

Prophecy from the Sky? What can UAVs tell us about water and nitrogen in corn and wheat?

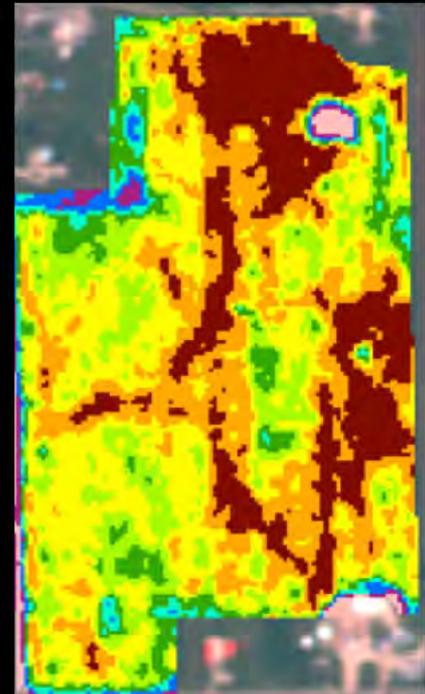
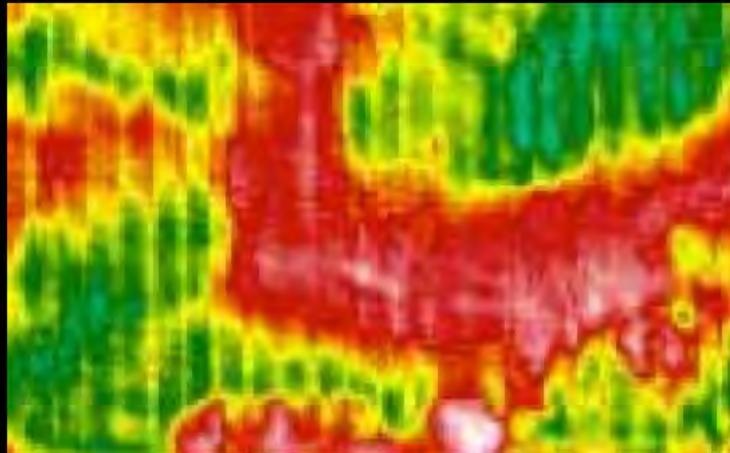
Bruno Basso and Ryan Nagelkirk



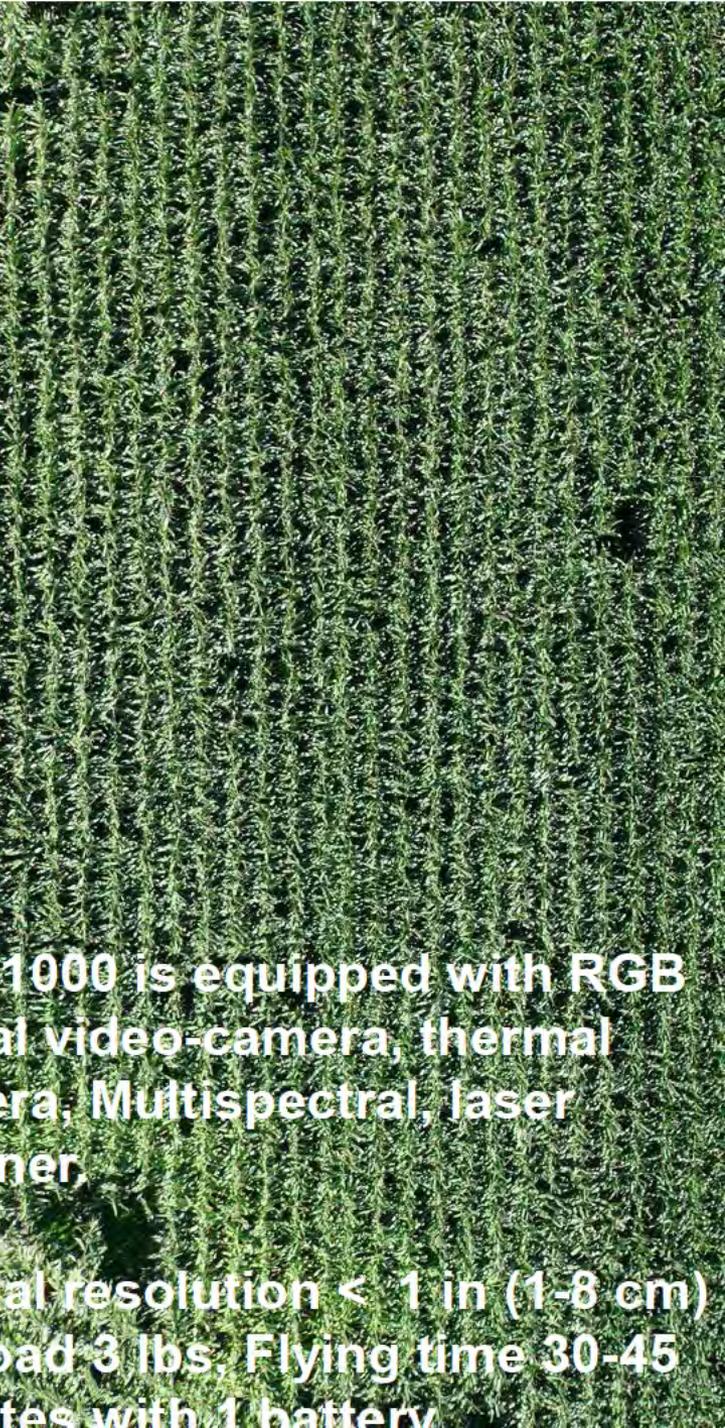
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# Benefits of UAVs in Agriculture

- Assessment of spatial and temporal variability
- Scouting tool
- Nutrient and water deficiencies
- Pests, weeds and other stressors
- Quantify plant stand



UAV model: mdr4-1000 – microdrones.com



md4-1000 is equipped with RGB digital video-camera, thermal camera, Multispectral, laser scanner,

Spatial resolution < 1 in (1-8 cm)  
Payload 3 lbs. Flying time 30-45 minutes with 1 battery

# Sensors on board of md4-1000

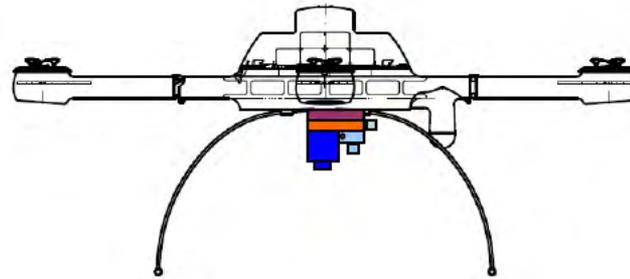
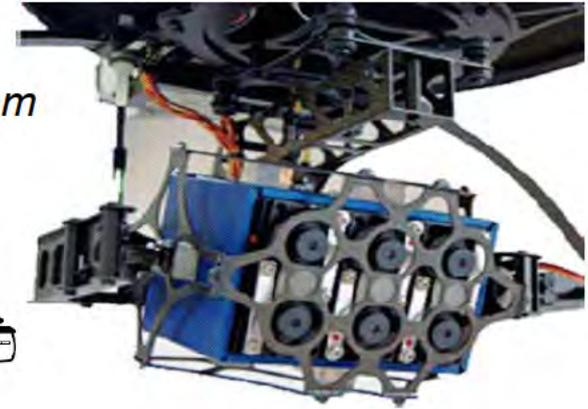
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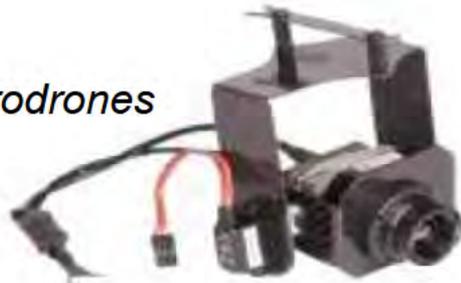
*Sony, microdrones*

Multispectral

*Tetracam*



*microdrones*



Thermal (IR)



