A NEW ERA OF AERIAL IMAGERY

Ivan A. Dozier **Chief Agronomist** **IntelinAir, Inc.**

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About Me

‘13 B.S. in Crop Sciences, University of Illinois
Minor in Atmospheric Sciences
‘16 M.S. in Crop Science, University of Illinois

- Taught Crop Growth and Mgmt. & Horticulture
- Nabor House Exec Board
- Students for Chief Illiniwek

- 2 Years with IntelinAir
- Previously with Bayer CropScience

- Family Farm in Mill Shoals, IL (White County)

Ivan A. Dozier

Chief Agronomist & Image Analyst

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IntelinAir is a leading company in the precision agriculture space, providing easy-to-use and actionable analysis of high-resolution images to identify issues and opportunities.

- 2015: Founded; NSF Grant for Weed Detection
- 2016: Beta Year with Drone Technology
- 2017: AgMRI becomes Commercially Available
- 2018: Tripled Number of Customers; >85% Customer Retention
- 2019: AgMRI 2.0 introduces improved Broad-Scale Interface

IntelinAir primarily supports corn/soy ops in Illinois, Indiana, and Iowa

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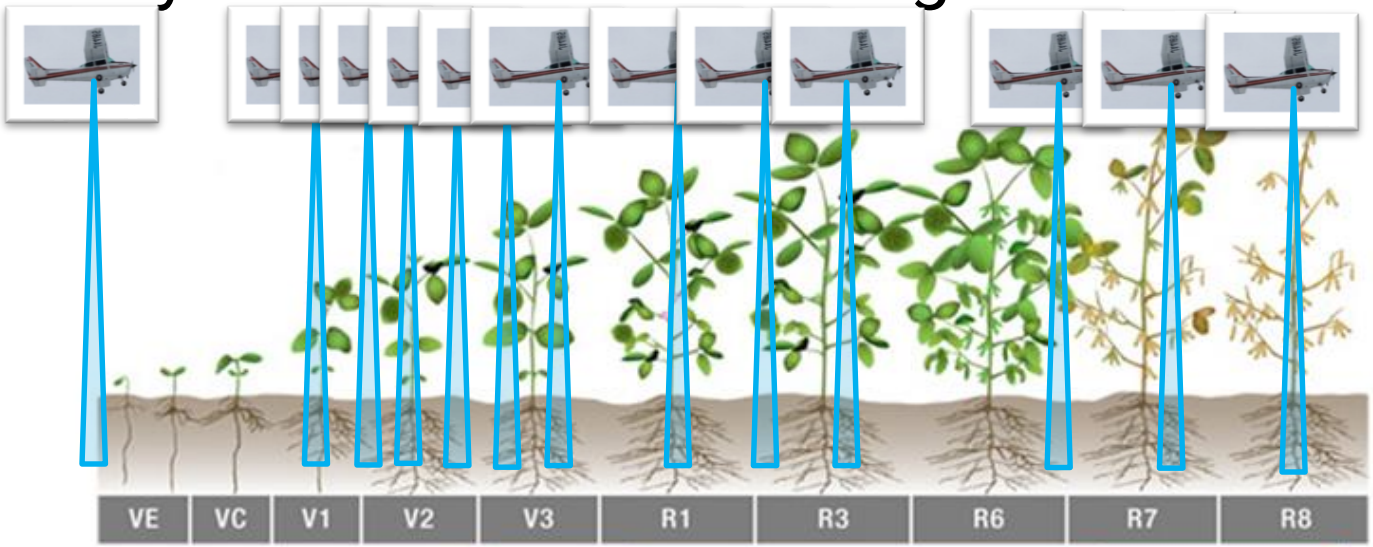
Soybean Decisions Throughout the Season



Harvest

- Identify Root Rot, Crusting, Poor Emergence
- Replant
- Evaluate Tile Lines

- Apply Herbicide
- Apply Insecticide
- Identify High Risk Areas for Disease

- Scout for SCN
- Scout for SDS
- Identify Leaf Disease; Stem Rot; Insects; Nutrient Deficiencies
- Identify Weather Damage

- Identify Late Season Disease / SDS
- Time Harvest
- Help with Insurance Claims

- Analyze Factors that Drive Yield
- Validate Nutrient Prescriptions
- Improve Variety Selection

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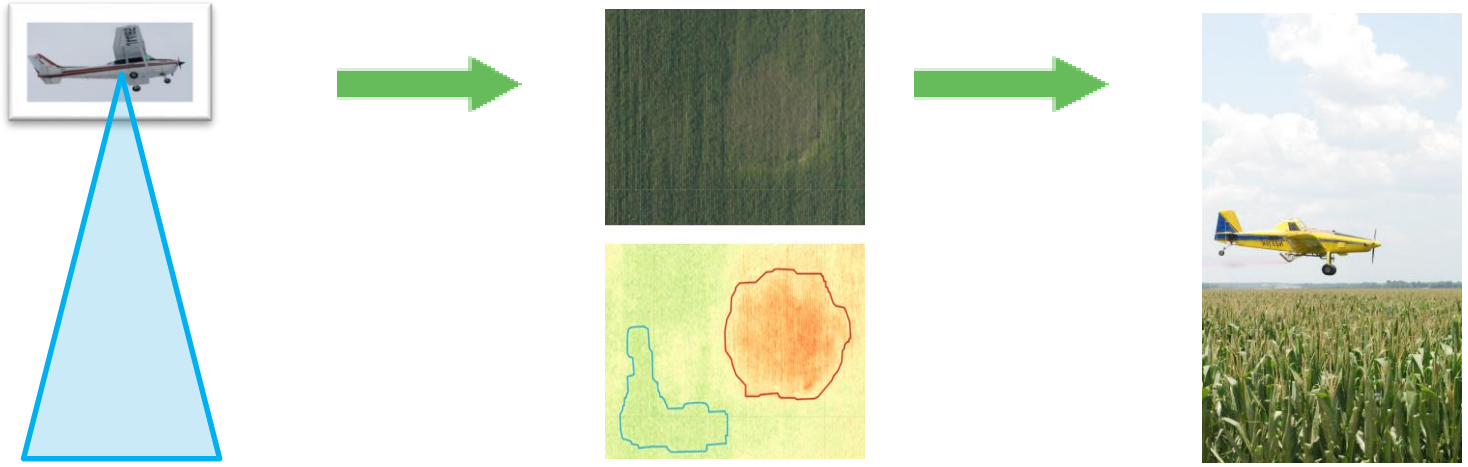
BRAD PITT
MONEYBALL

OVERVIEW

- Era 1: Raw Image Collection
  - Timing, Sources, and Scale
- Era 2: Better Tech, Better Image Specs
  - Resolution, Wavelength, and Data Management
- Era 3: Image Analytics
  - Anomalies, Sort-Filter; Notifications & Alerts



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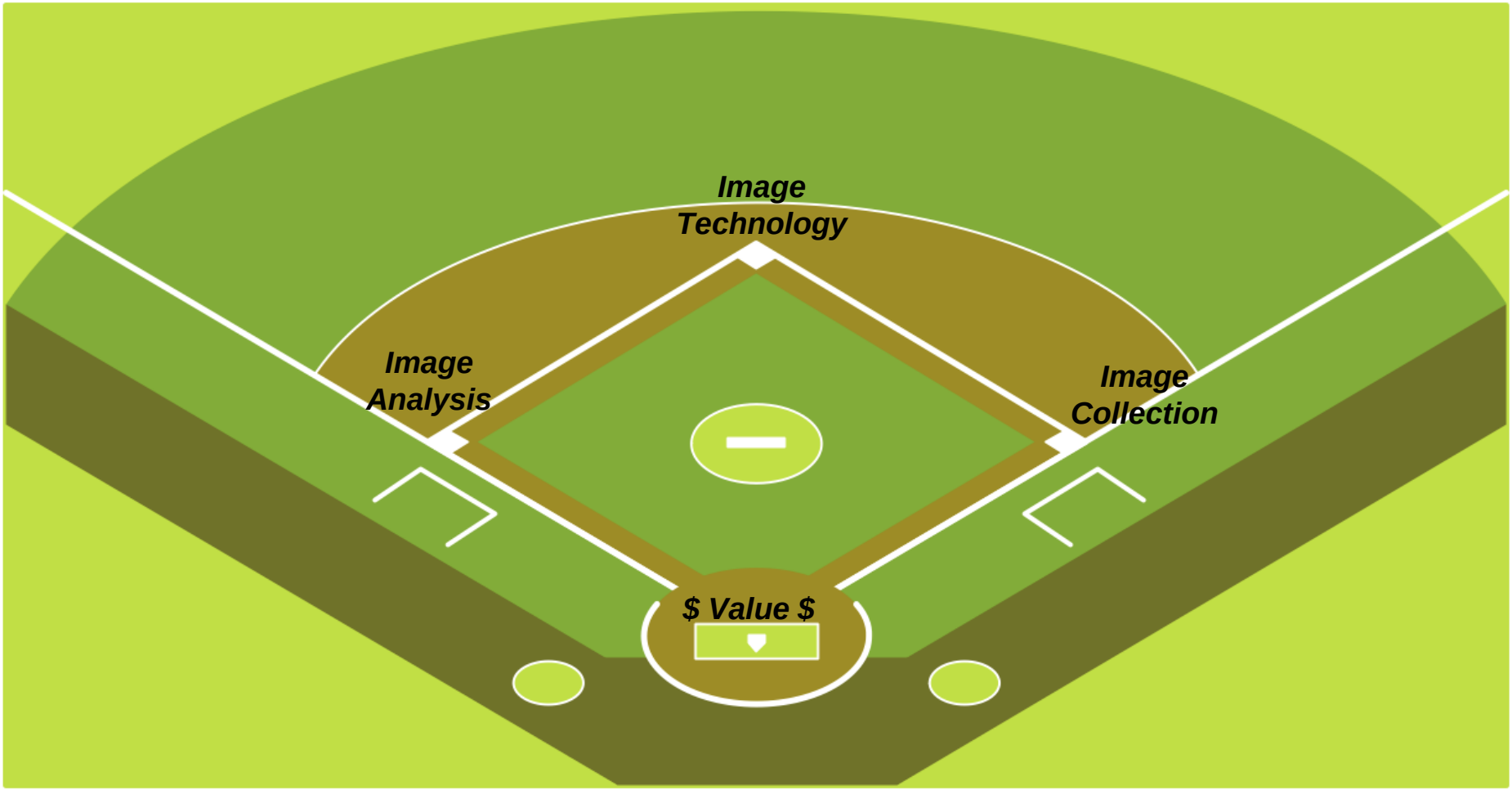
OVERVIEW to GENERATING VALUE



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First Things First, Where Does Imagery Come From?

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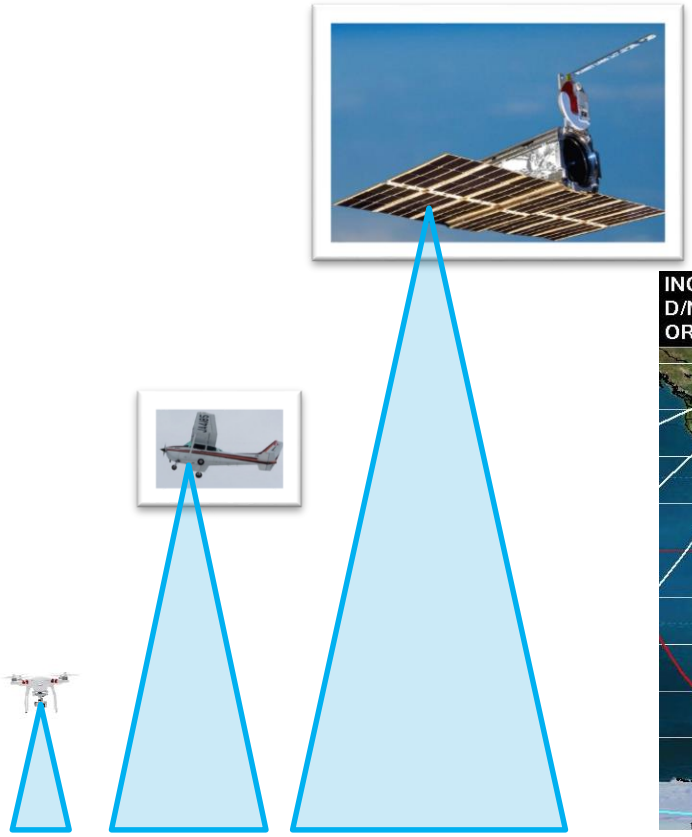
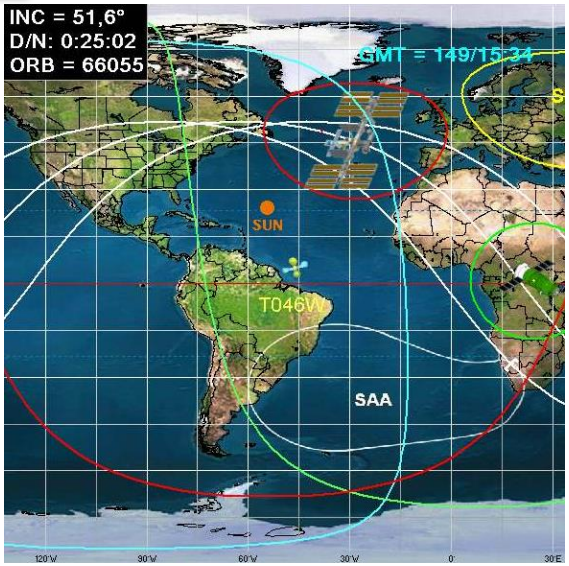
A Challenge of Scale: Technology meets Data Management

- Resolution & Scale Drive Capacity for Deep Learning

- Altitude Trade-Off
  - (Area * Resolution)





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Choosing an Image Provider: Drones; UAVs

- Pros
  - Prices have plummeted
  - Getting easier to use
  - Can achieve high resolution from flying right above the canopy
  - Fly on demand
- Cons
  - Someone has to fly
  - Battery limitations + prohibition on beyond line of sight flight limits acres that can be covered in a day
  - Licensing required / still a bit complex
  - Make sure you have a good camera if you want to do analysis

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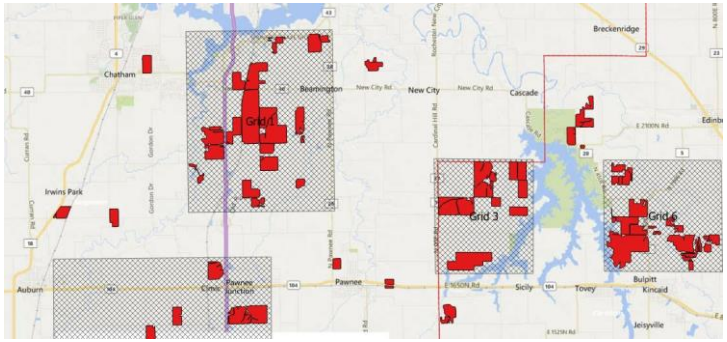
Choosing an Image Provider: Airplanes; Manned Aircraft

