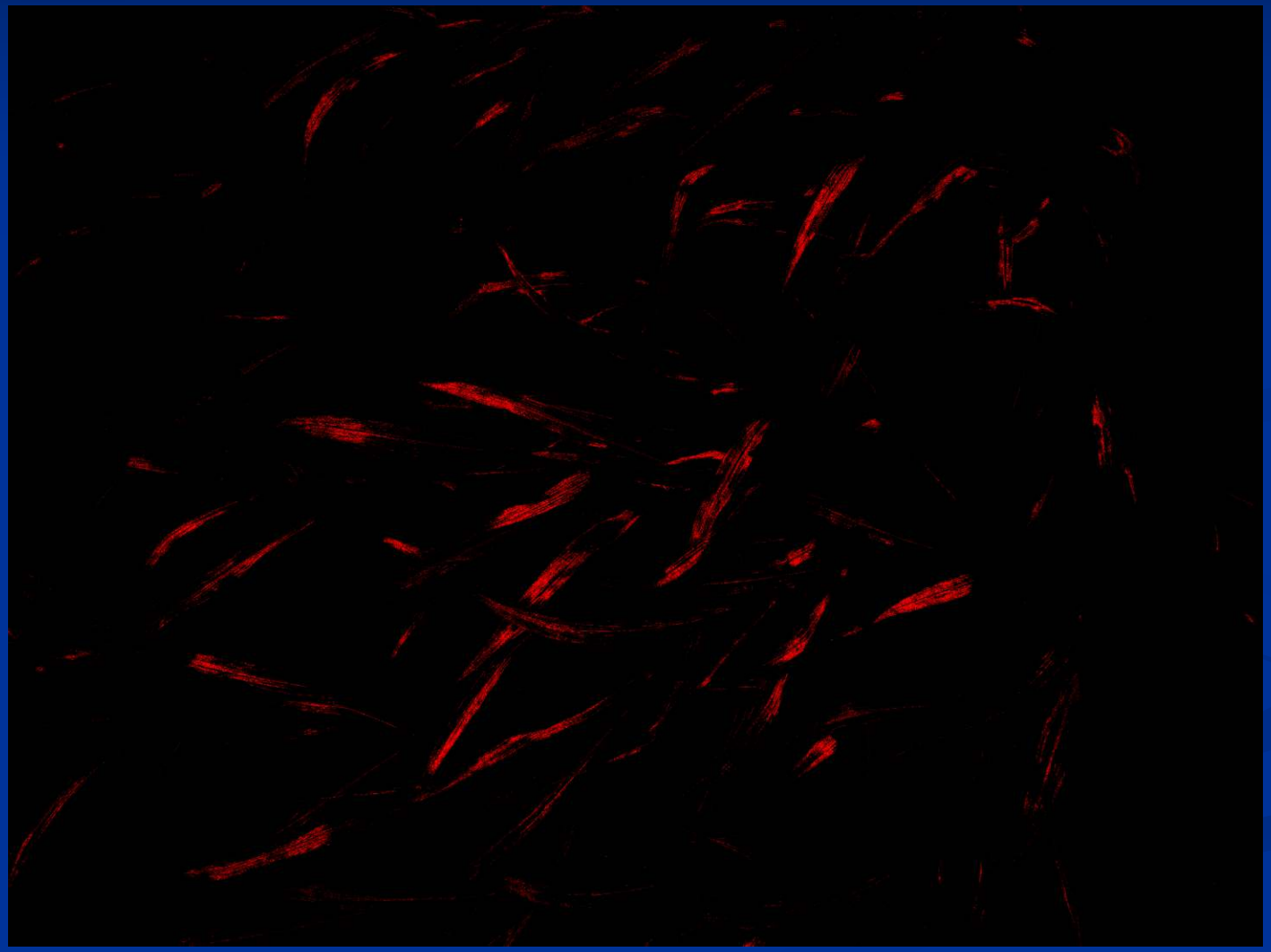


- Calculate median color for each color (RGB) and select based on standard deviation around that mean
- Works when colors different
- High speed: can do 10 to 20 images per second
- Doesn't handle sunlight changes very well (could be more automated with white standards, etc.)