Laser Scanner LD-MRS

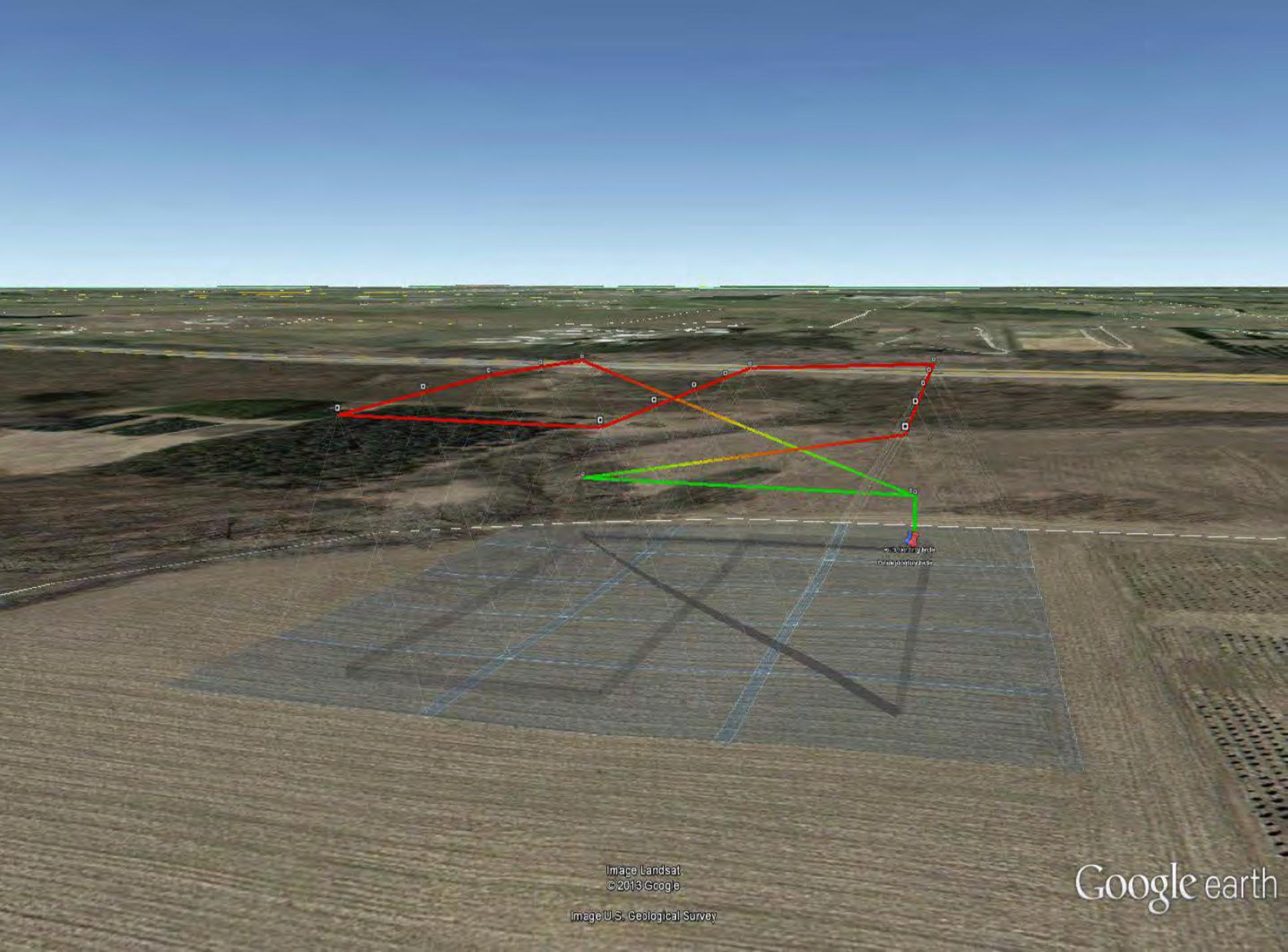


Image Landsat  
© 2013 Google

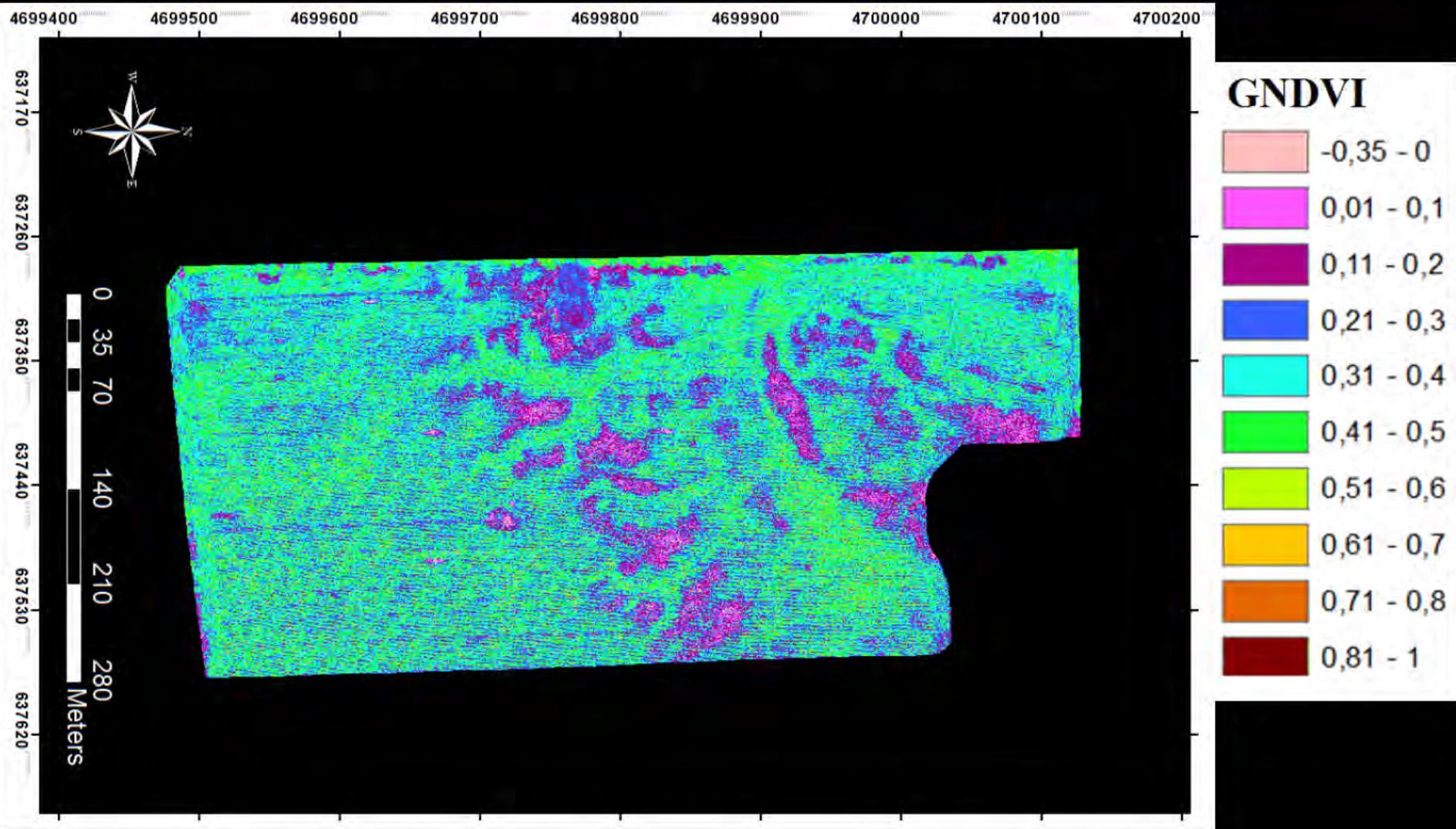
Image U.S. Geological Survey

Google earth

# Visible image August 13 from UAV for Field M



# Multispectral August 13



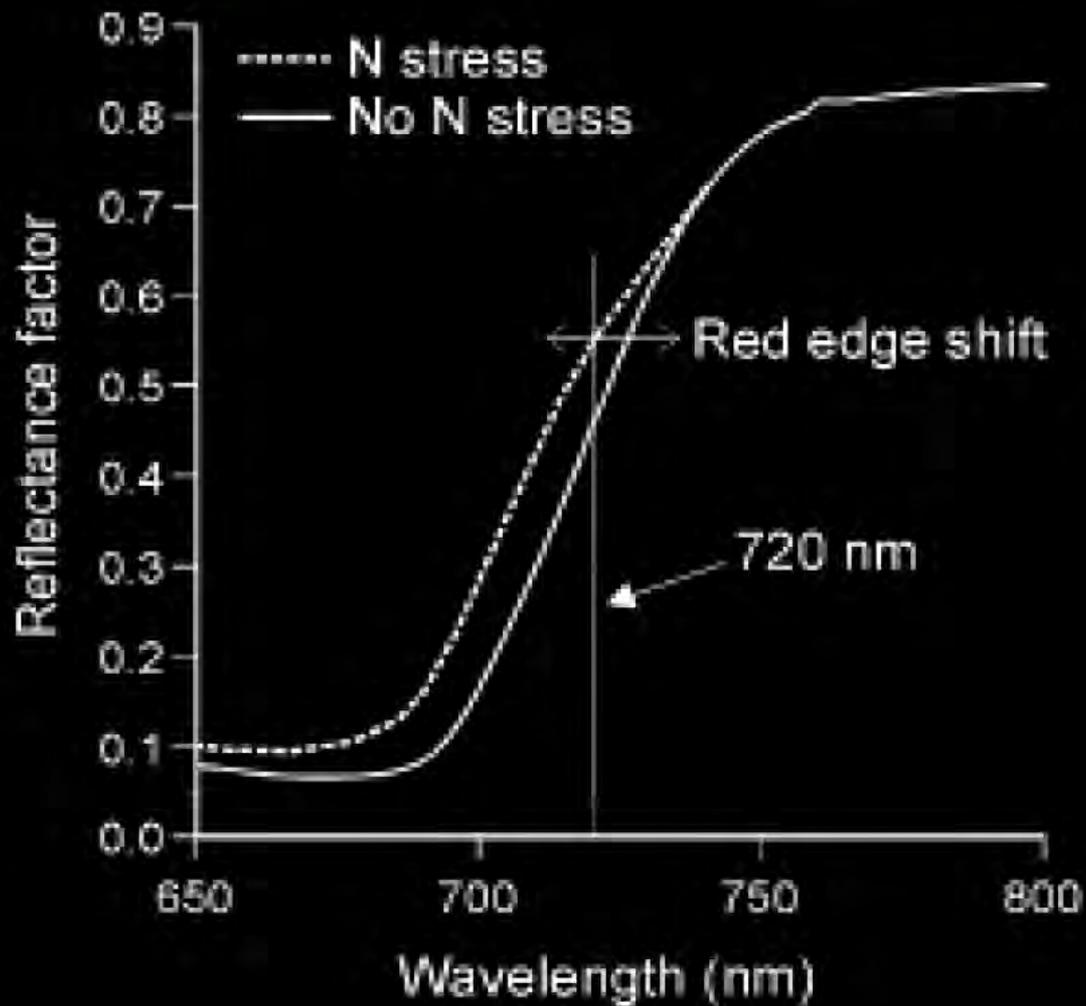
PHANTOM 2 VISION+







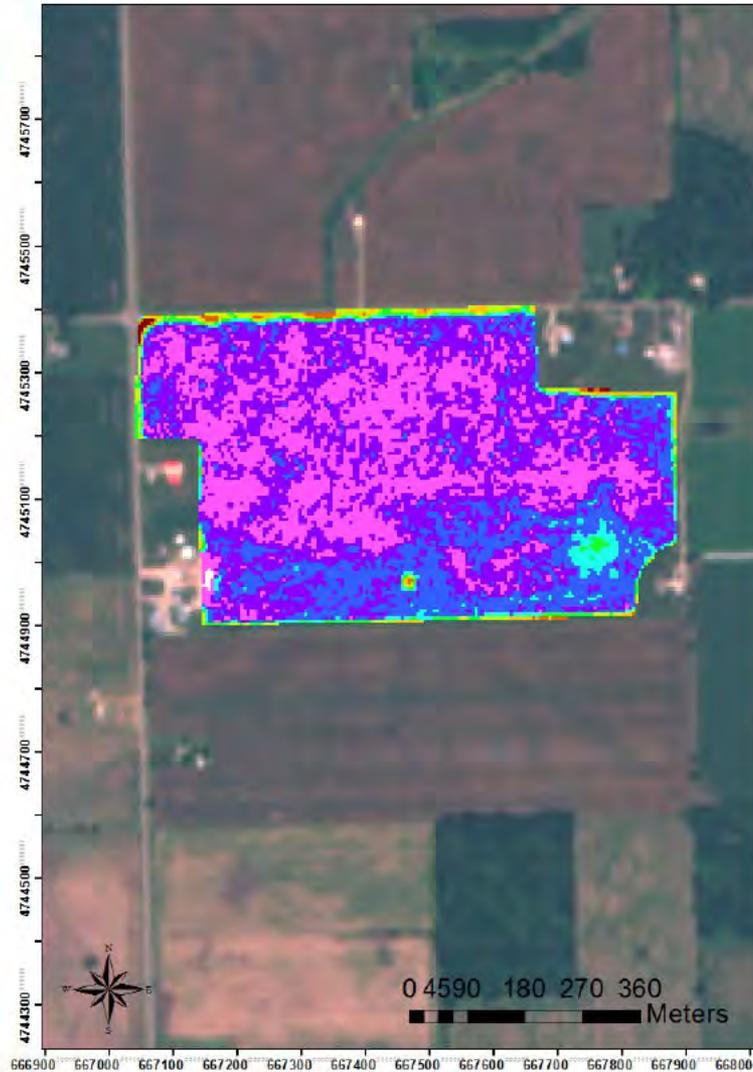
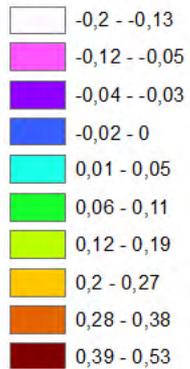
# Red-Edge Spectral Band