- Pros
  - Can cover large numbers of acres
  - Supports an expanded range of sensors
  - Becoming increasingly more affordable due to sensor technology improving and new subscription offerings
- Cons
  - Flights typically happen on a schedule or with a lag time
  - Compared to a drone, resolution is limited
  - Can be areas with difficult or infeasible coverage



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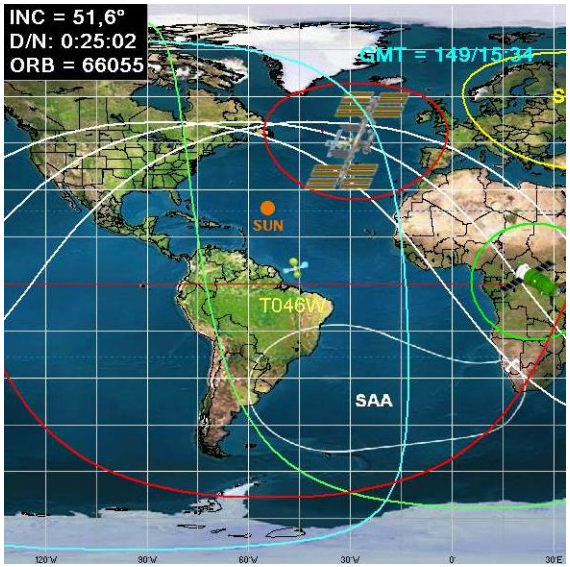
Choosing an Image Provider: Satellite

- Pros
  - Cheap
  - Ubiquitous
  - New systems mean more frequent visits
- Cons
  - Low spatial resolution
  - Cloud cover
  - Thermal blocked
  - Actionability during the season is limited / misses early season
- Uses
  - Once canopy closes, management zones/yield prediction on large scale



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Choosing an Image Provider:

Resolution

Dependability; Scale

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Taking a Second to Check Out the Stats

All-Star; World Series MVP
5’6” / 170 lbs.
David Eckstein
.294 / 8 HR / 61 RBI

6’4” / 200 lbs.
Scott Seabol
.219 / 1 HR / 10 RBI

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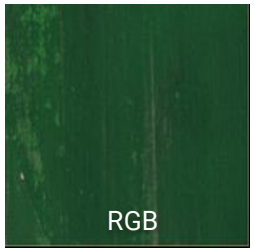
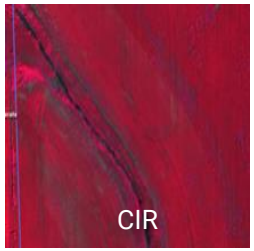
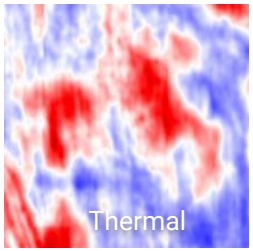
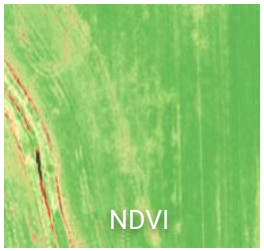
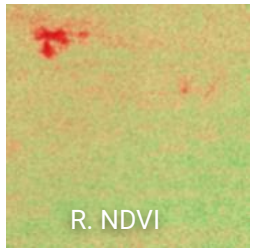
Multispectral Data Analysis







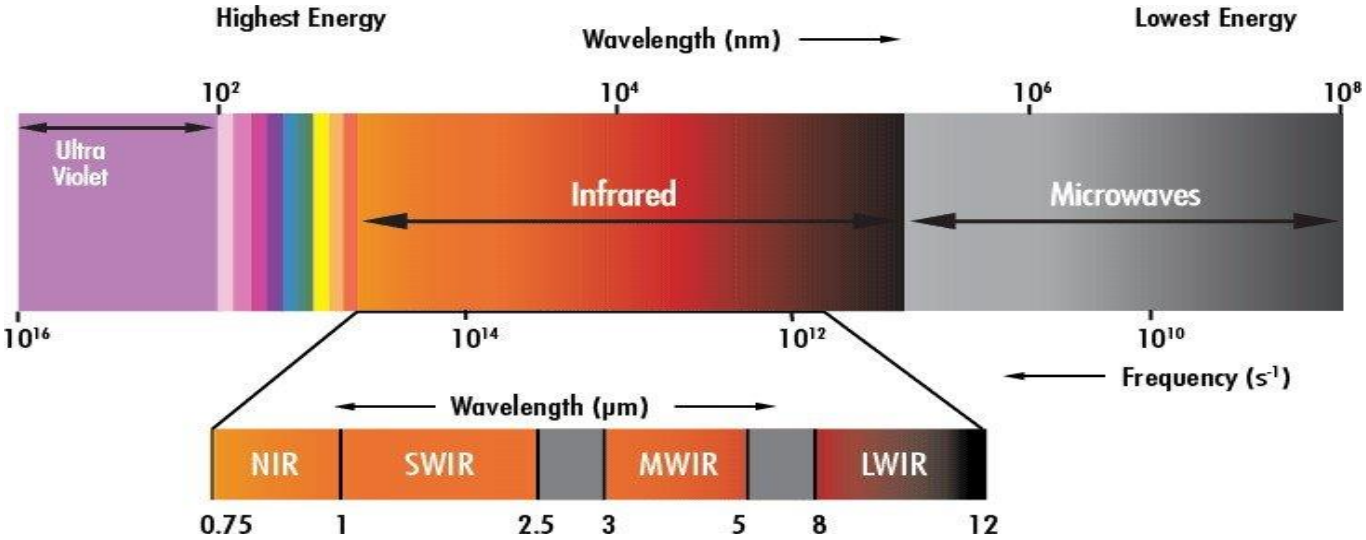




- AgMRI supplies tilesets from multiple inputs across the visual and non-visual spectrum for comprehensive diagnostics

- Each tileset is generated using high resolution imagery inputs to supply insights on a plant-by-plant basis.

Normal cameras capture imagery in the visible light spectrum



Thermal & CIR cameras measure band of infrared radiation

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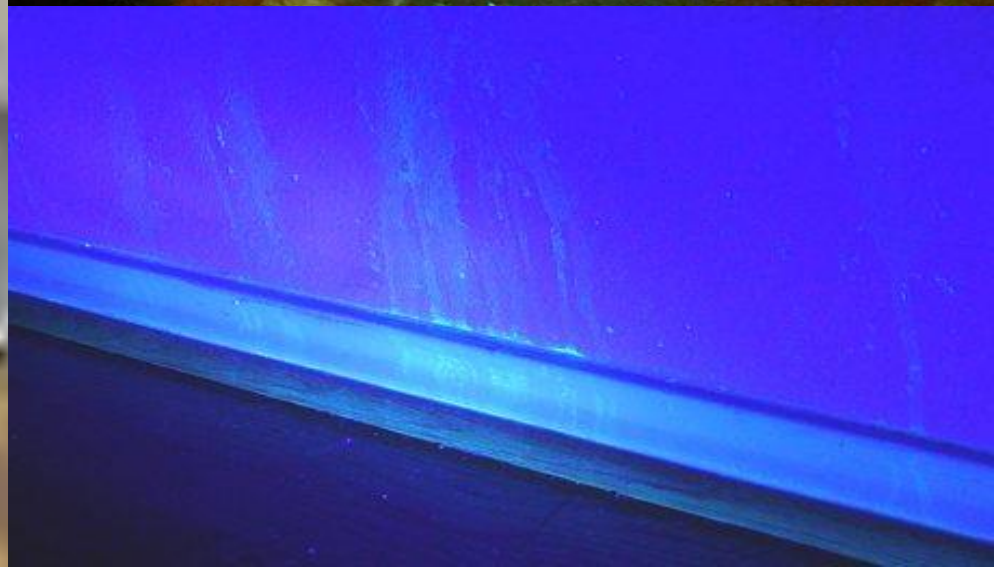
What Kind of Imagery is Available?



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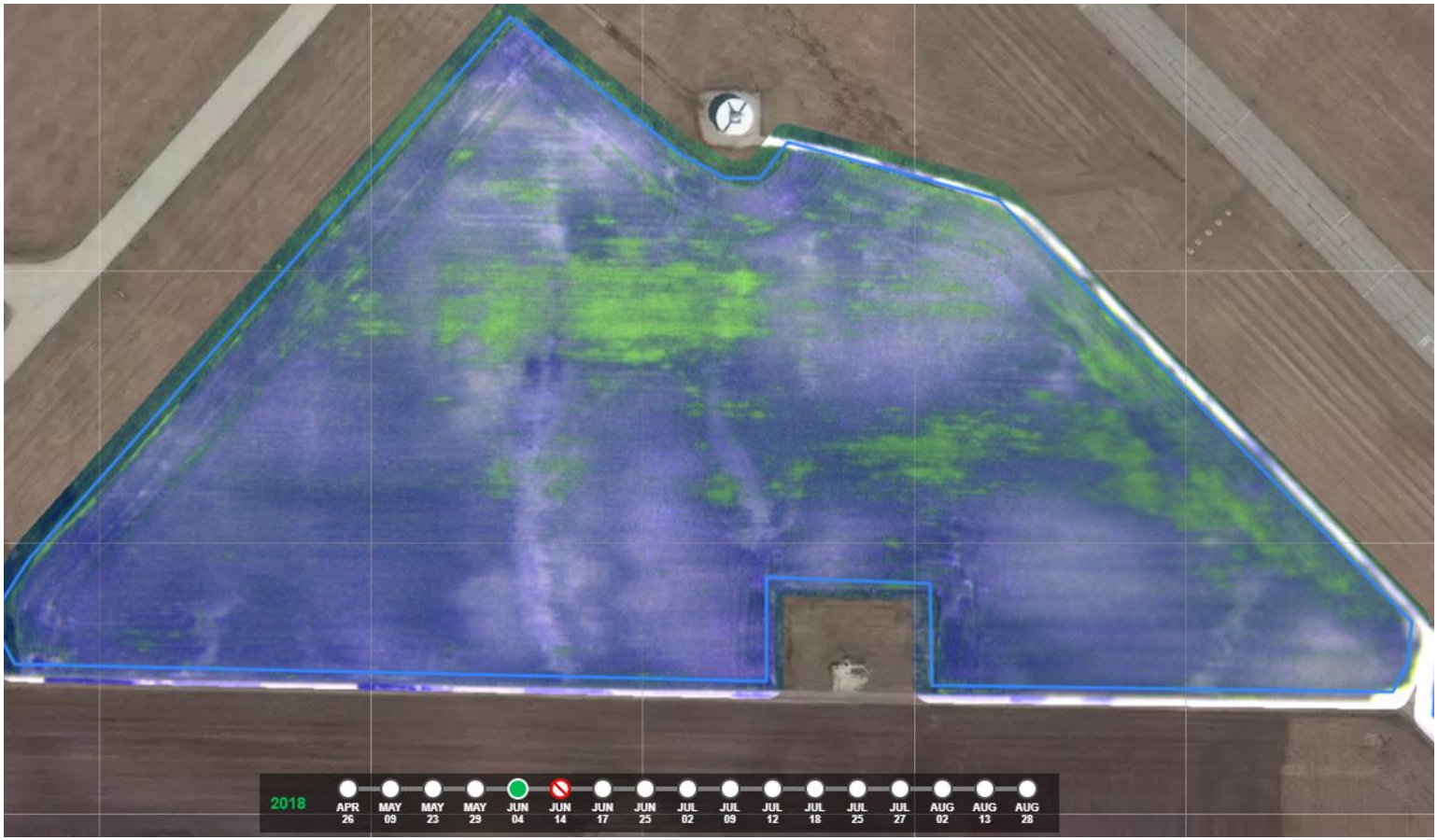
Bird’s Eye (Red, Green, Blue)

- Uses Red, Green and Blue bands to generate true color image



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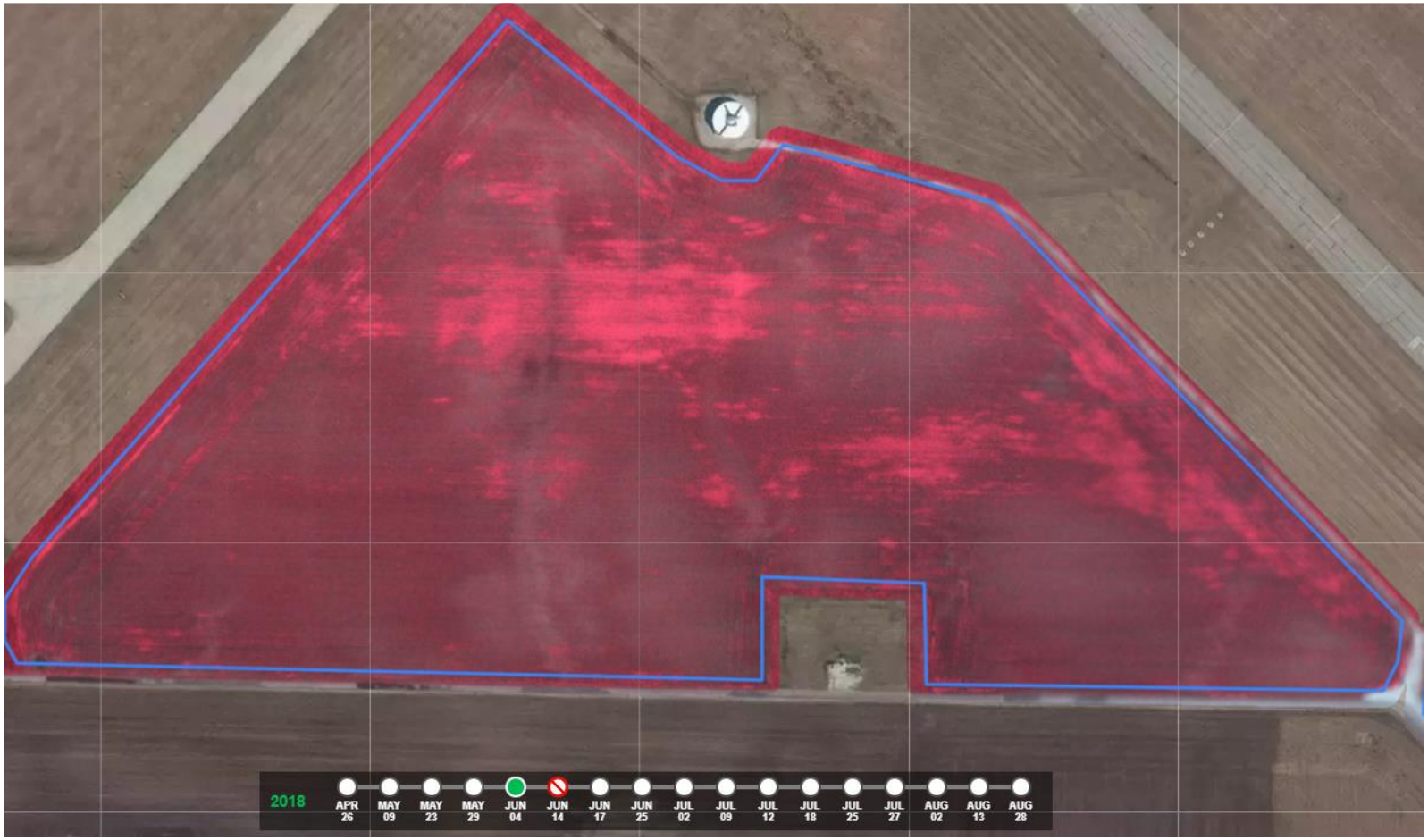
CIR (Color Infrared)