Detecting Johnson Grass from Sugarcane:

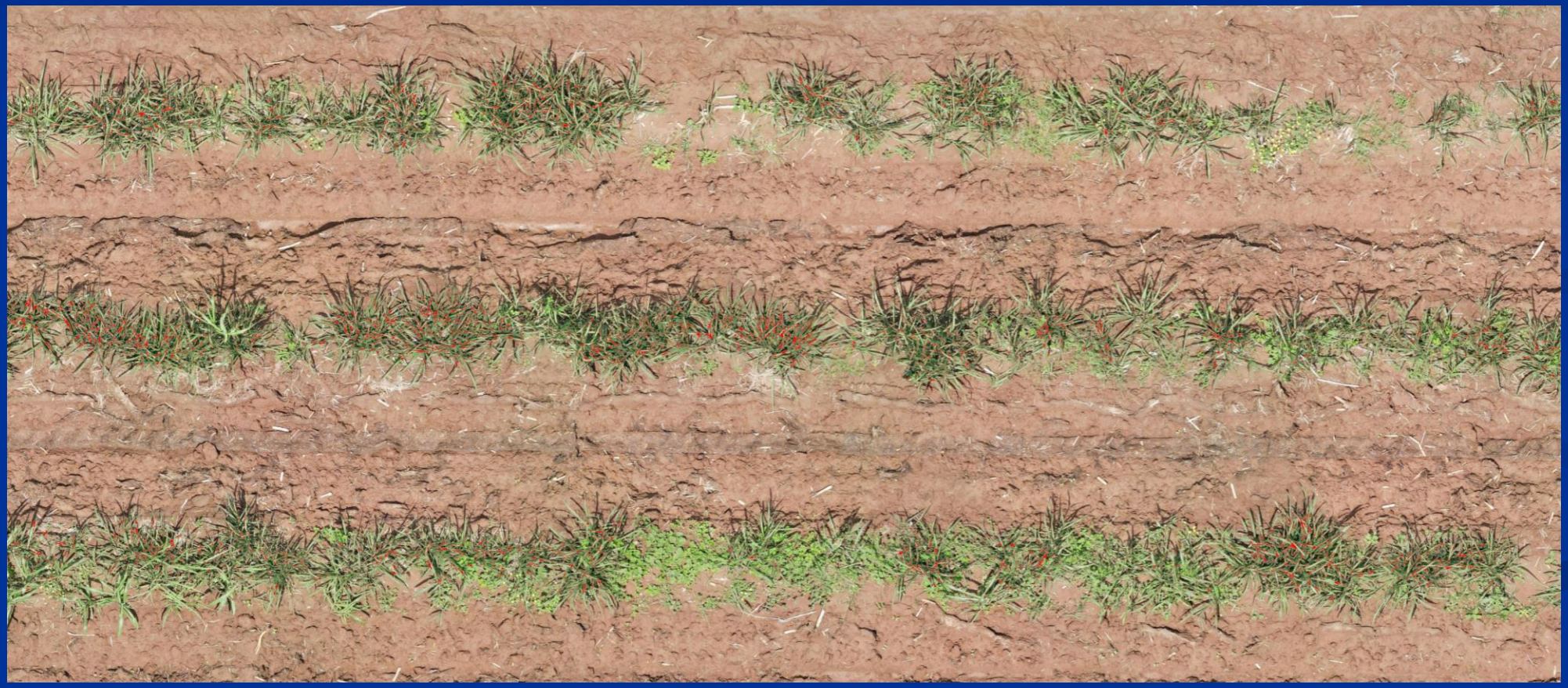
Close-Up of Johnson Grass Selection:



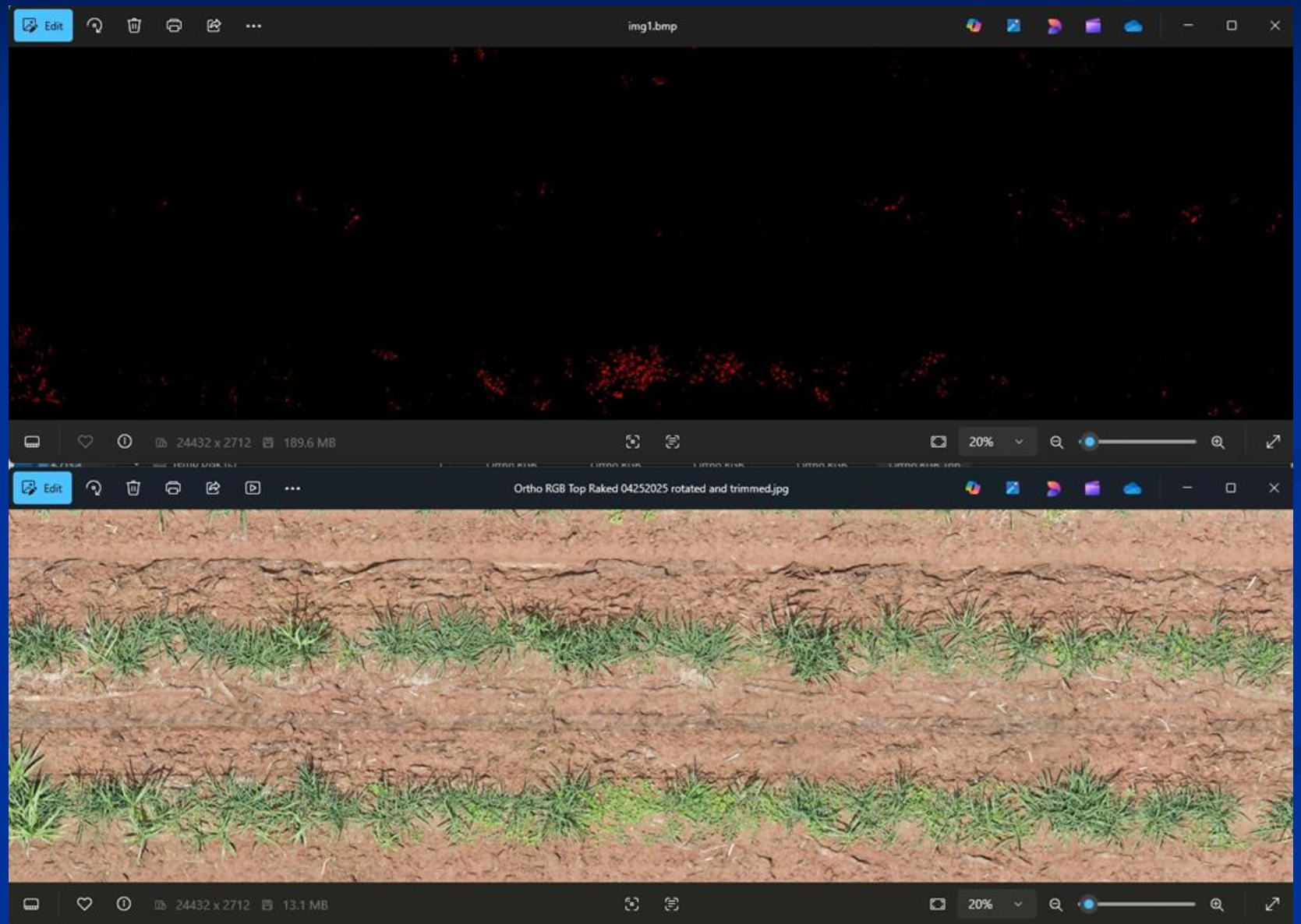
Detect of Sugarcane from Johnson Grass:

Detection of Sugarcane from Clover:

- Larger Image did not affect classification quality:



Detection of Clover From Sugarcane:



Close-Up:

Conclusions:

- Crop disease damage detection and quantification possible with RGB drones
- RGB drones were able to detect crop disease severities with $R^2 = 0.78$ to 0.93 using the GR Index.
- Ground truthing currently required to determine type of disease or damage.
- Total solution will (disease detection and severity) will require both close-up and long-distance imagery.
- Drones will become capable of obtaining both as Pixel resolutions increase
- Newer A.I. systems and machine learning algorithms will most-likely help in this area.

The End

Questions?