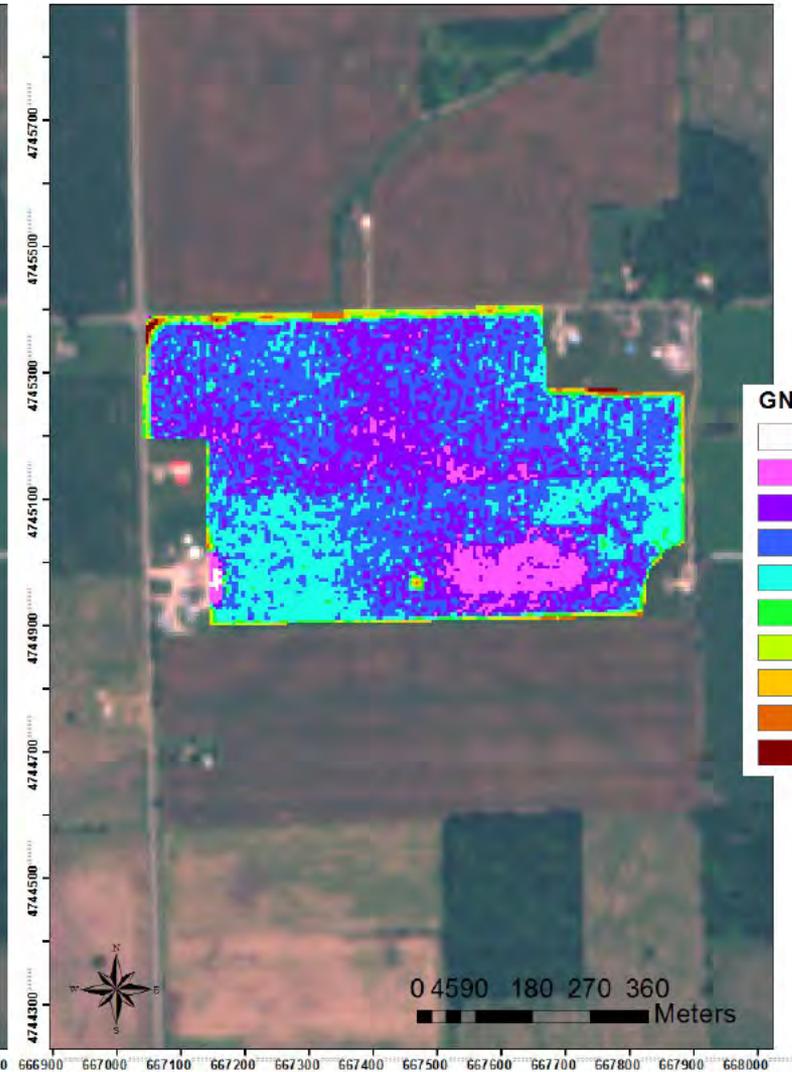
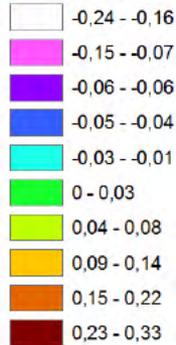
# Biomass Vegetation Indices

## May 30, 2014

NDVI May

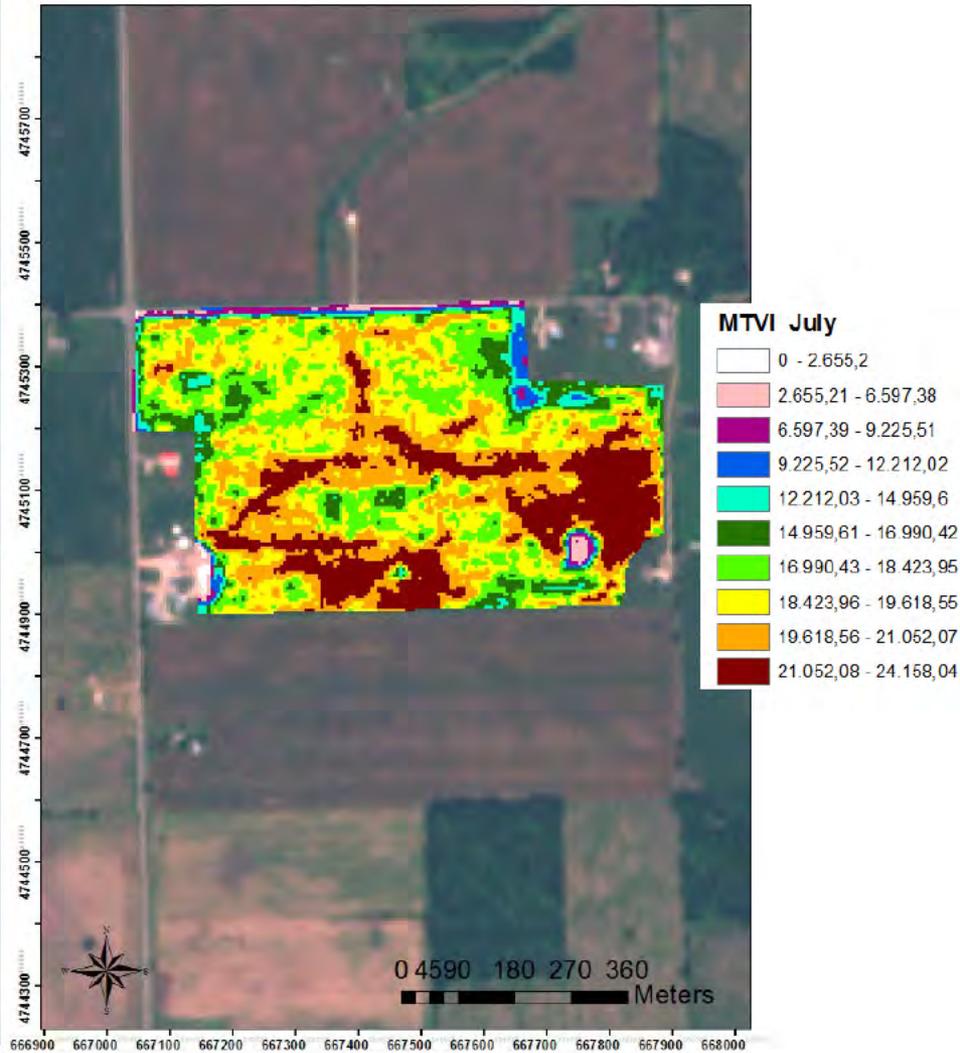
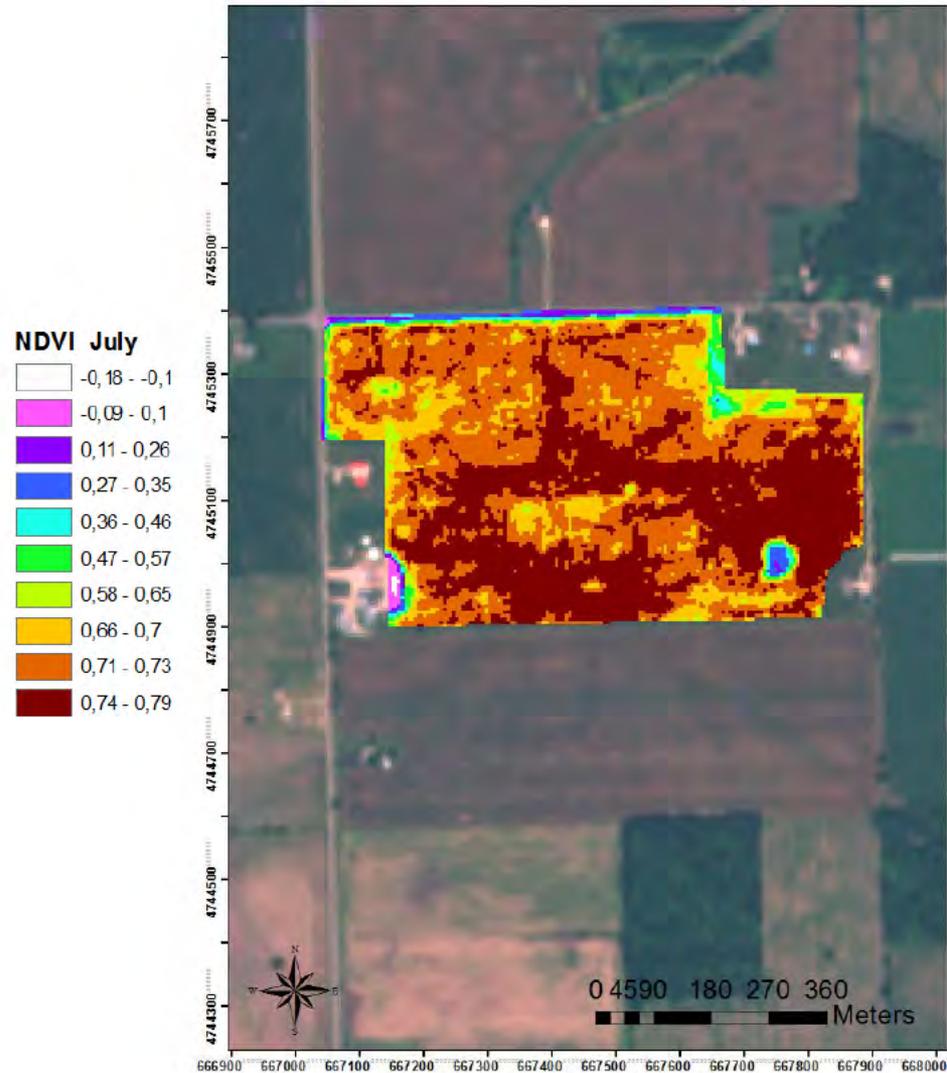