- Uses the NIR, R, G bands; to show plant responses invisible to the naked eye



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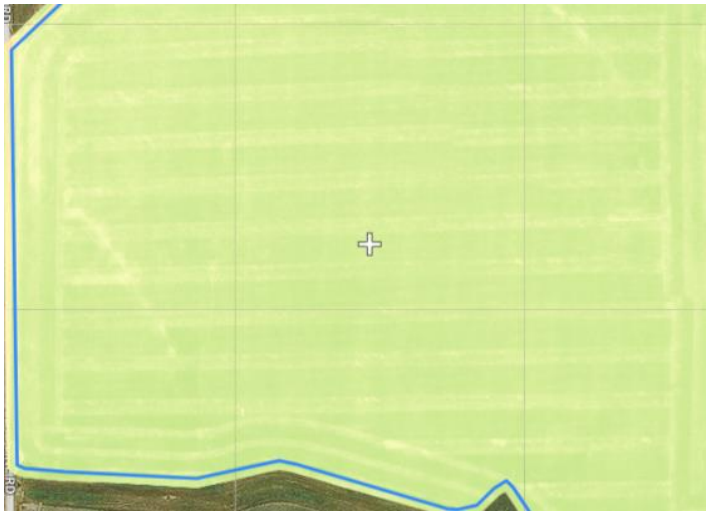
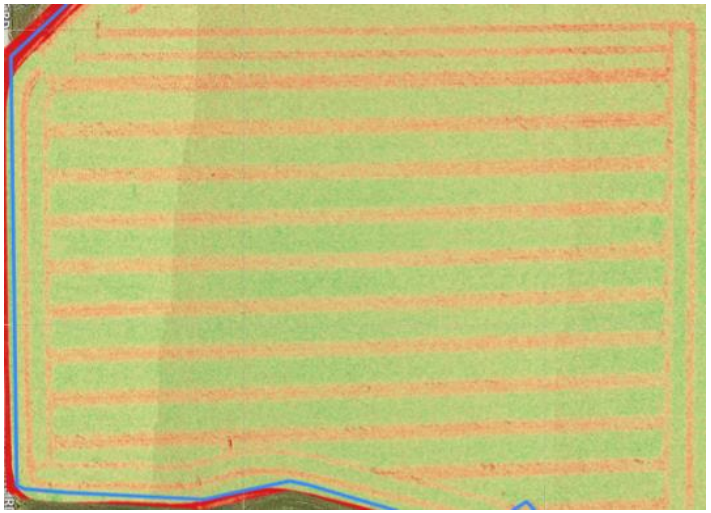
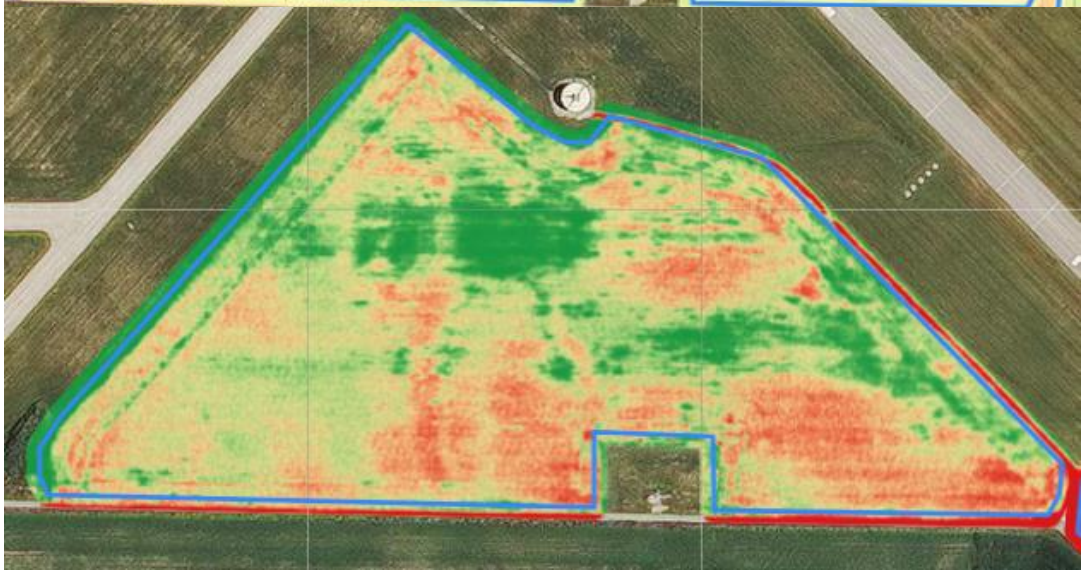
NDVI (Normalized Difference Vegetation Index)







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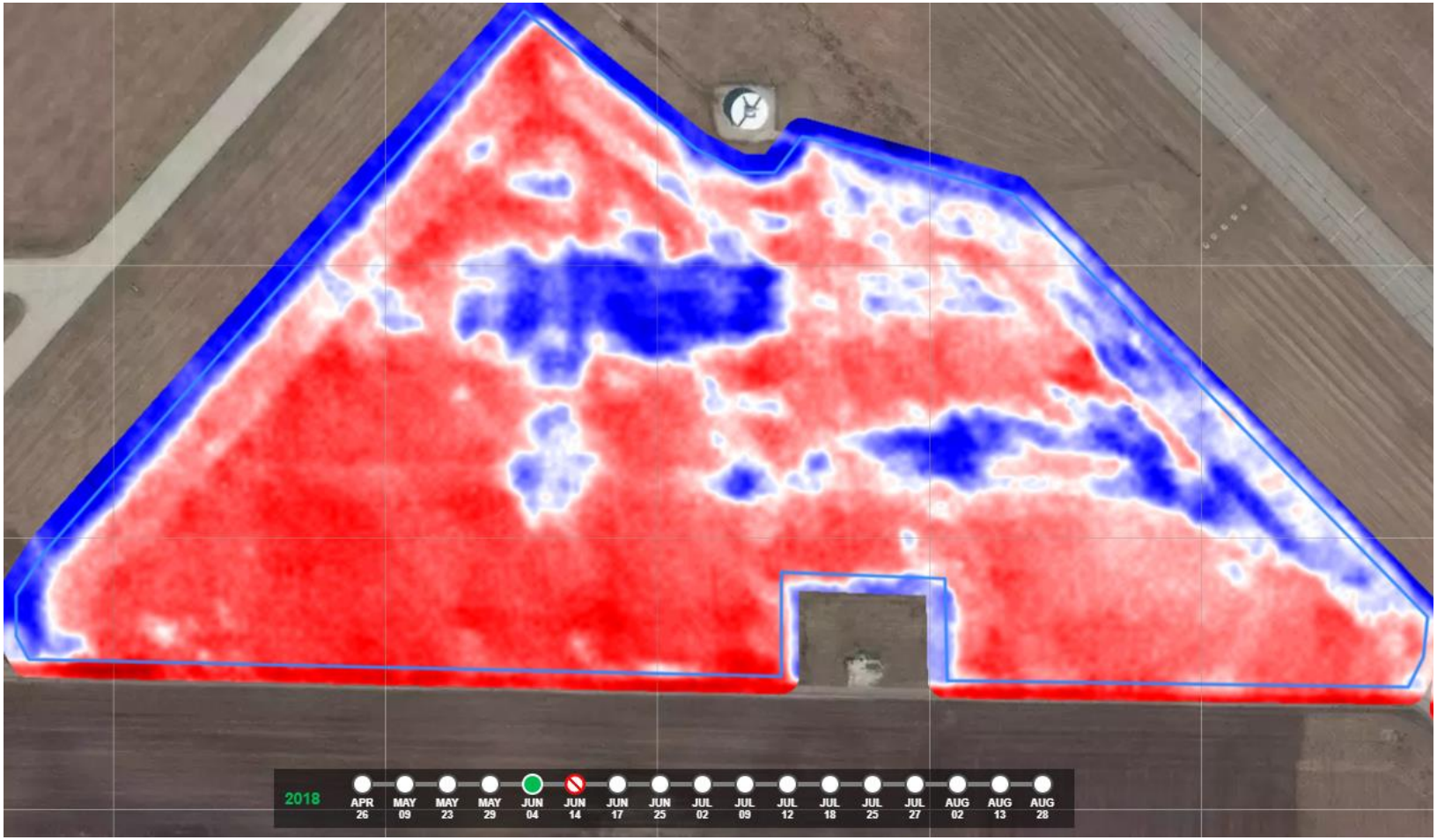
Thermal

- Measures infrared heat-radiation; Highly correlated to field moisture



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Each Lens is a Tool, Use it When You Need It

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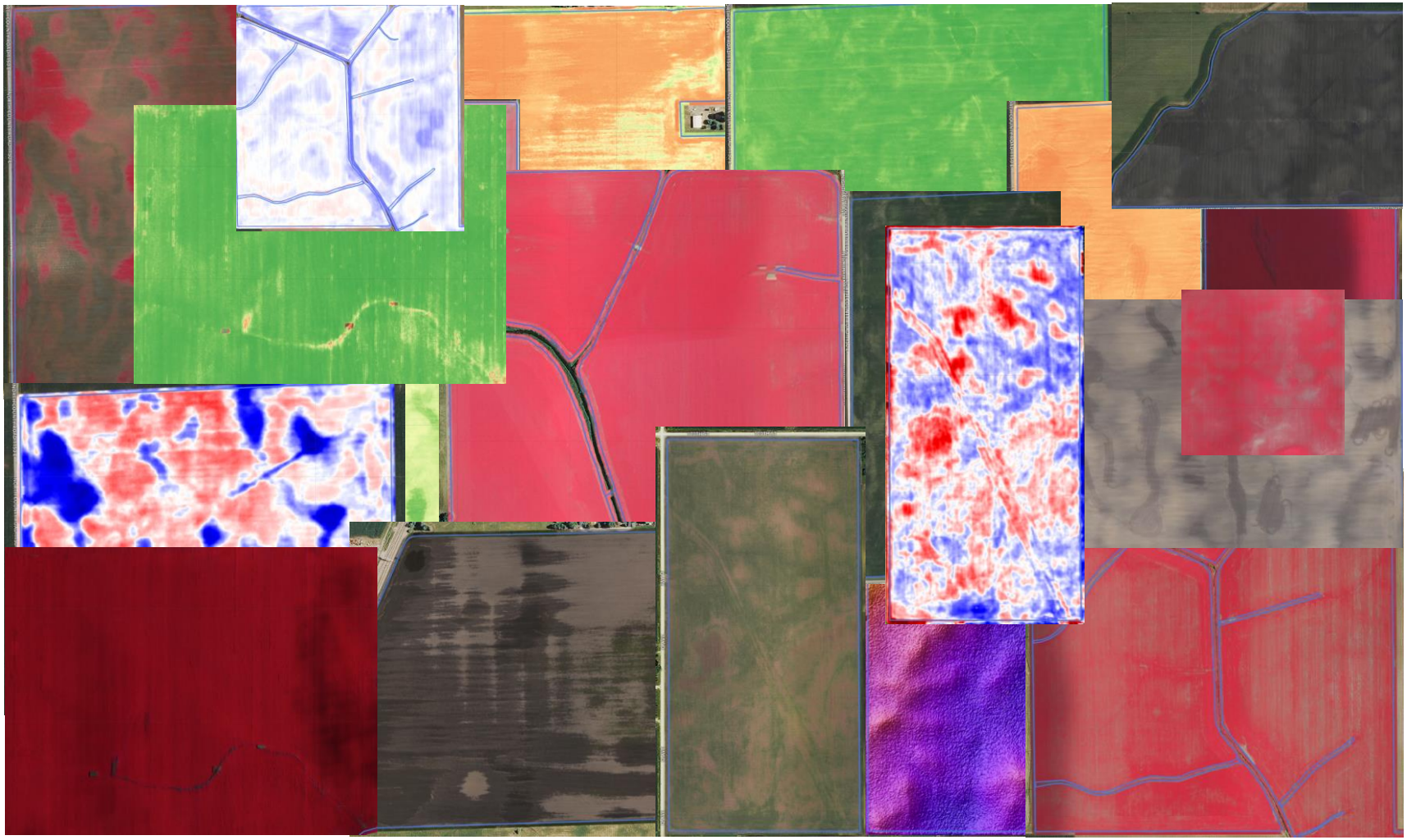
With No Analytics … Imagery Overwhelms:



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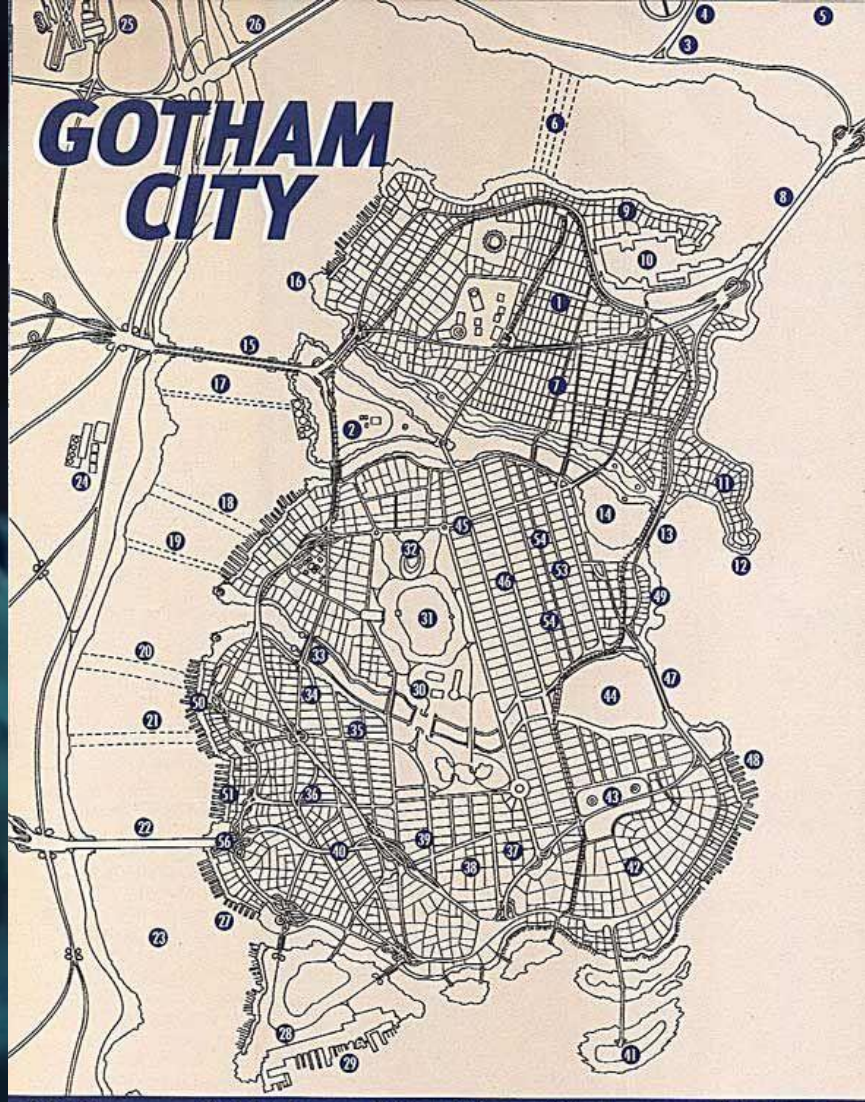

1) Grime Alley
2) Arkham Asylum
3) Wayne Manor
4) The Drake Household
5) Brentwood Academy
6) Gotham County Underwater R.R. Tubes
7) Old Gotham
8) Robert Kane Memorial Bridge
9) Amusement Mile
10) Rogers Yacht Basin
11) Robbinsville
12) Cape Carmine
13) Sprang Bridge
14) Sprang River
15) New Trigate Bridge
16) Aparo Park
17) Old Steam Tunnel
18) Brown R.R. Tubes
19) Gotham Water District Tunnel
20) Novick Tunnel
21) Peterson R.R. Tubes
22) Vincefinkel Bridge
23) Gotham River
24) Gotham Light & Power
25) Archie Goodwin International Airport
26) Mooney Bridge
27) Dixon Dock
28) Gordon's House
29) Tricorner Yards
30) Robinson Park
31) The Reservoir
32) Wayne Botanical Garden
33) Finger River
34) City Hall District
35) City Hall
36) Gotham Superior Courthouse
37) G.P.C.D. Headquarters
38) The Clocktower
39) Wayne Tower
40) One Gotham Center
41) Blackgate Isle
42) Cathedral Square
43) Grant Park
44) Miller Harbor
45) Monolith Square
46) The "C" Building
47) Aparo Expressway
48) Port Adams
49) Knights Dome Sporting Complex
50) Ranelagh Ferry
51) One Port Trinity Place
52) Von Gruenwald Tower
53) R.H. Kane Building
54) Sarh Complex
55) Kubrick District
56) Vauxhall Opera Shell & Indoor Concert Center

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Rounding Third: Adding Analysis

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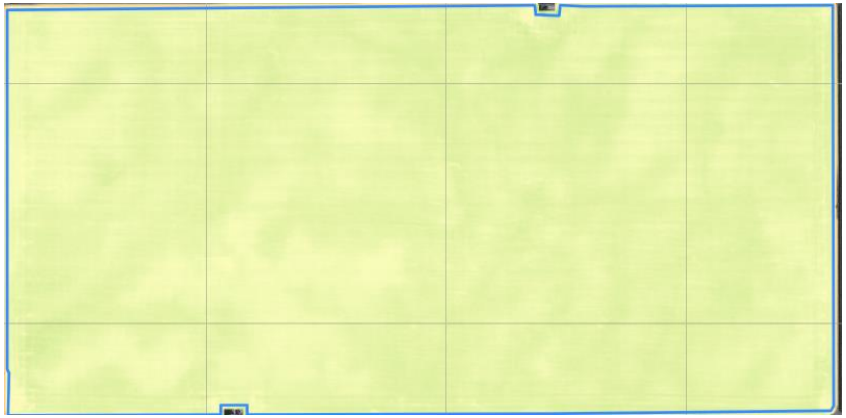
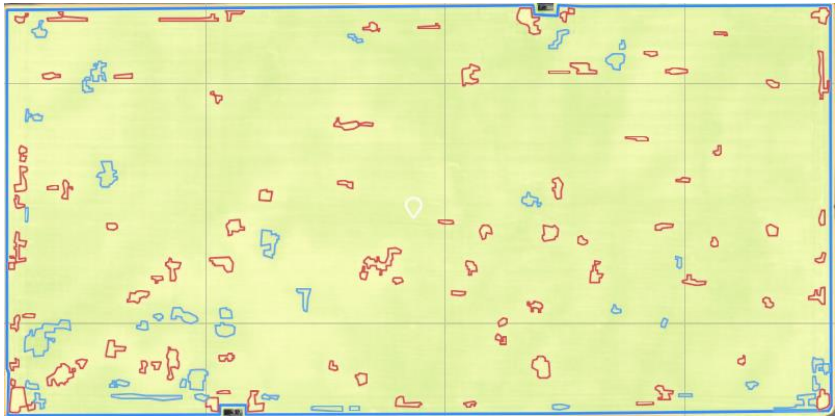
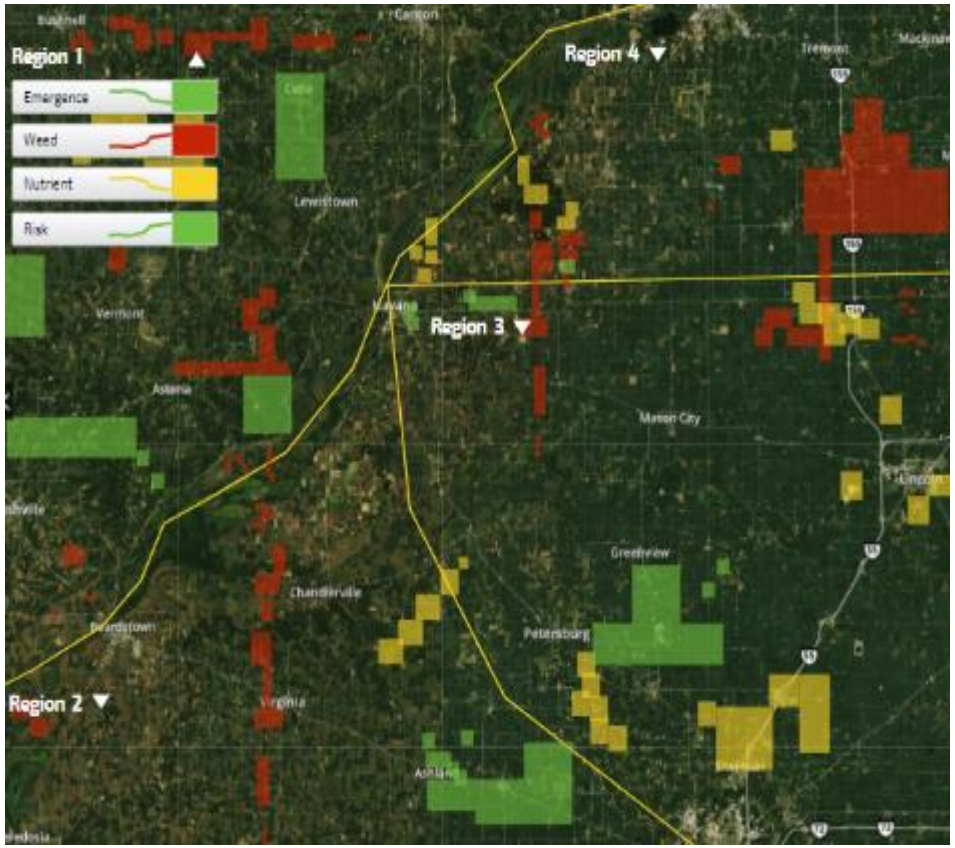
Analytics Usher In the New Era of Imagery

Field Level

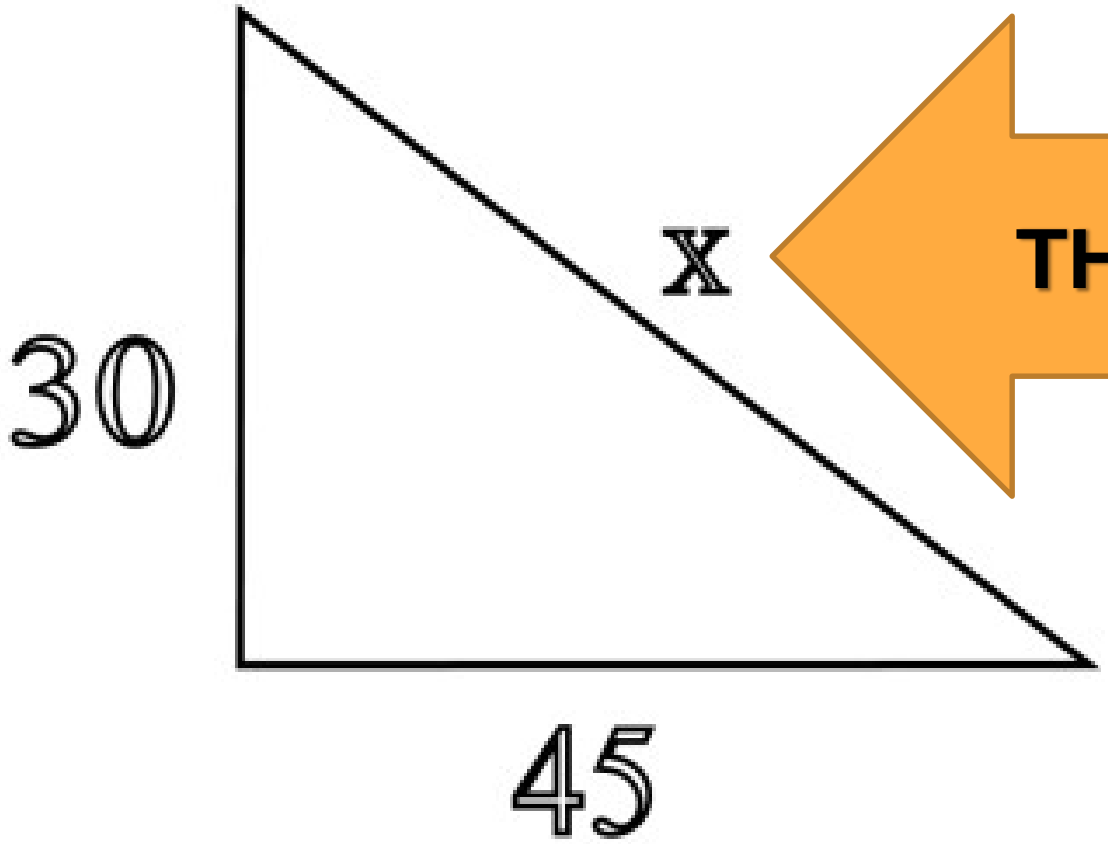




Regional



Find X



THERE IT IS!

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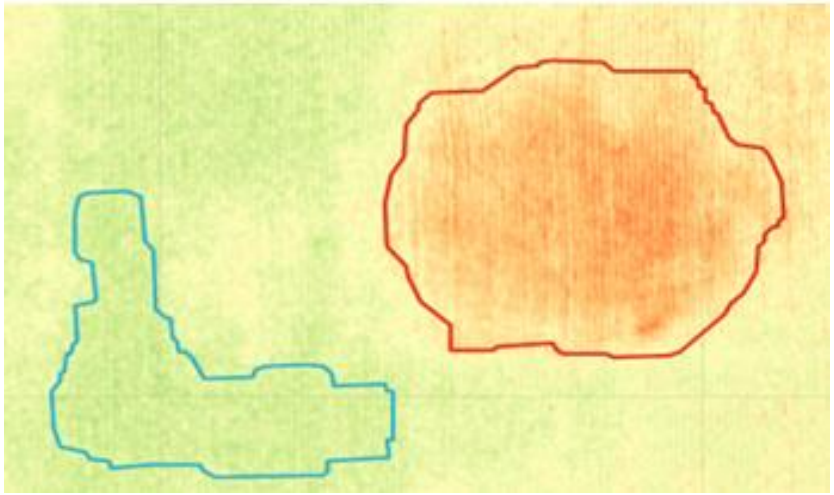
Automated Yield Risk Detection



AgMRI's precise and quantifiable anomaly zones automatically highlight and prioritize areas of low or high NDVI, which can reveal:

- Nutrient deficiencies
- Pest damage
- Weather damage
- Weed pressure
- Emergence issues

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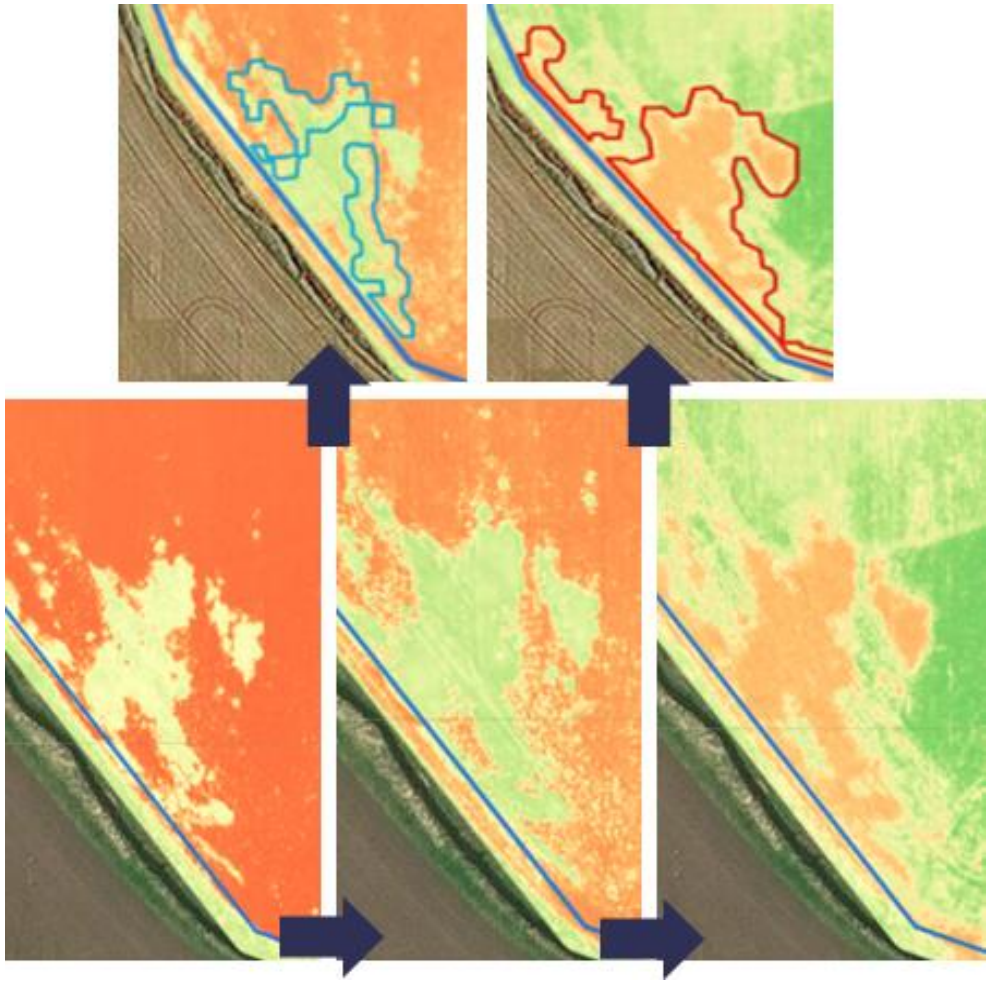
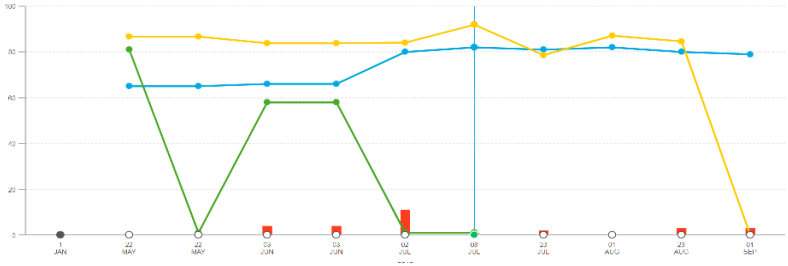
Change Monitoring with Trend Zone