Contact Information: Dr. Randy Price, LSU AgCenter, Dean Lee Research and Extension Center, 8105 Tom Bowman Drive, Alexandria, LA 71302; Email: rprice@agcenter.lsu.edu ; Phone: 225-936-7593

Thanks to Following Commodity Boards for Support:

THE LOUISIANA Soybean & Grain RESEARCH & PROMOTION BOARD

American Sugar Cane League

Typical Drone System We Use:

- Low-cost RGB Retail Store Camera Drone:
- Components:
  - Drone ($700 to $3000)
  - Tablet or Smart Phone
    - Recommend iPad or Android fine
  - Program to Operate Drone
    - Manufactures (Free)
    - Mapping software
  - Cables (Longer cables – 10 ft., Adapters, etc.)
  - Storage Case (Optional)
  - Extra batteries (3) and charger in truck, etc.

Figure 1: Complete real-time mapping system: DJI Mavic Pro, case, Apple iPad, DroneDeploy and an extra-long lightning to USB cable.

Index Change:

- Map conversion done to imagery to help highlight properties that you are interested in:
  - For example vegetative state: NDVI, VARI, etc. are good ones
- Index transformations help eliminate camera and sunlight inconsistencies

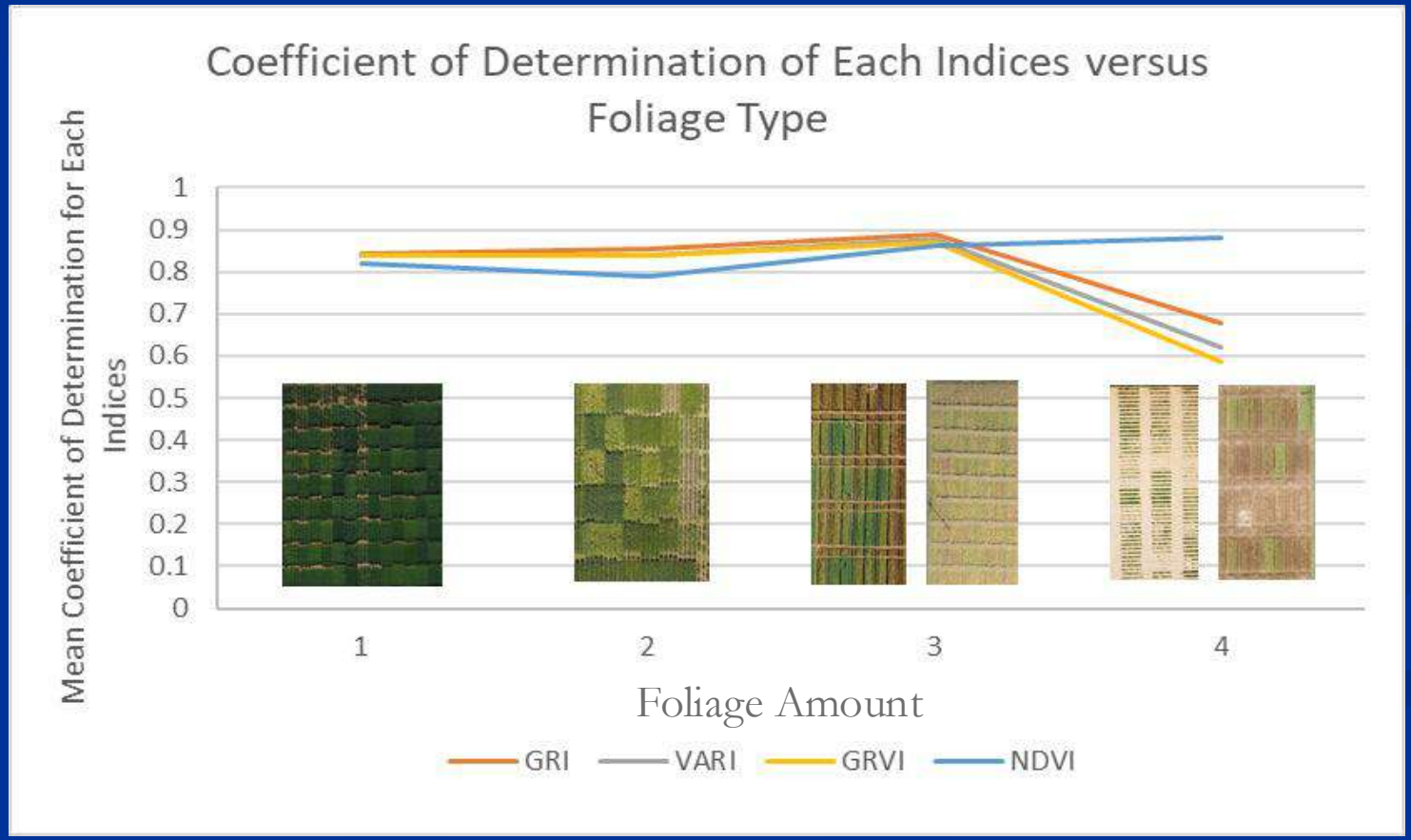
Table. Available indices in *FIELDimageR*. Any other index can be implemented using the option *myIndex* and the new formula (*FIELDimageR::fieldIndex*).