GNDVI May



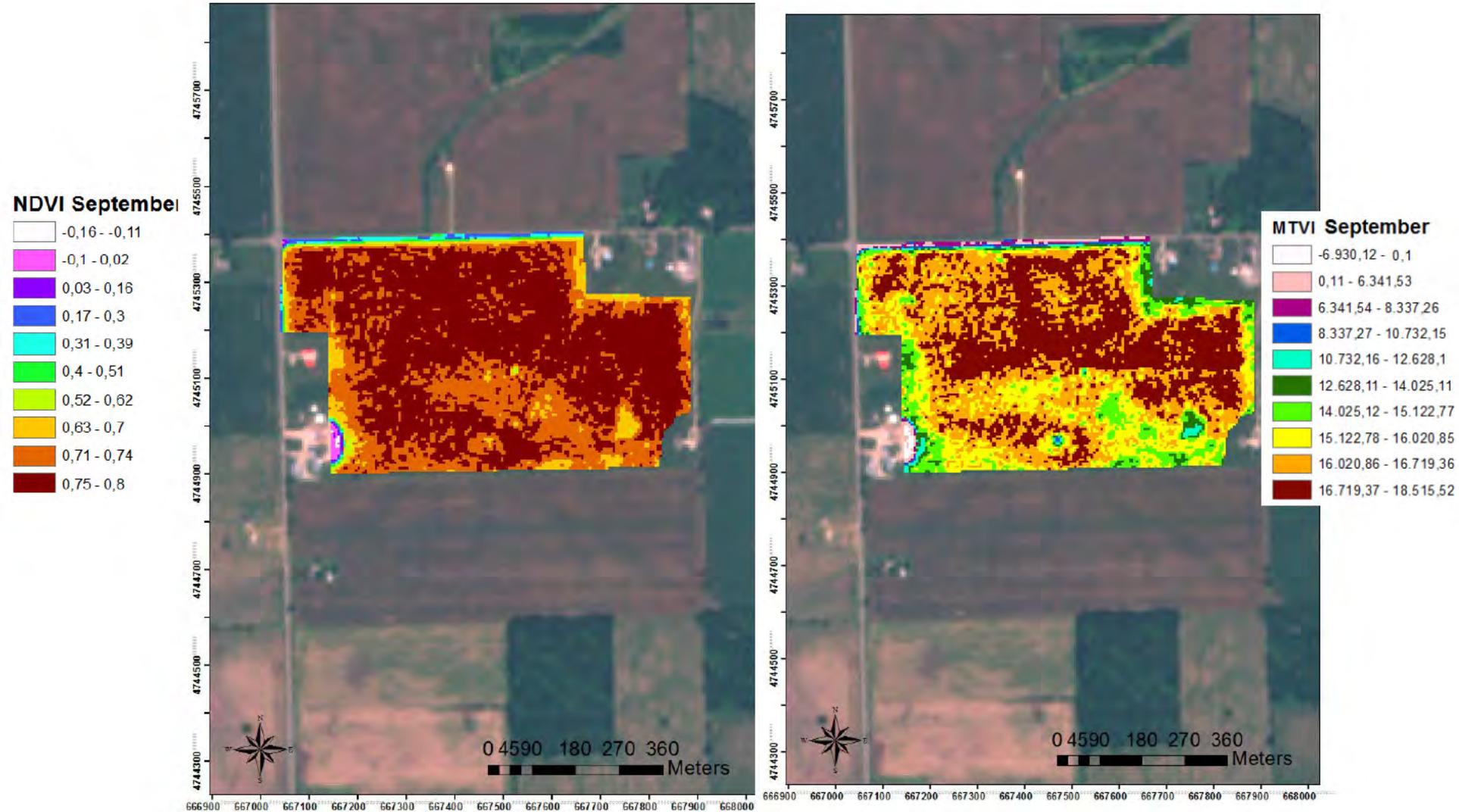
# Biomass Vegetation Indices

## July 3, 2014



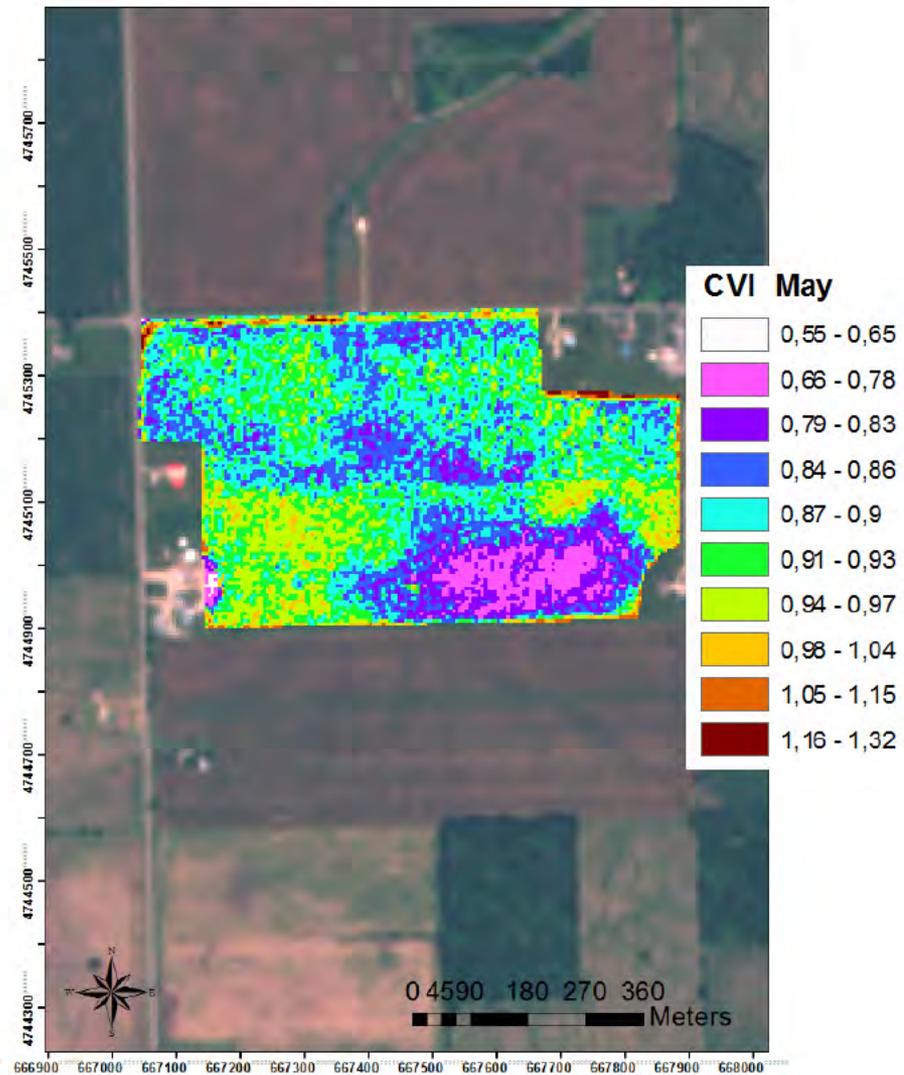
# Biomass Vegetation Indices

## Sept 8, 2014



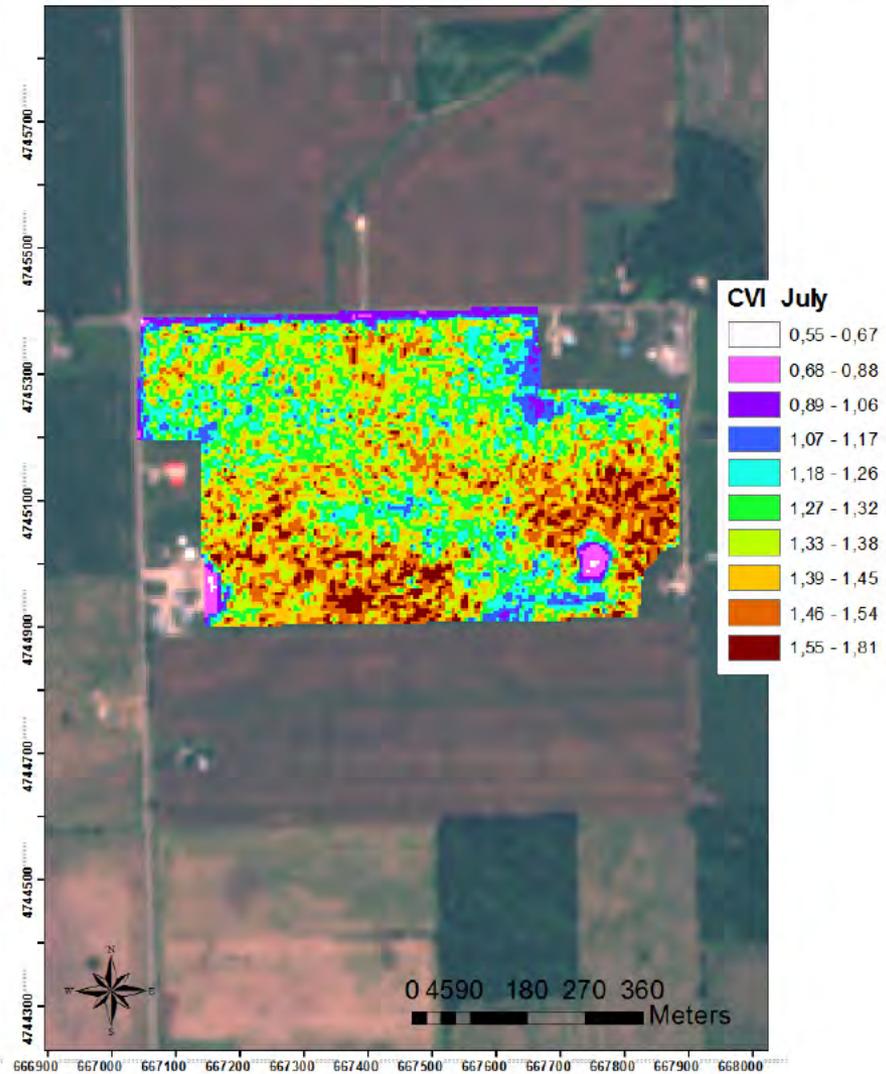
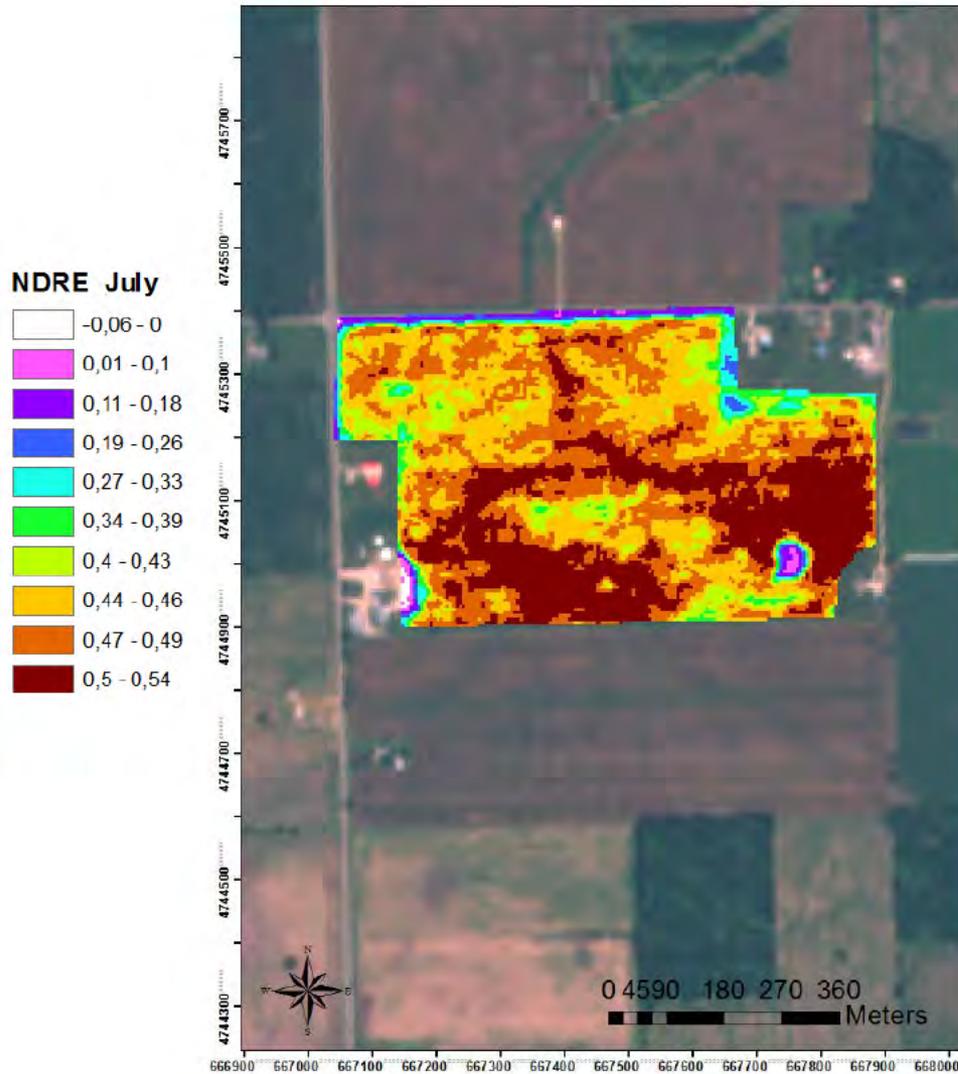
# Chlorophyll Vegetation Indices