AgMRI's change algorithm utilizes multiple flights per season to highlight areas performing better or worse over time. These analytics help reveal:

- Early onset pest infestations
- Herbicide resistant weeds
- Hybrid performance
- Plant Maturity



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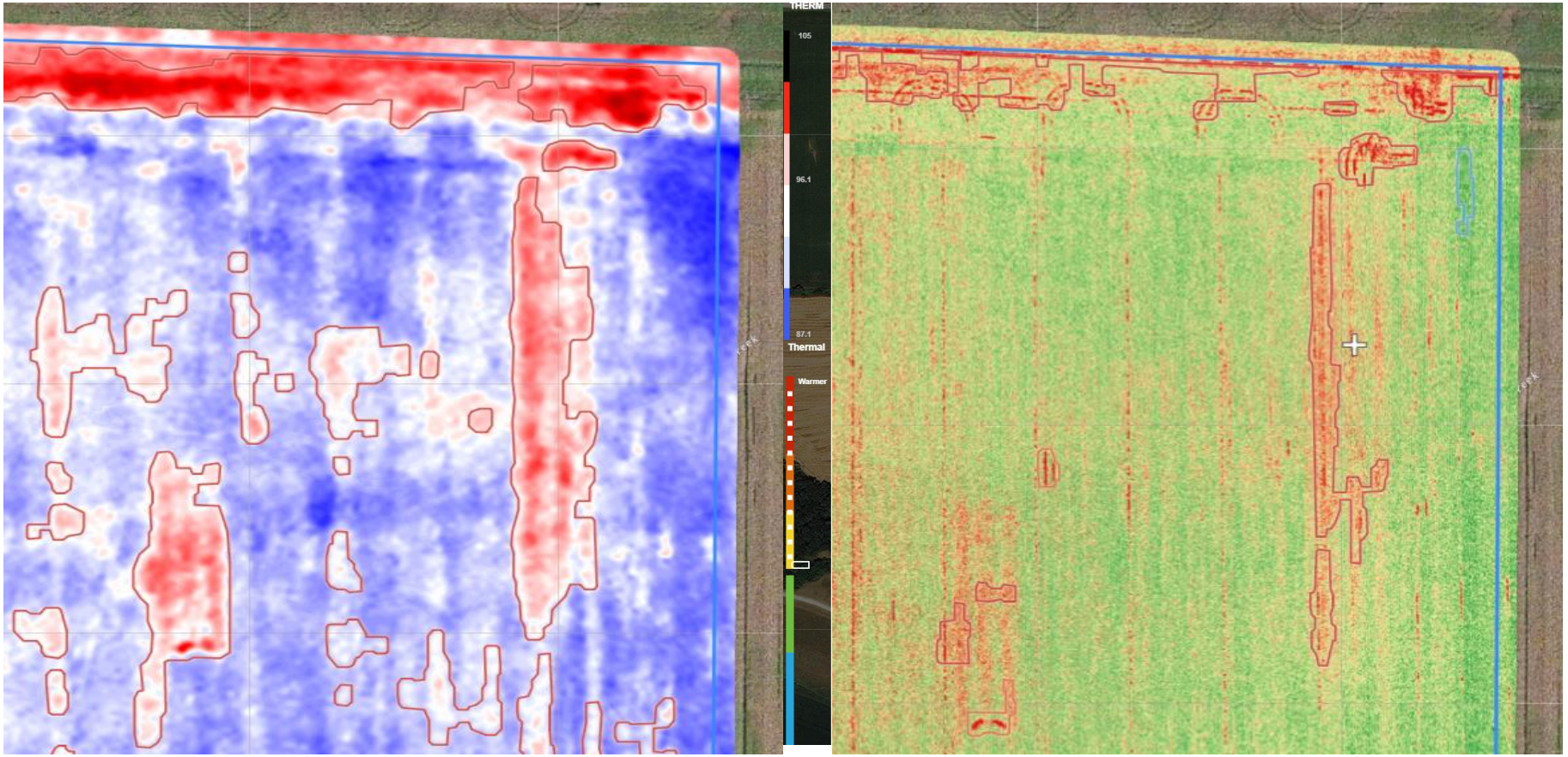
Non NDVI Analytics:
Utilizing Thermal with Heat-Seeker



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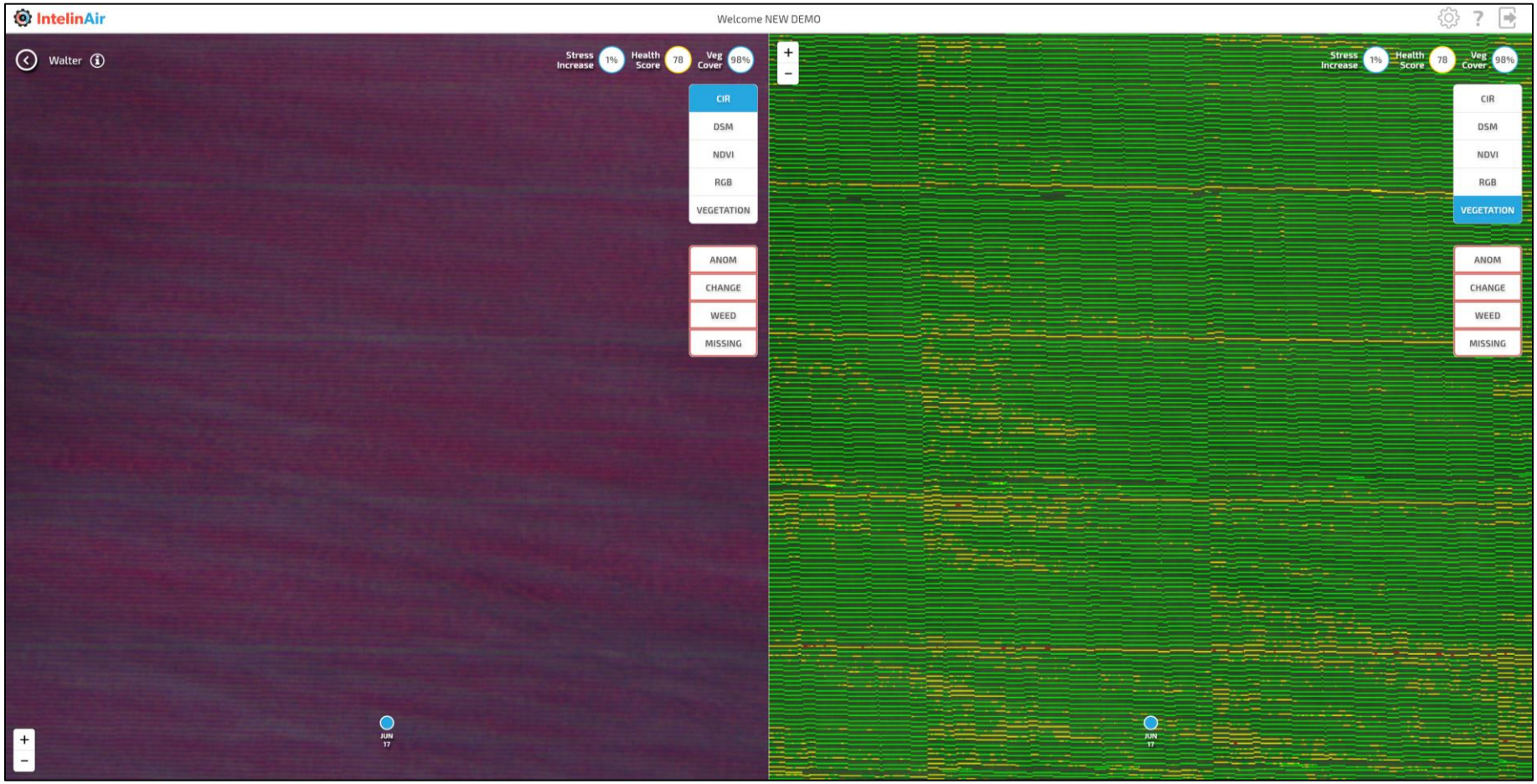
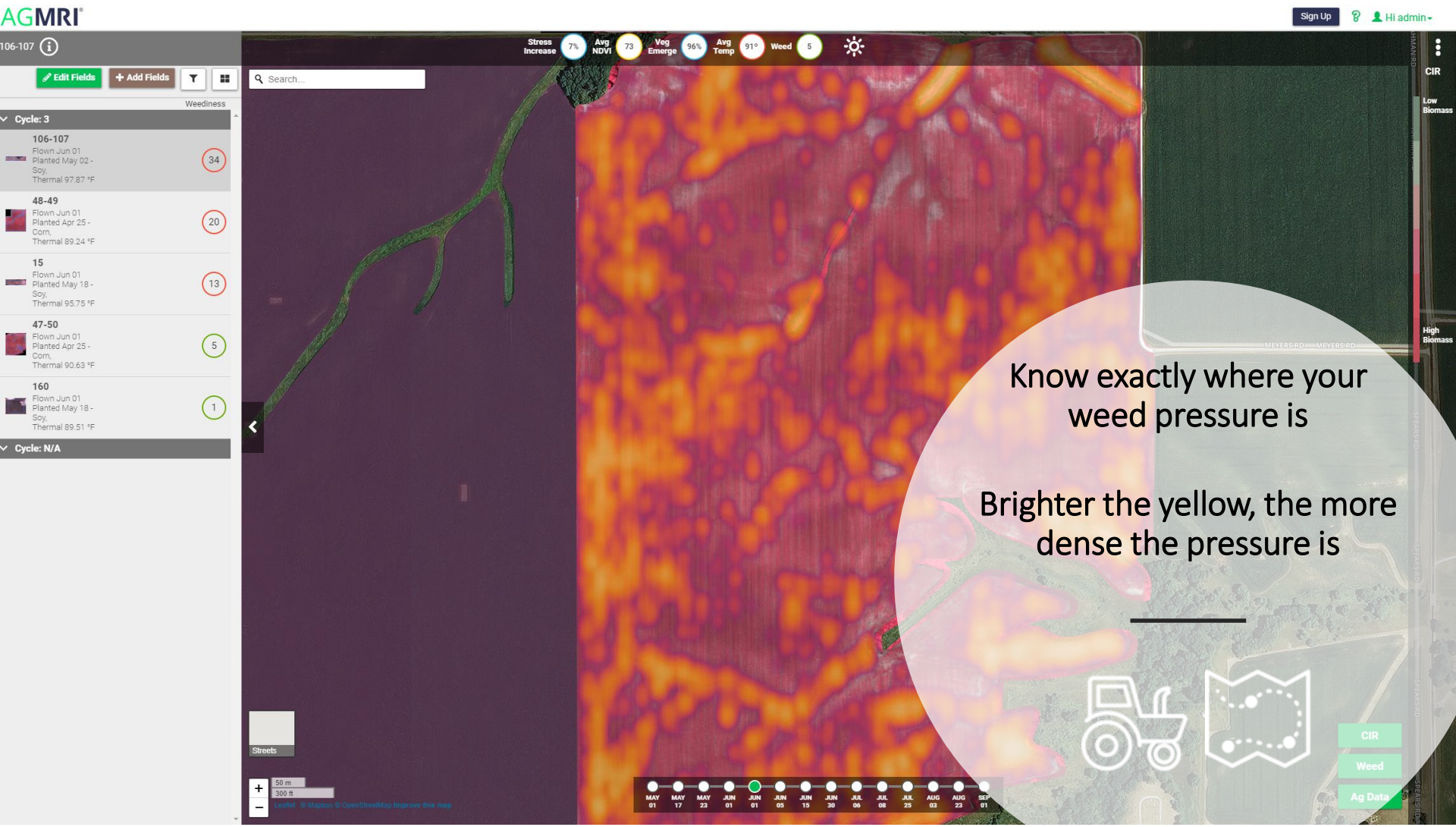
Pattern Recognition & Machine Learning: Insights on Every Plant with Row Tracer