Description	Index	Formula	Related traits	References
Brightness Index	BI	sqrt((R^2+G^2+B^2)/3)	Vegetation coverage, water content	Richardson and Wiegand (1977)
Soil Color Index	SCI	(R-G)/(R+G)	Soil color	Mathieu et al. (1998)
Green Leaf Index	GLI	(2*G-R-B)/(2*G+R+B)	Chlorophyll	Louhaichi et al. (2001)
Primary Colors Hue Index	HI	(2*R-G-B)/(G-B)	Soil color	Escadafal et al. (1994)
Normalized Green Red Difference Index	NGRDI	(G-R)/(G+R)	Chlorophyll, biomass, water content	Tucker (1979)
Spectral Slope Saturation Index	SI	(R-B)/(R+B)	Soil color	Escadafal et al. (1994)
Visible Atmospherically Resistant Index	VARI	(G-R)/(G+R-B)	Canopy, biomass, chlorophyll	Gitelson et al. (2002)
Overall Hue Index[#]	HUE	atan(2*(B-G-R)/30.5*(G-R))	Soil color	Escadafal et al. (1994)
Blue Green Pigment Index	BGI	B/G	Chlorophyll, LAI	Zarco-Tejada et al. (2005)
Plant Senescence Reflectance Index	PSRI	(R-G)/(RE)	Chlorophyll, nitrogen, maturity	Merzlyak et al. (1999)
Normalized Difference Vegetation Index	NDVI	(NIR-R)/(NIR+R)	Chlorophyll, LAI, biomass, yield	Rouse et al. (1974)
Green Normalized Difference Vegetation Index	GNDVI	(NIR-G)/(NIR+G)	Chlorophyll, LAI, nitrogen, protein content, water content	Gitelson et al. (1996)
Ratio Vegetation Index	RVI	NIR/R	Biomass, water content, nitrogen	Pearson and Miller (1972)
Normalized Difference Red Edge Index	NDRE	(NIR-RE)/(NIR+RE)	Chlorophyll	Gitelson and Merzlyak (1994)
Triangular vegetation index	TVI	0.5*(120*(NIR −G)−200*(R −G))	Green LAI, chlorophyll, canopy	Broge and Leblanc (2000)
Chlorophyll vegetation index	CVI	(NIR*R)/(G^2)	Chlorophyll	Vincini et al. (2008)
Enhanced vegetation index	EVI	2.5*(NIR −R)/(NIR + 6*R −7.5*B + 1)	Chlorophyll, biomass, nitrogen	Huete et al. (2002)
Chlorophyll index – green	CIG	(NIR/G) −1	Chlorophyll	Gitelson et al. (2003)
Chlorophyll index – red edge	CIRE	(NIR/RE) −1	Chlorophyll	Gitelson et al. (2003)
Difference Vegetation Index	DVI	NIR-RE	Nitrogen, chlorophyll	Jordan (1969)