## May 30, 2014



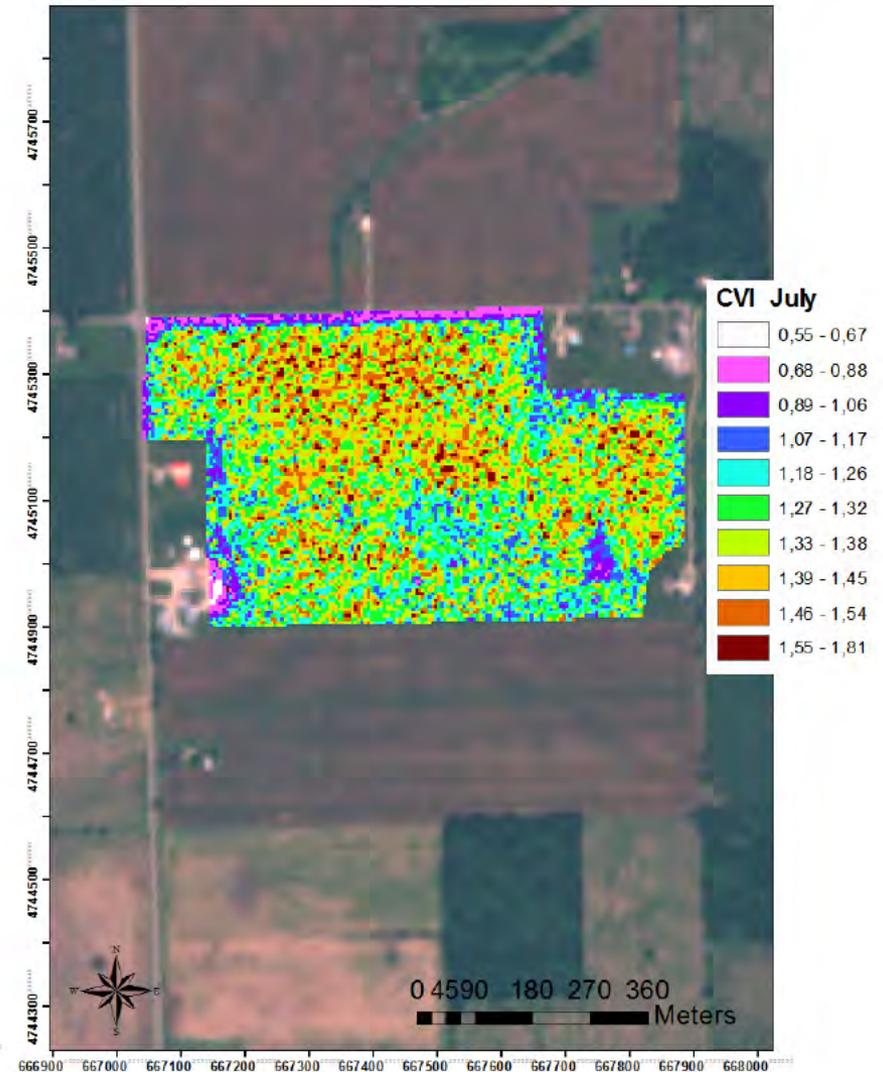
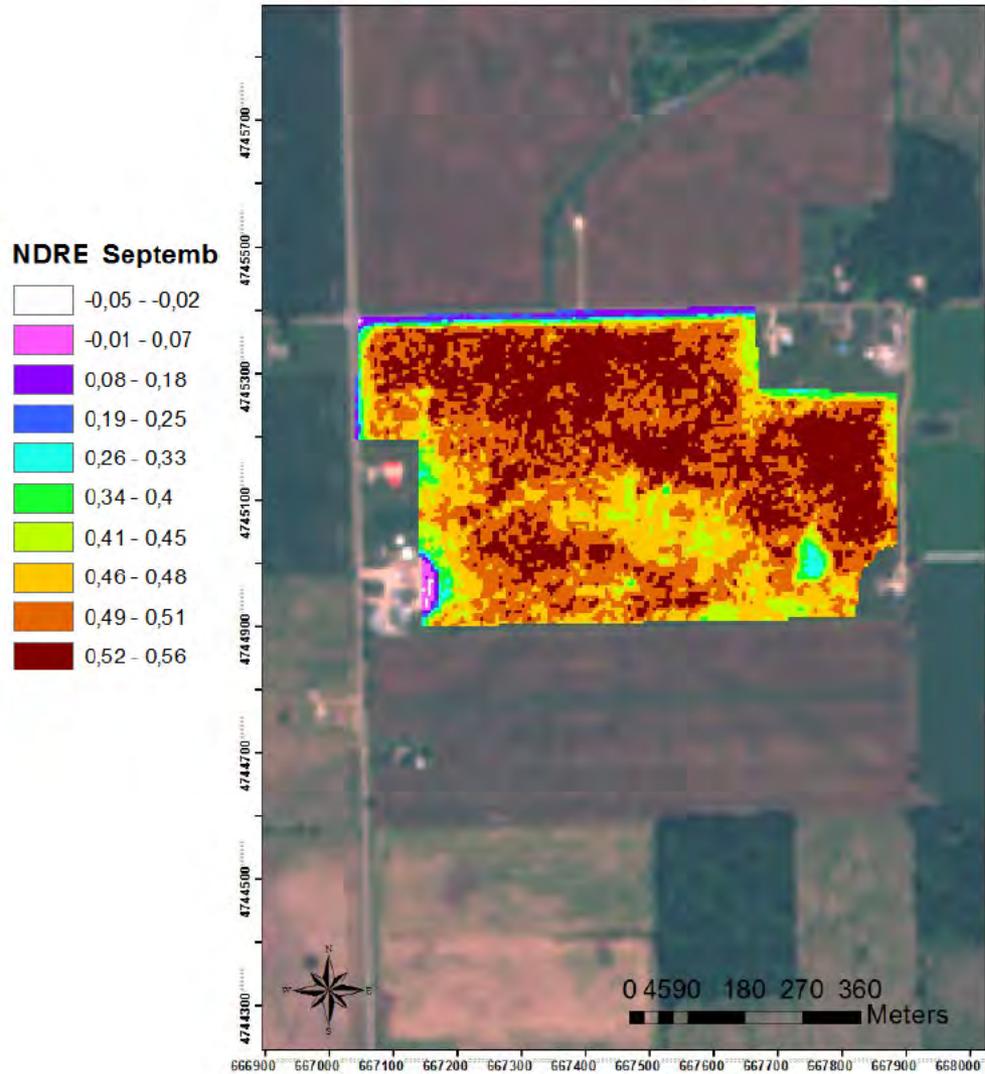
# Chlorophyll Vegetation Indices