Specialized Analytics: Be on the Weed Watch



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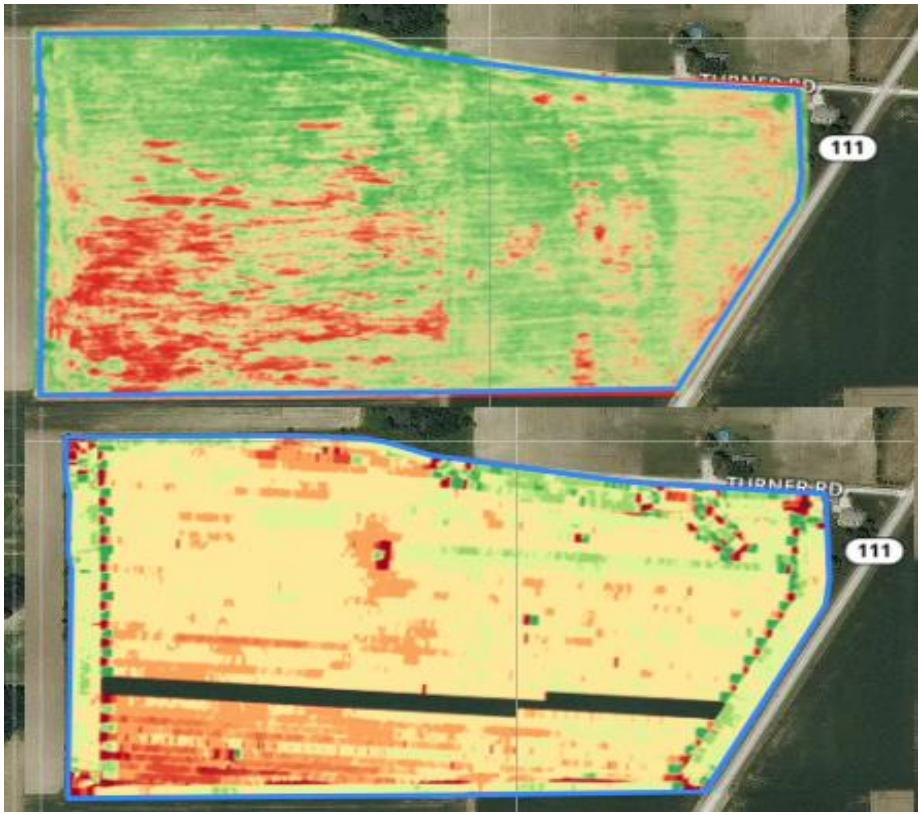
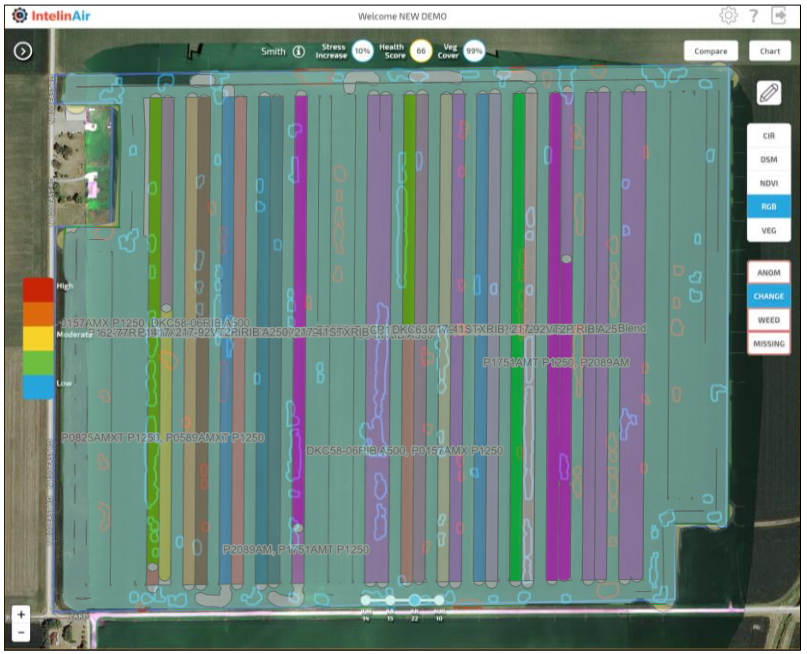
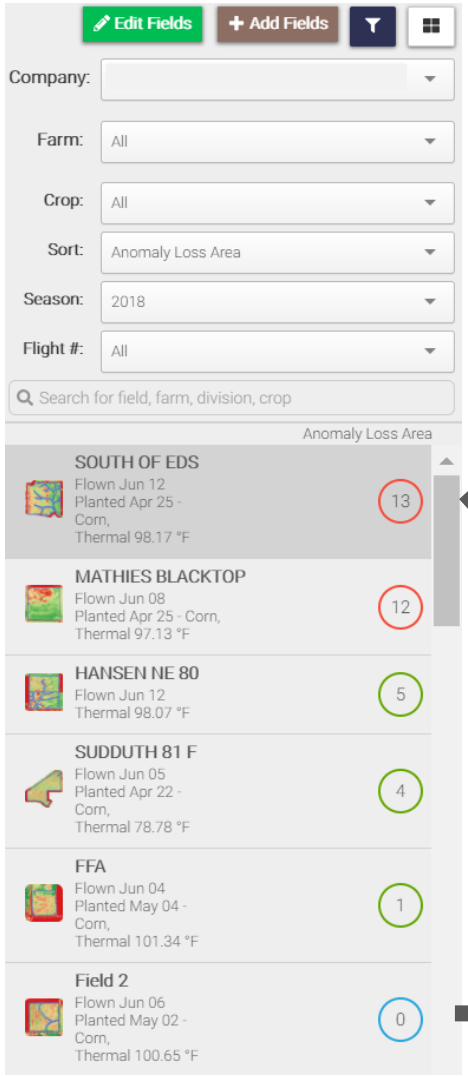
Supplementary Ag Data Layers

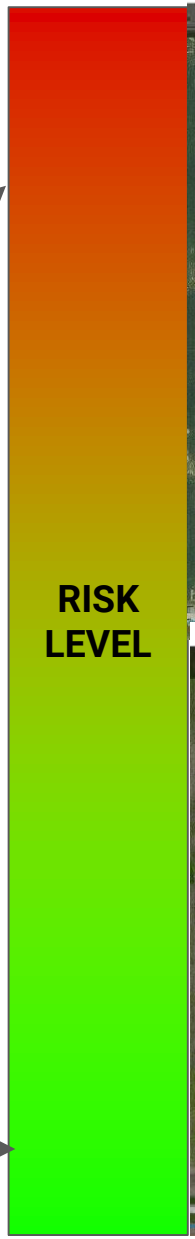
- Planter Data & Yield Maps from Integration Data
- Topography and Soil Type Visualizations from Publicly Available Sources

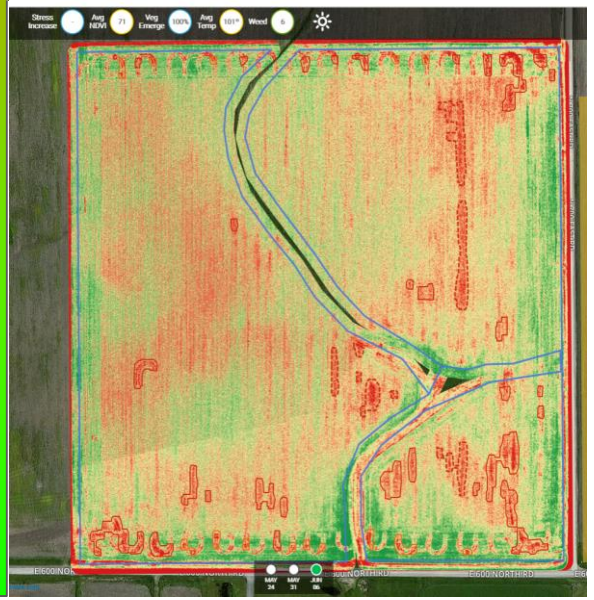




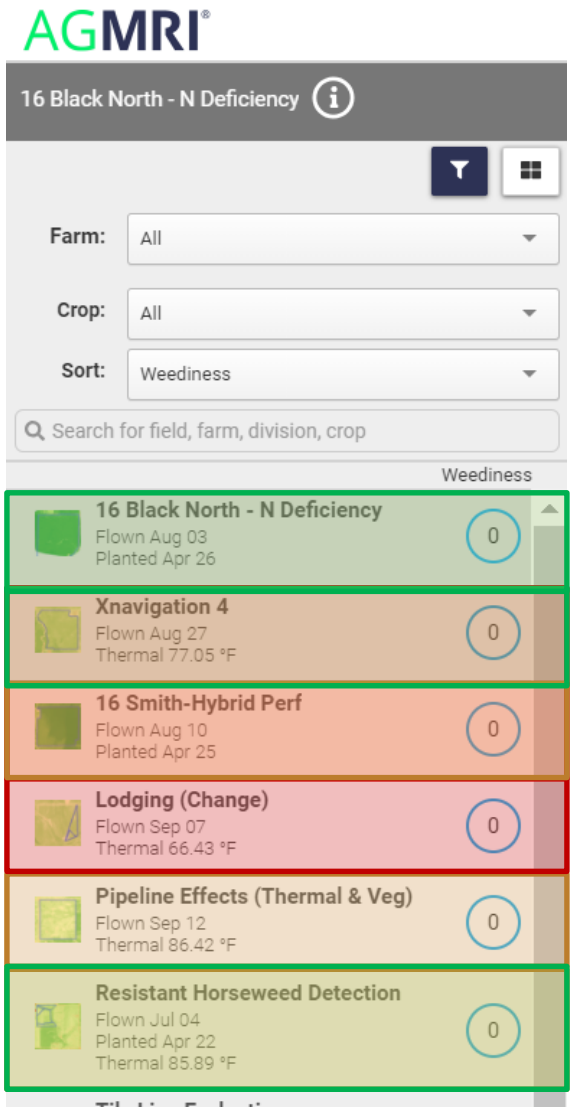
Sorting & Prioritization







Prioritized, Actionable Intelligence All Season Long



EARLY SEASON

- Planting Readiness
- Weediness
- Emergence
- Plant Stress

MID-SEASON

- Plant Stress
- Pest Presence
- Yield Estimation

LATE SEASON

- Harvest Timing

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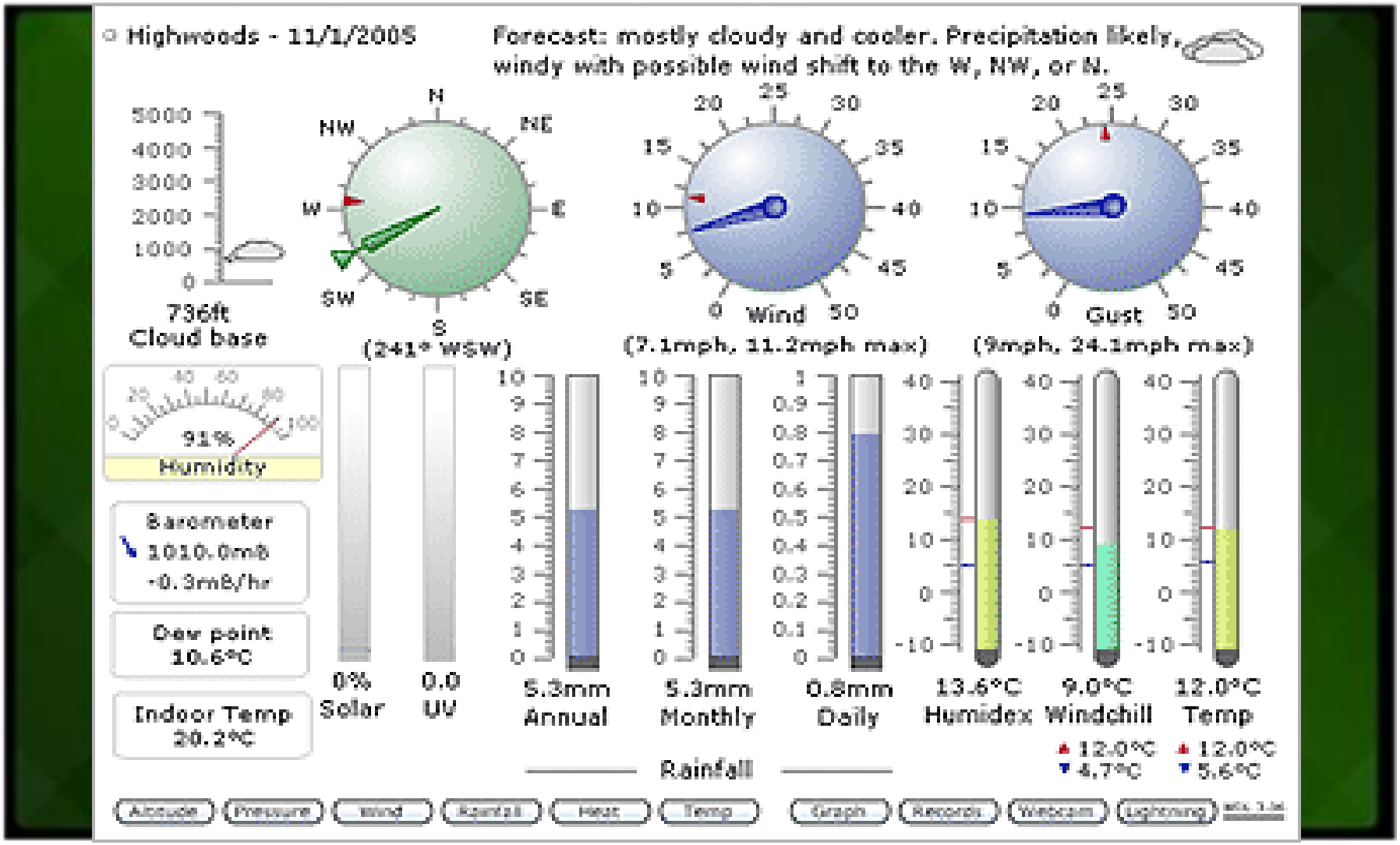
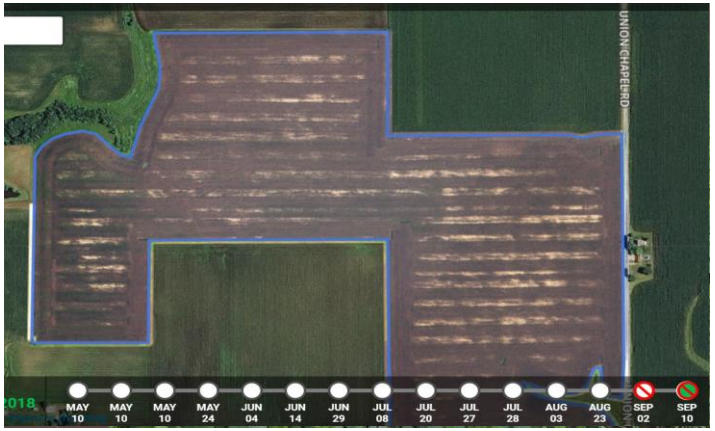
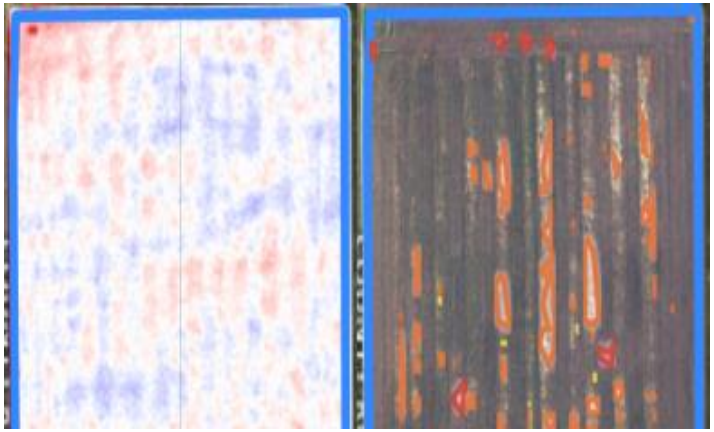