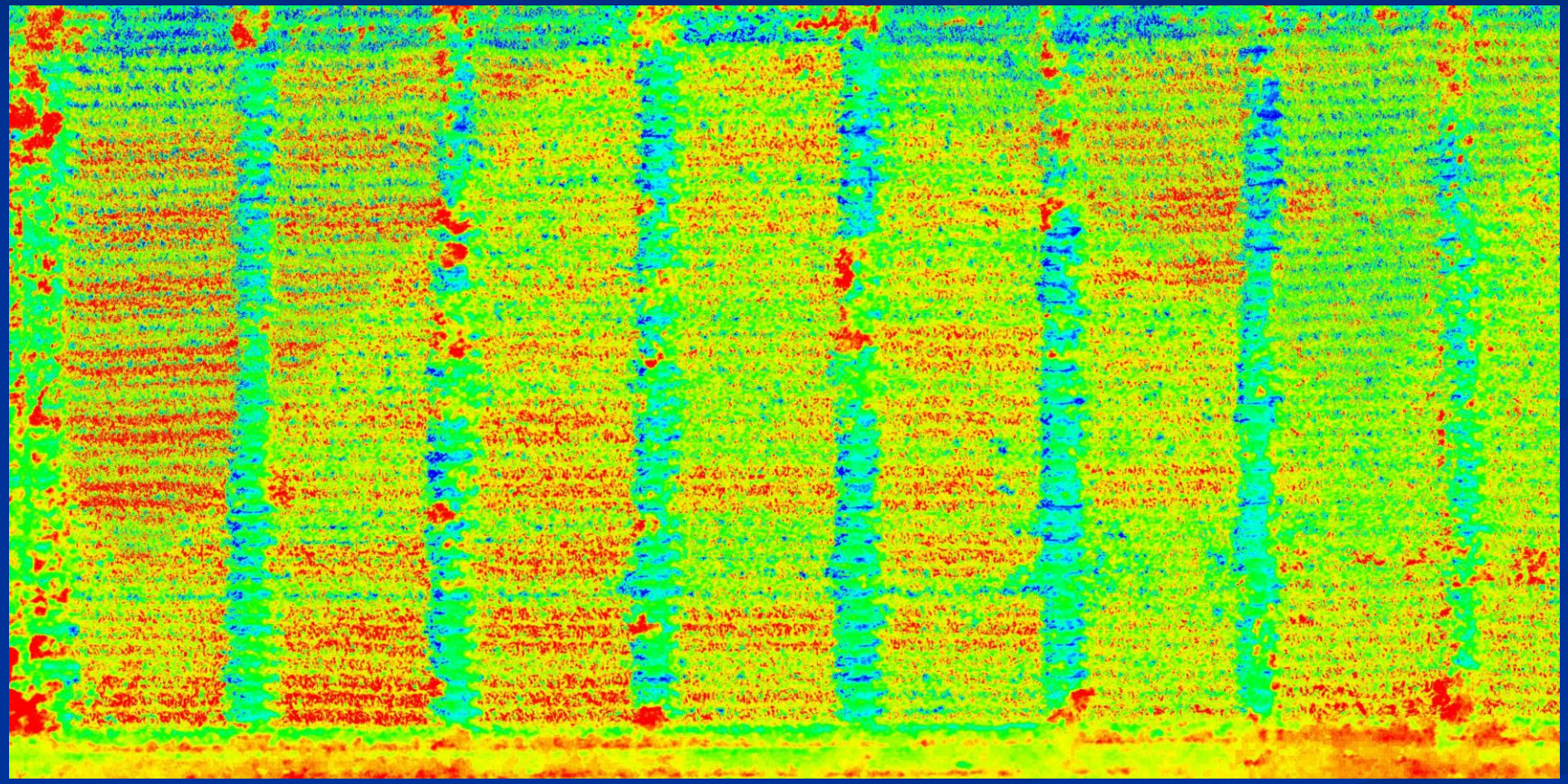
[#] Index HUE was modified to capture better the soil color. Original equation: "atan(2*(R-G-B)/30.5*(G-B))" (Escadafal et al., 1994)

RGB Camera compared to NIR for Detecting General Field Variability:

- RGB cameras (and associated indices) had higher correlation coefficients than NIR cameras with NDVI.
- The NIR cameras (with the $NDVI_{red}$ Index) perform better in fields with less foliage and higher amounts of dead foliage.



GR of 2020 Corn Plot Using Heat Scale:



pGRVI Index Related to NCLB, SCLB, and Rust in Corn (2024):

- $R^2 = 0.83$