## July 3, 2014



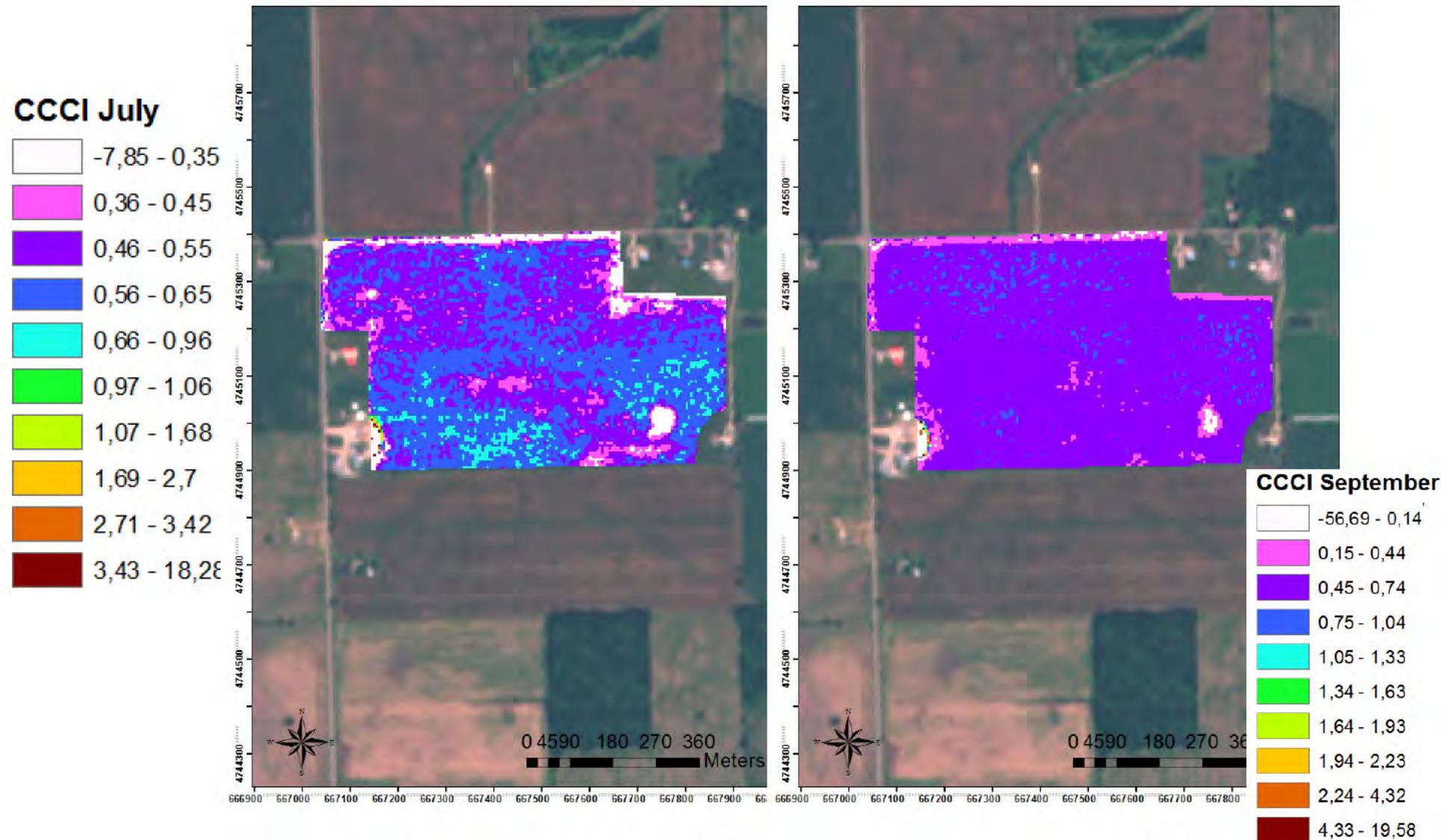
# Chlorophyll Vegetation Indices

## Sept 8, 2014

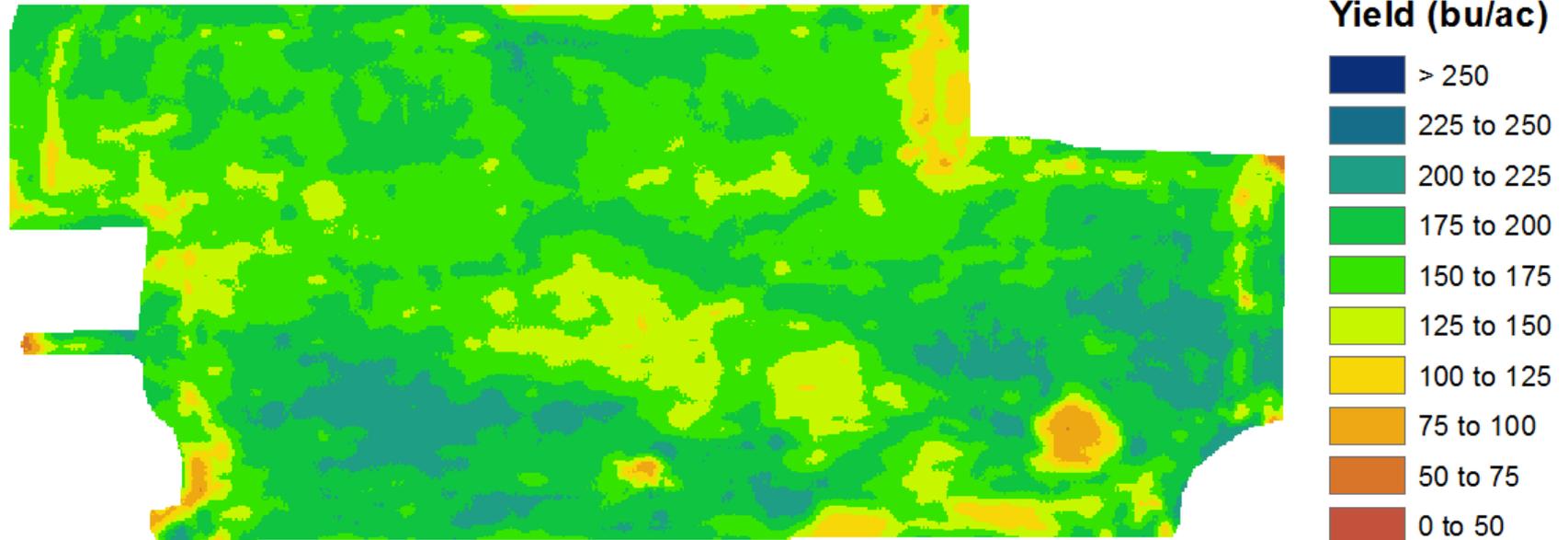


# Chlorophyll Vegetation Indices

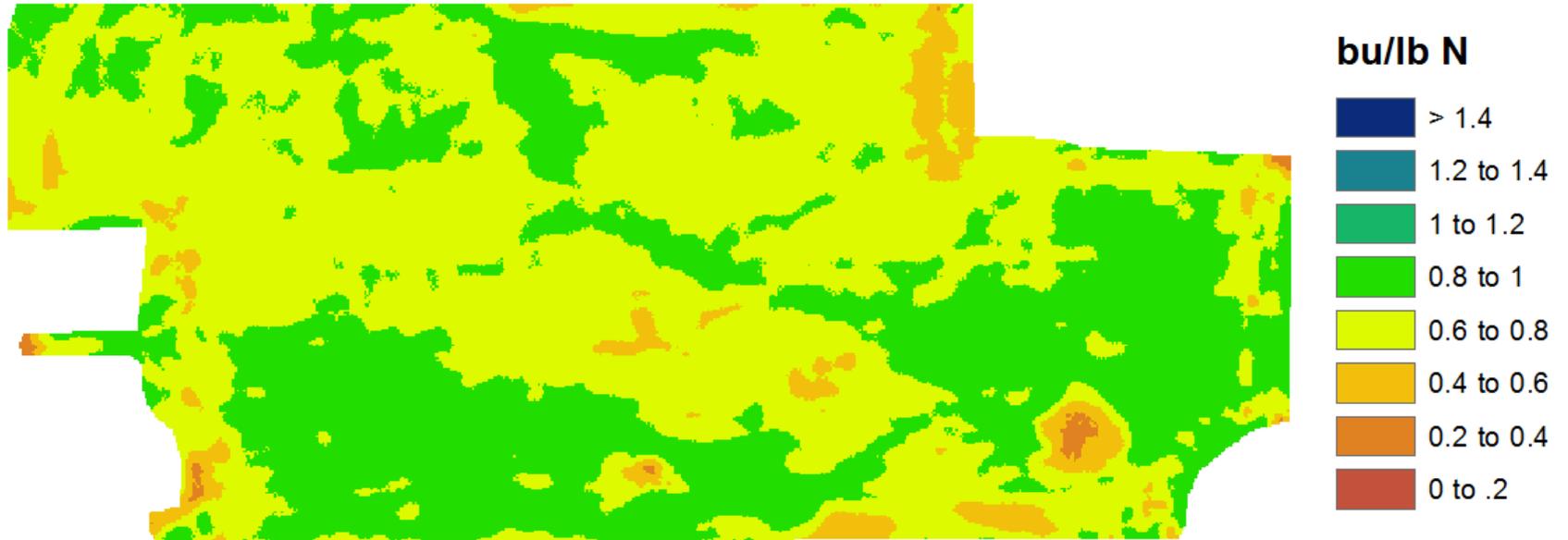
## July 3, 2014



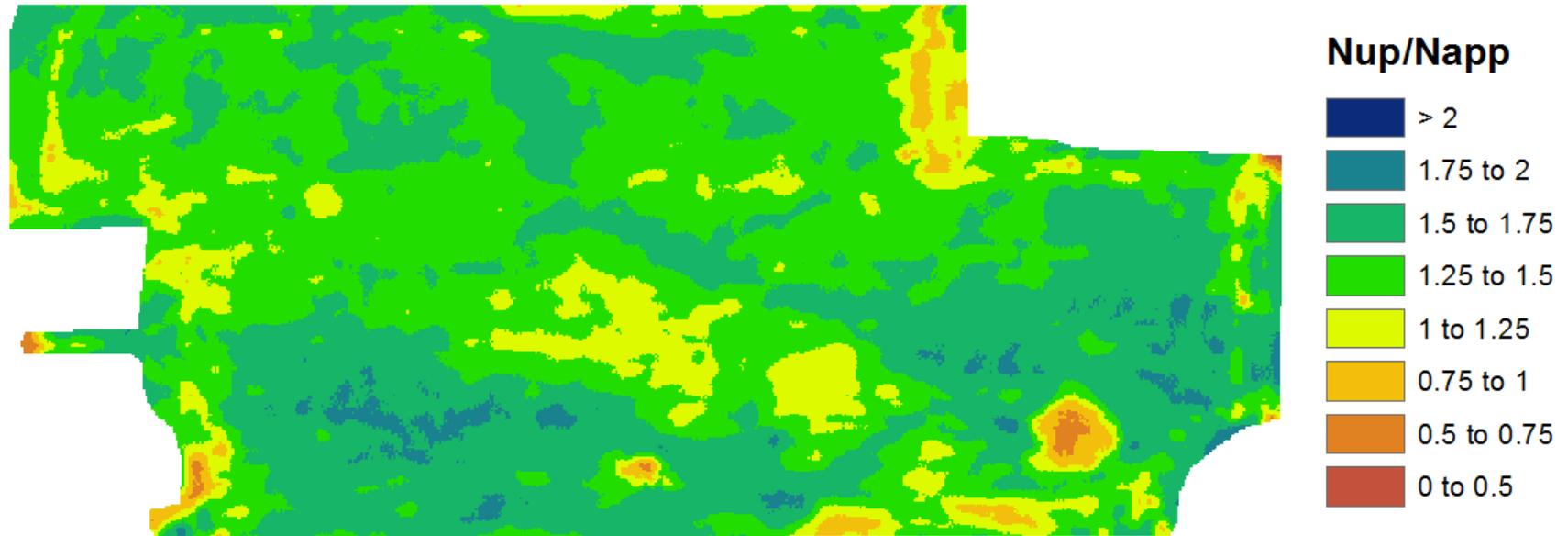
# 2014 Yield Map



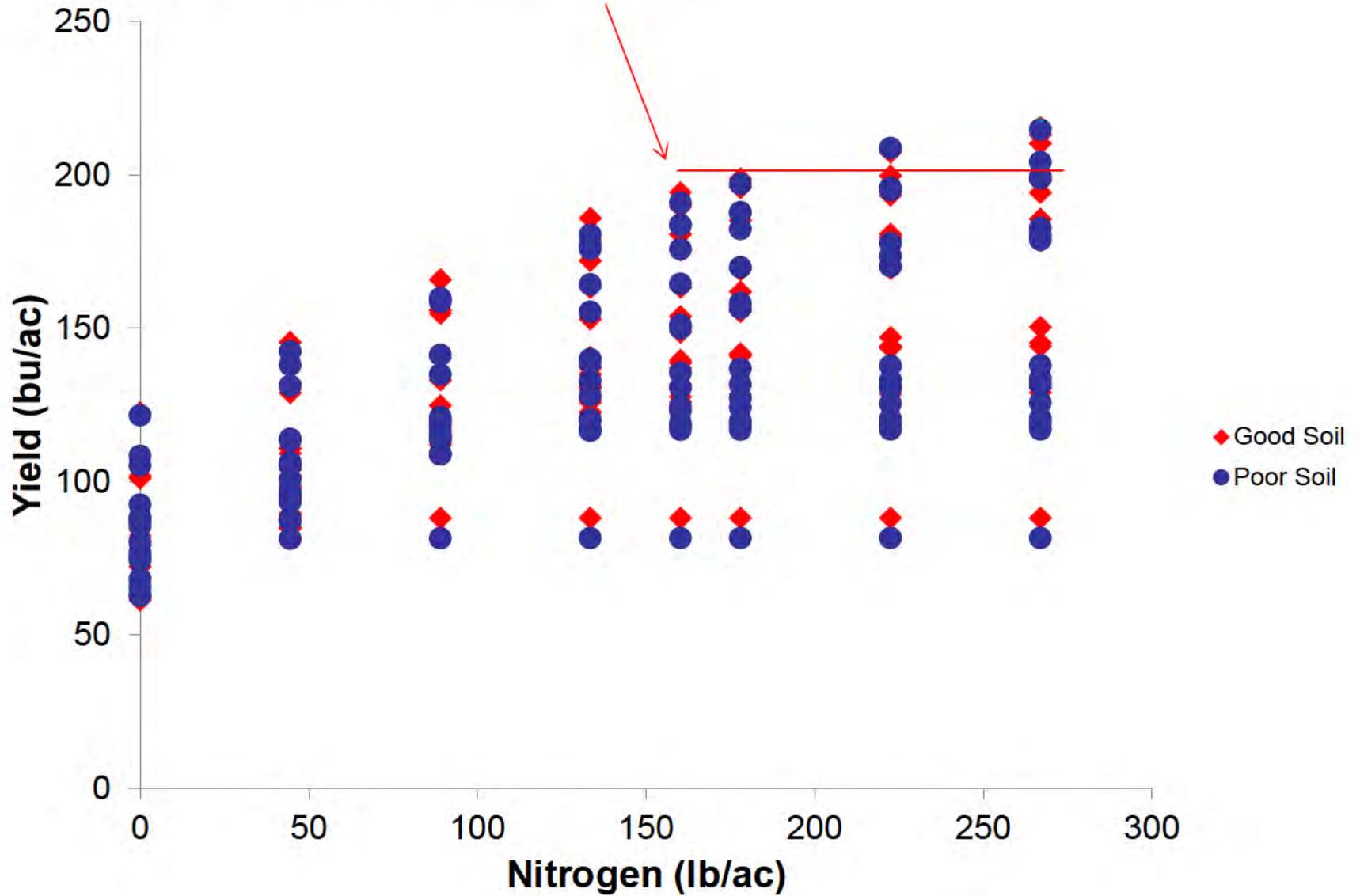