Highwoods - 11/1/2005
Forecast: mostly cloudy and cooler. Precipitation likely, windy with possible wind shift to the W, NW, or N.
736ft
Cloud base
(241° WSW)
Wind
(7.1mph, 11.2mph max)
Gust
(9mph, 24.1mph max)
91%
Humidity
Barometer
1010.0mB
-0.3mB/hr
Dew point
10.6°C
Indoor Temp
20.2°C
0%
Solar
0.0
UV
5.3mm
Annual
5.3mm
Monthly
0.8mm
Daily
13.6°C
Humidex
9.0°C
Windchill
12.0°C
Temp
12.0°C
4.7°C
12.0°C
5.6°C
Rainfall
Altitude
Pressure
Wind
Rainfall
Heat
Temp
Graph
Records
Webcam
Lightning

2019: Notifications & Alerts

- Row-by-Row Emergence
- Outstanding Weed Pressure
- Crop Maturity and Shattering





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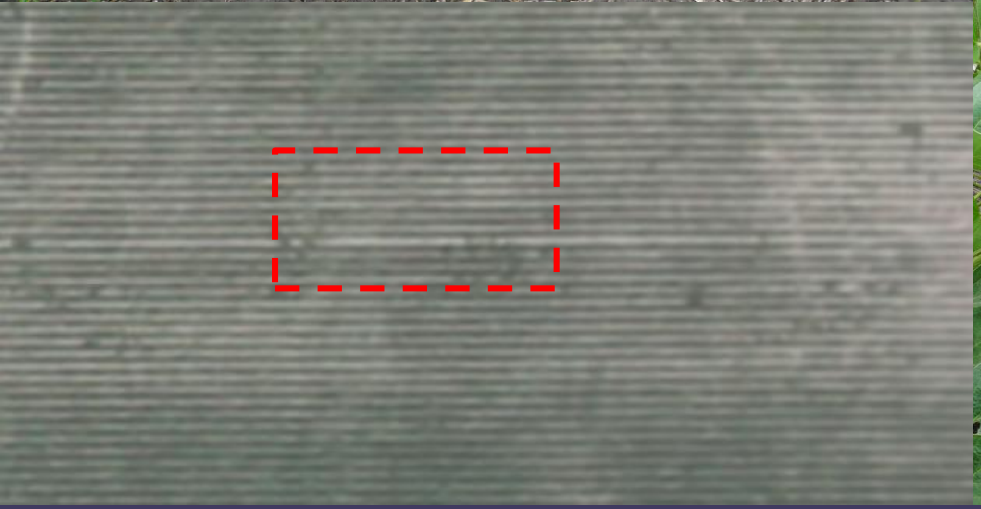
From The Road…



Aerial Imagery Reveals:

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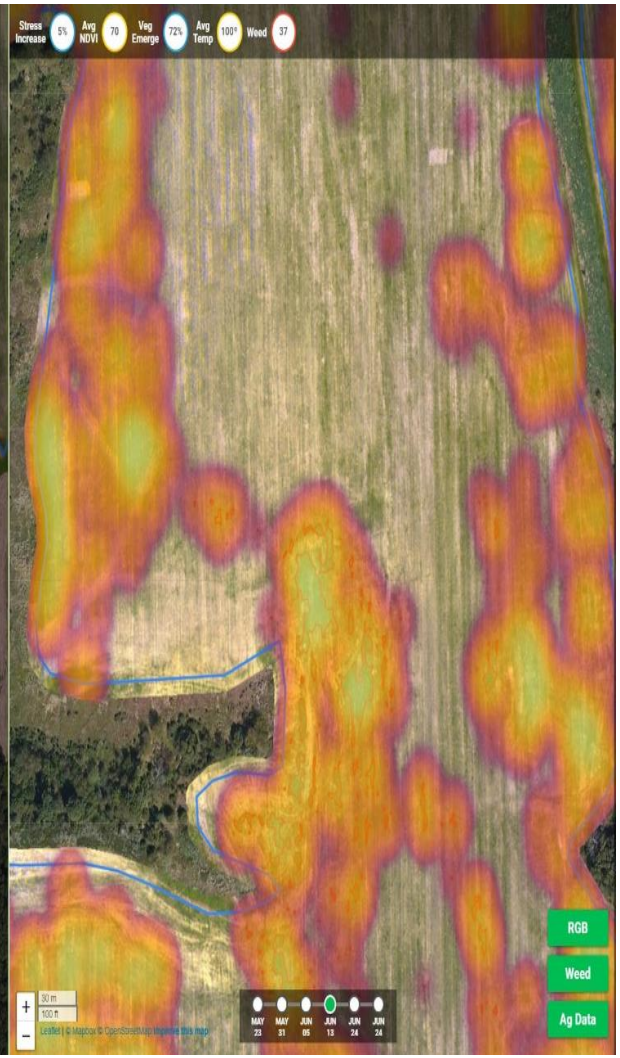
Weed Identification

Weed Alert!



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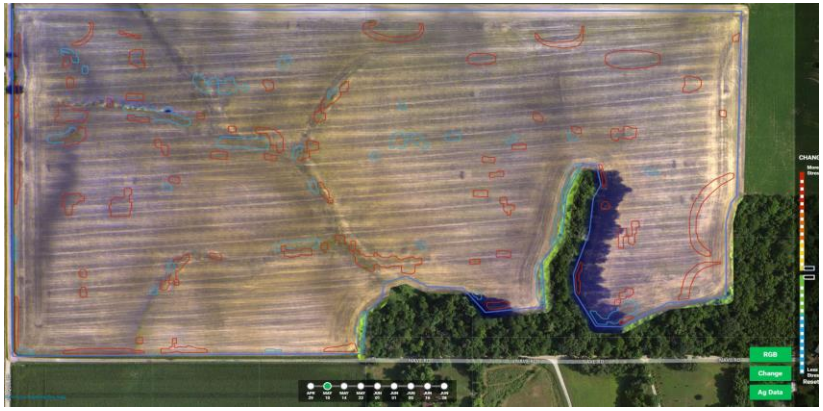

Weed Identification

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Alerts Use Case: Resistant Weeds

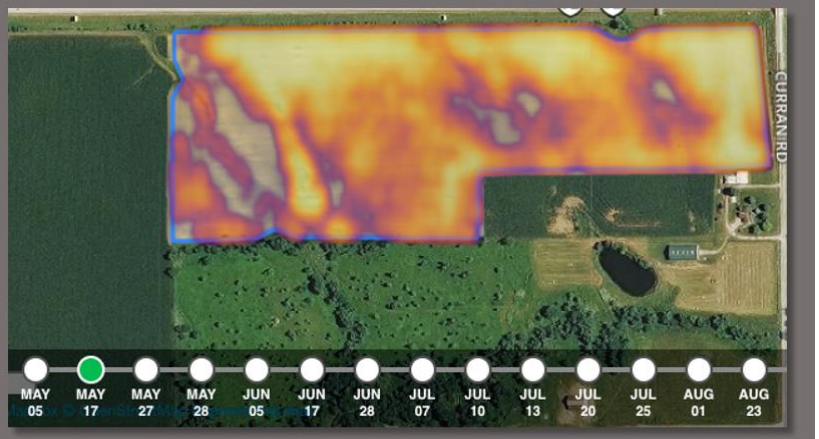
Lee Stowell North
42 acres
Planted May 15, 2018
Last Flight May 17, 2018

View Field Details | Directions

Preemergence weed pressure

Significant weed pressure may be returning after winter or newly emerged weeds.

At this point in the season, we are not expecting row crops to be large enough to register on our imagery. Therefore, we have flagged all significant vegetation as weed pressure.



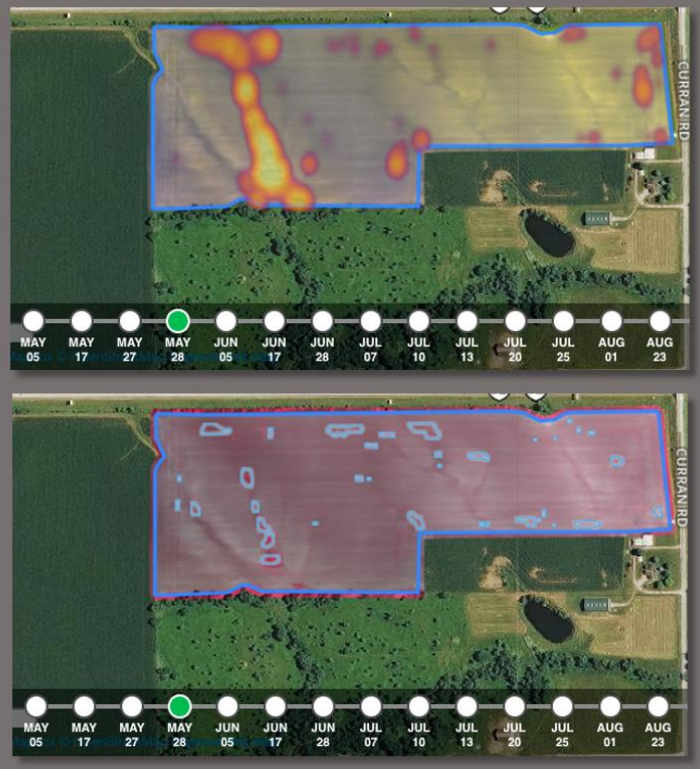
Lee Stowell North
42 acres
Planted May 15, 2018
Last Flight May 28, 2018

View Field Details | Directions

Worsening Weed Pressure

Weeds are actively growing

An overlap of analytical layers are showing not only are weeds present, but they are actively growing.



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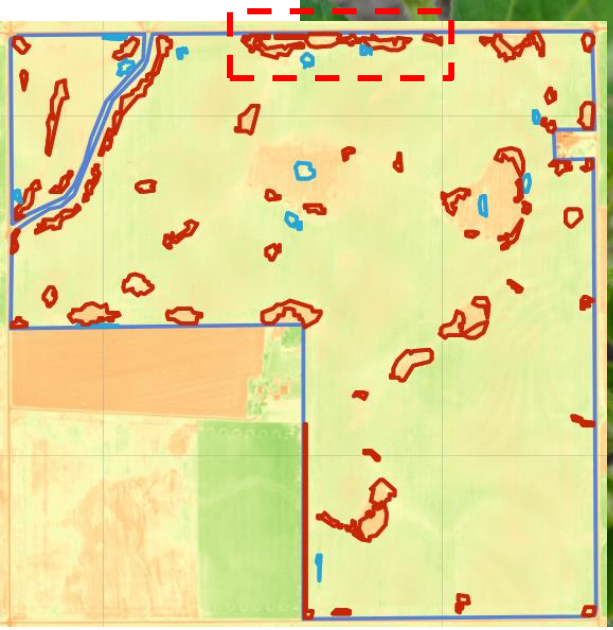
Japanese beetle (Popillia japonica) Appears in field edges



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Alerts Use Case: Fertility

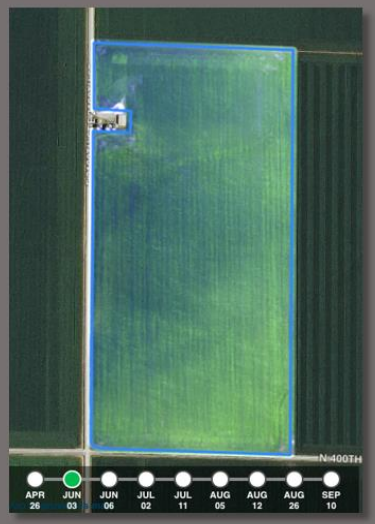
Jones 120
120 acres
Planted April 28, 2018
Last Flight June 3, 2018

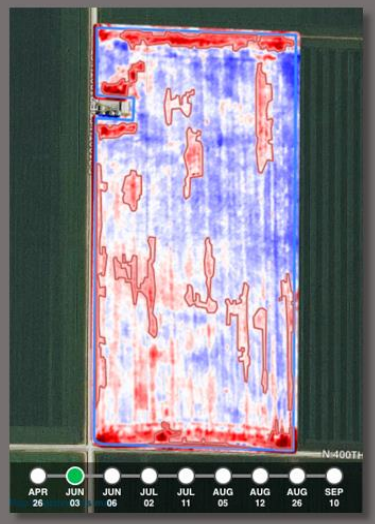
View Field Details | Directions

New Risk

We have detected a new issue in this field which could lead to sub-optimal yield.

At this point in the season fertility, early disease or insect feeding are common inhibitors of plant growth. Scouting is recommended to determine root cause.





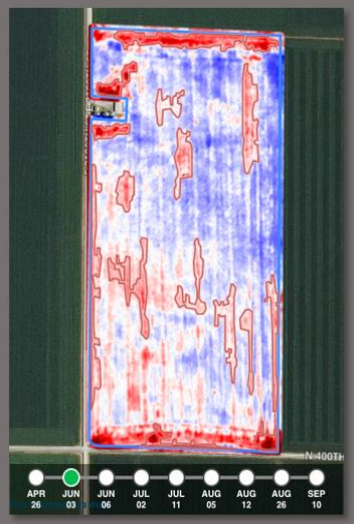
Jones 120
120 acres
Planted April 28, 2018
Last Flight July 2, 2018

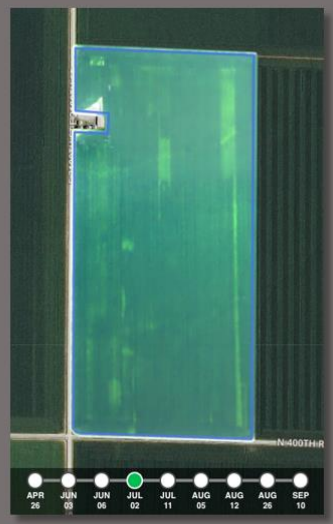
View Field Details | Directions

Fertility Error

Crop health is likely being inhibited by a man-made nutrient deficiency.

Our plant analysis indicates a nutrient deficiency, but the shape of the anomaly suggests that it may be man-made. Consult as-applied data for confirmation.





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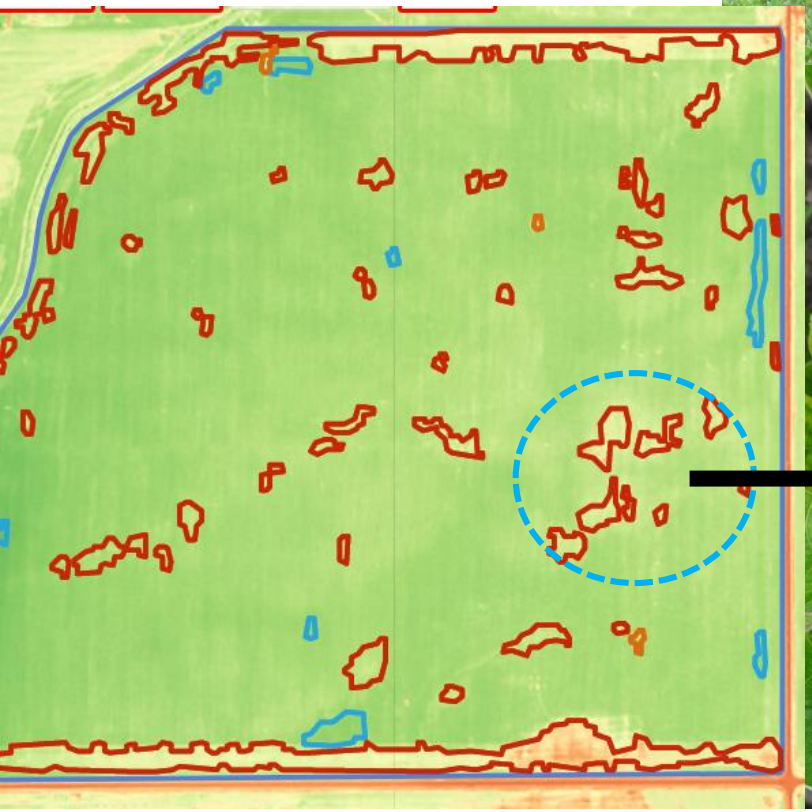
Micronutrient Deficiency



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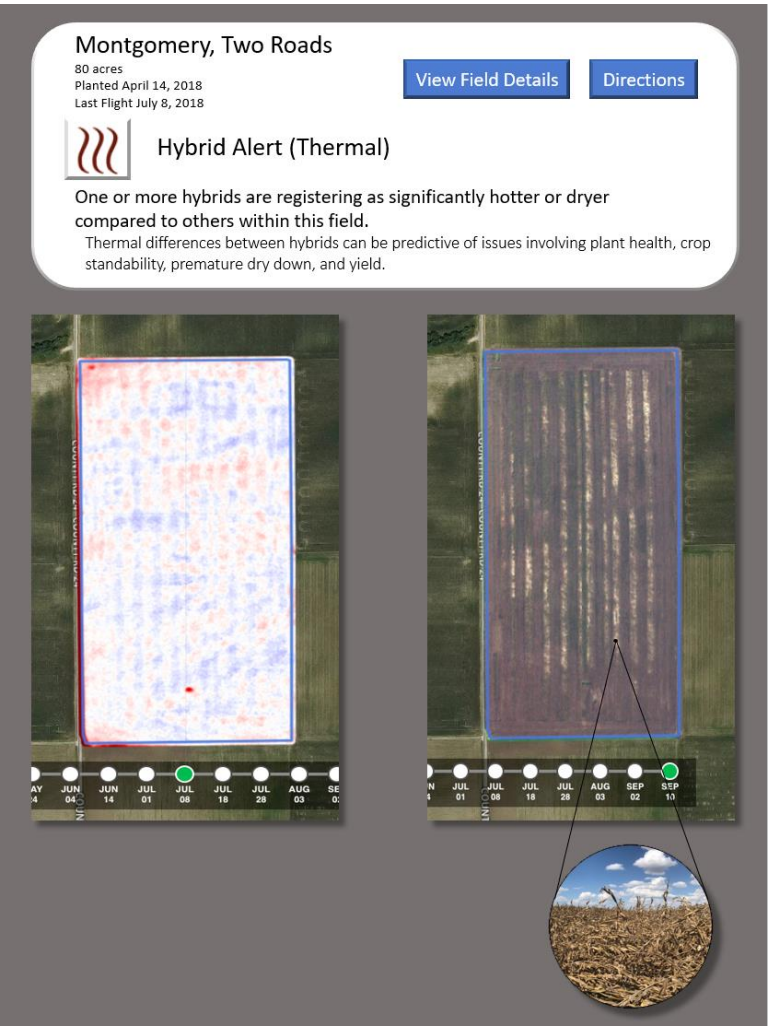
Hybrid Alert: Stalk Rot



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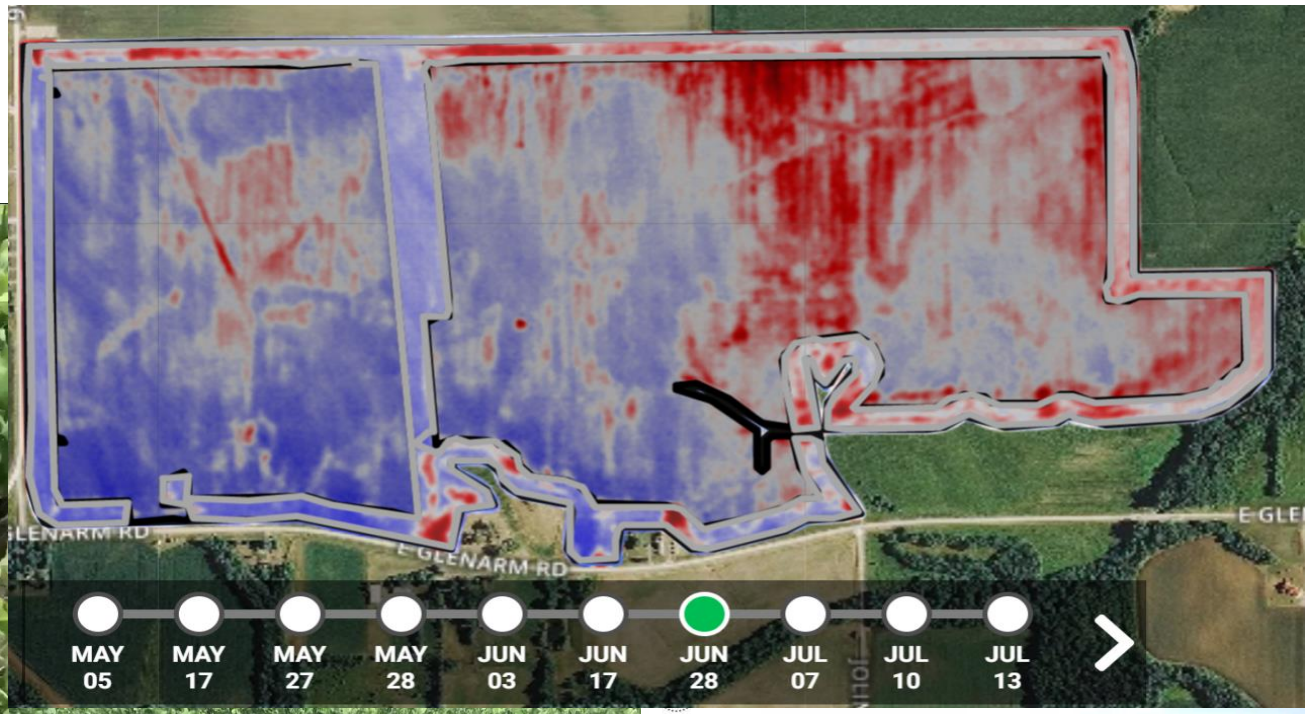
Root Rot



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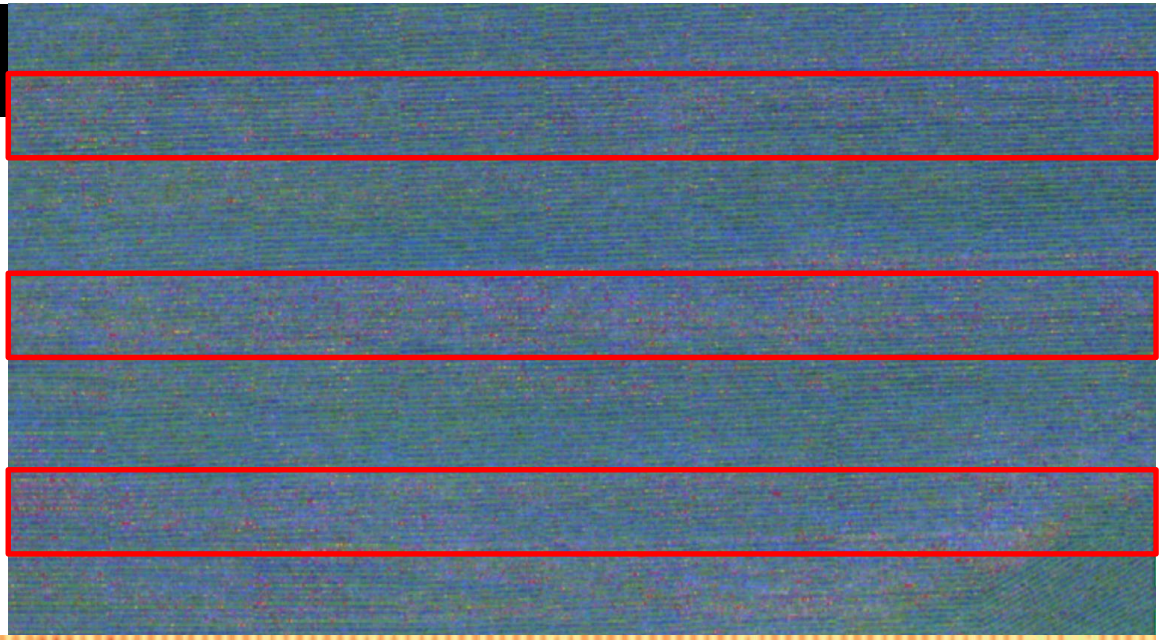
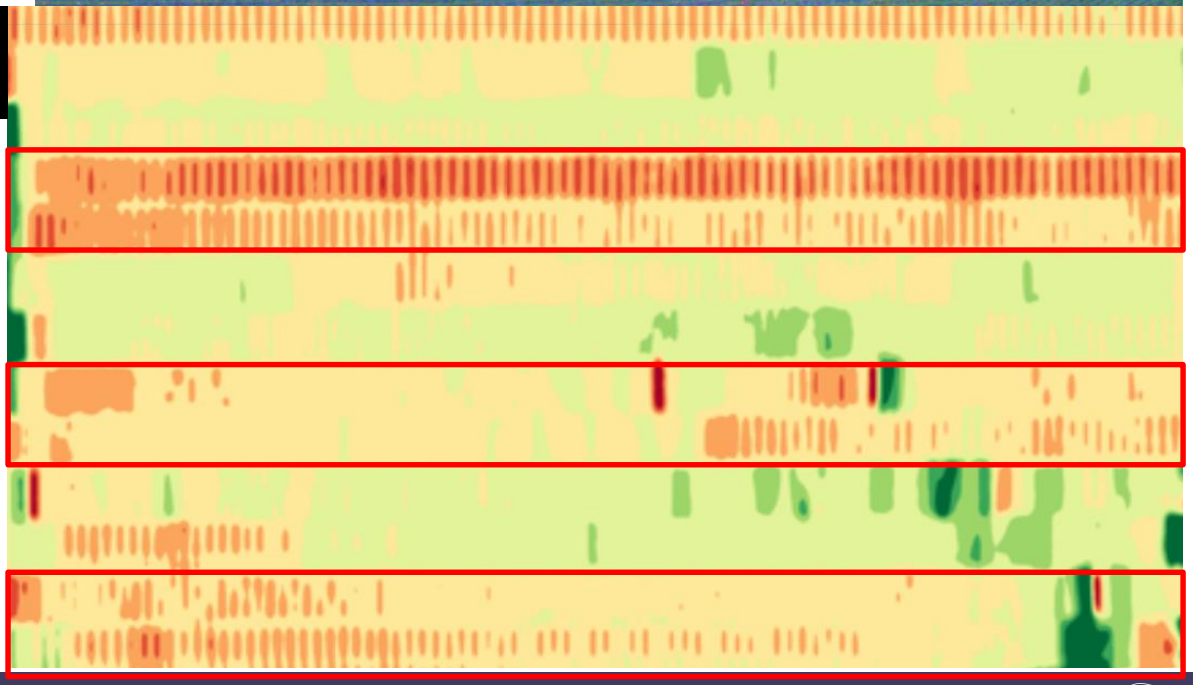
Variety & Hybrid Emergence

May 28



Yield



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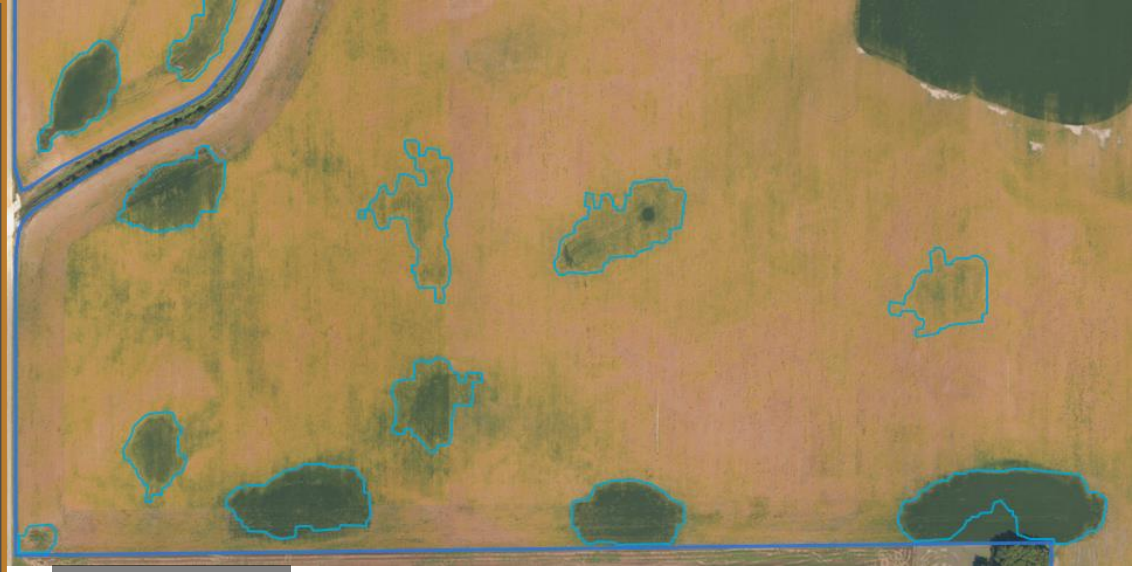
Late August Anomalies highlight replant zones that were still growing and not ready to harvest. Harvesting too early can affect net yield and grain spoilage.

**

Our anomaly zone matches almost perfectly with what was avoided by the combine operator. This shows that IntelinAir's Heat-Seeker analytics can be used to guide in-field variable harvest operations.



8/26/17

9/8/17

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YOU DON'T HAVE TIME FOR THIS…
WELCOME TO THE AUTOMATED ERA!

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BRAD PITT
MONEYBALL