# 2014 Nitrogen Use Efficiency



# 2014 Nitrogen Fertilizer Efficiency

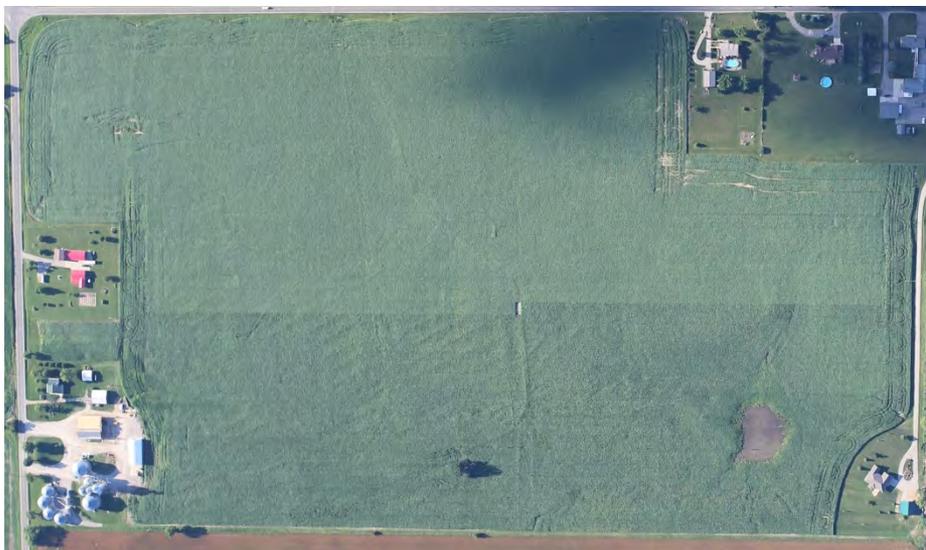


Application Rate Assumed: 160 lb/ac

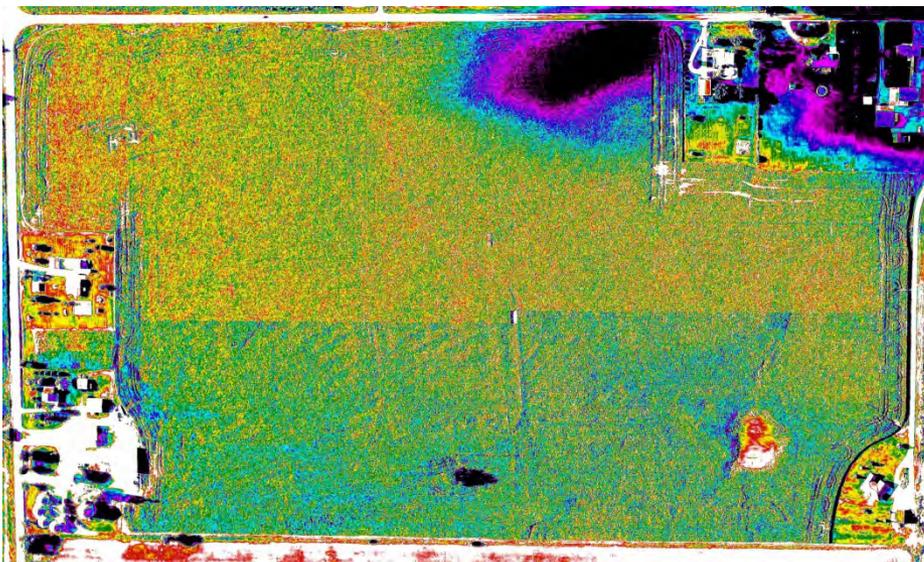


7/10/14

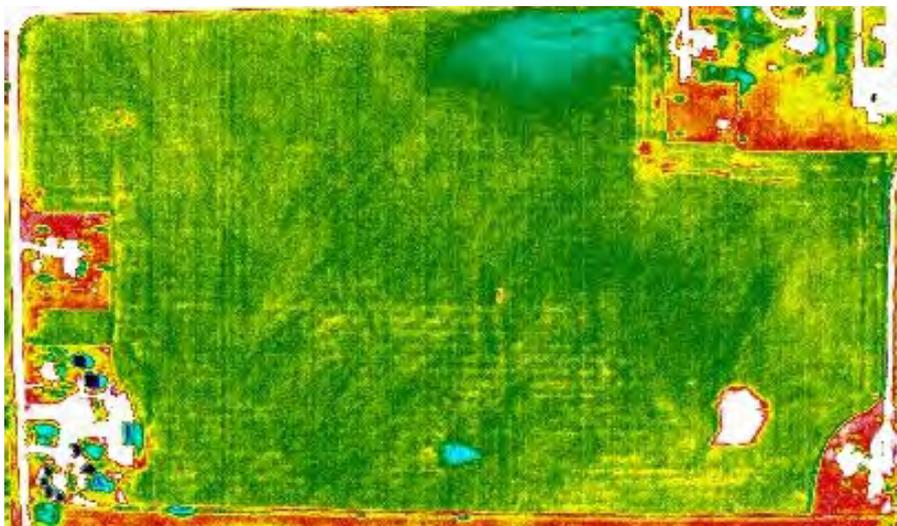
Visible



RGB Calculation



Thermal

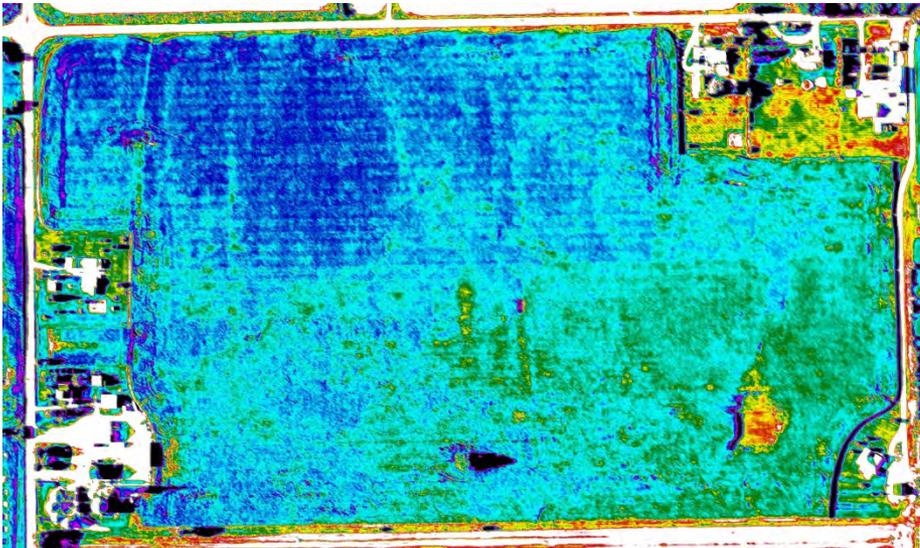


8/14/14

Visible



RGB Calculation



Thermal

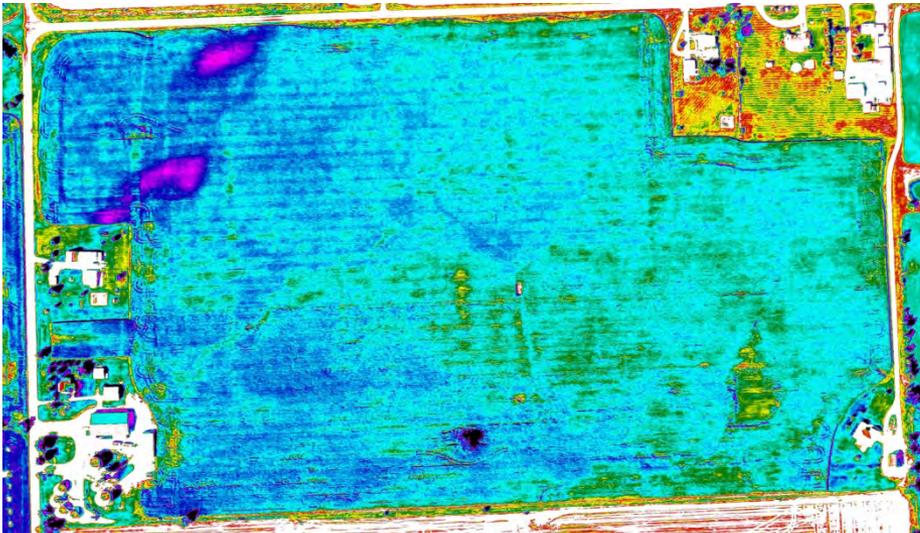


9/2/14

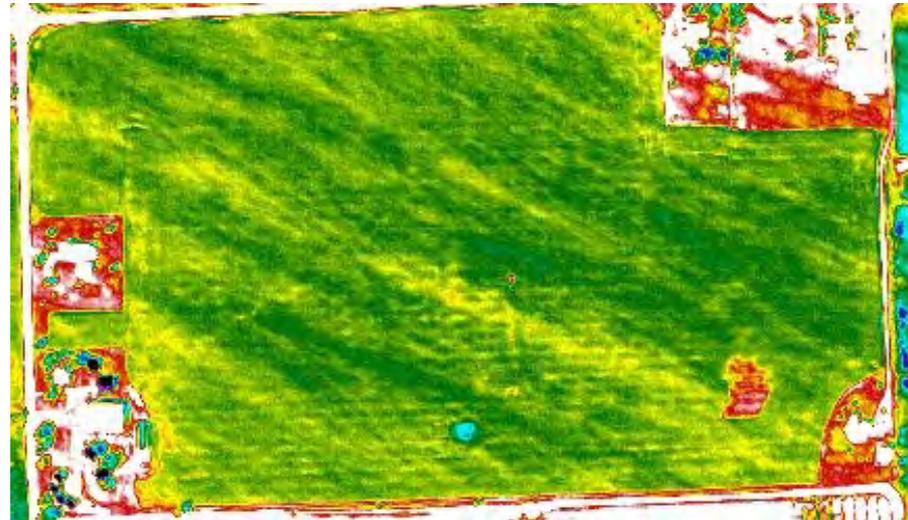
Visible



RGB Calculation



Thermal

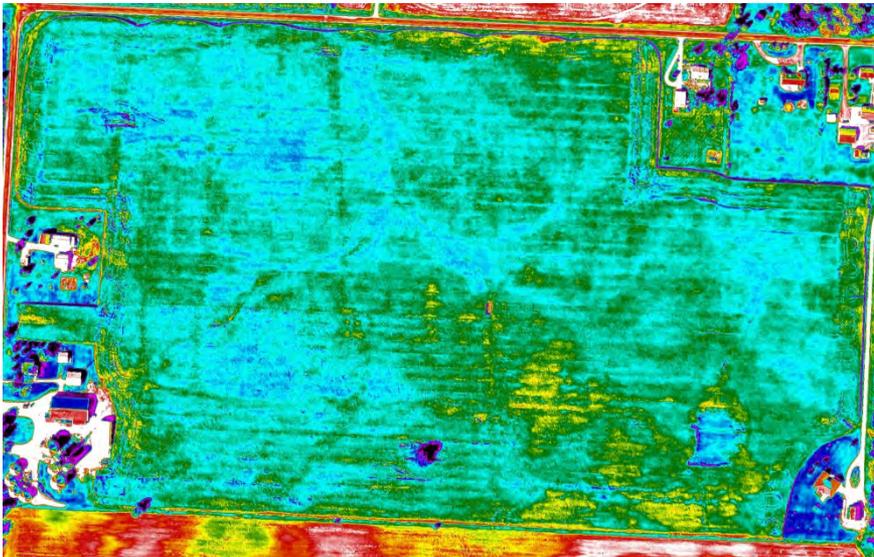


9/23/14

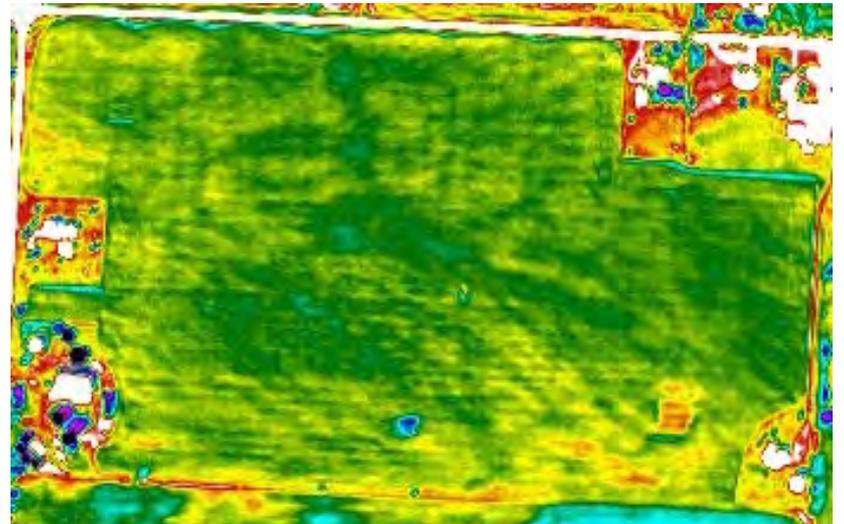
Visible



RGB Calculation



Thermal

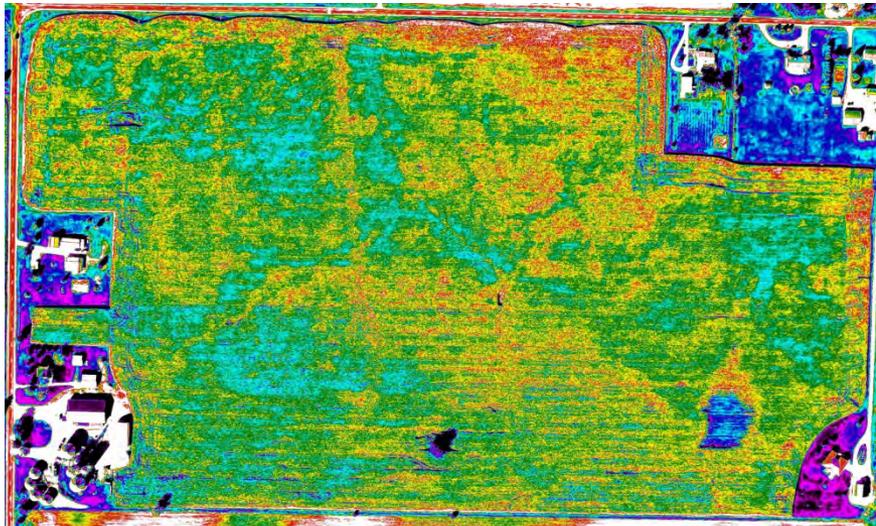


10/9/14

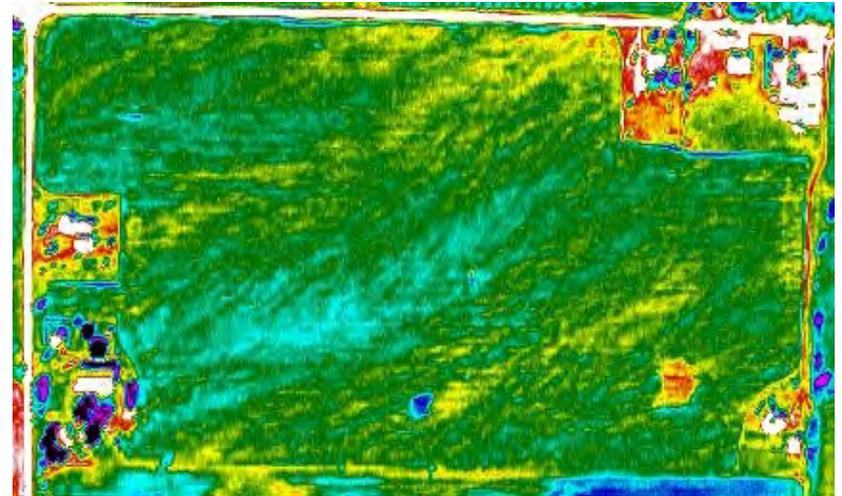
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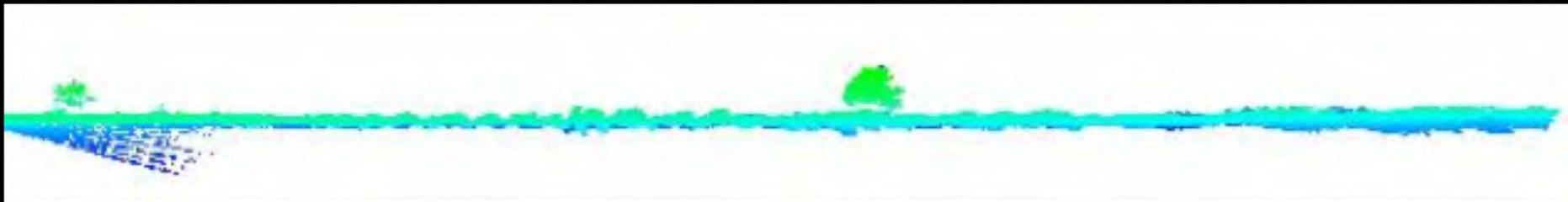
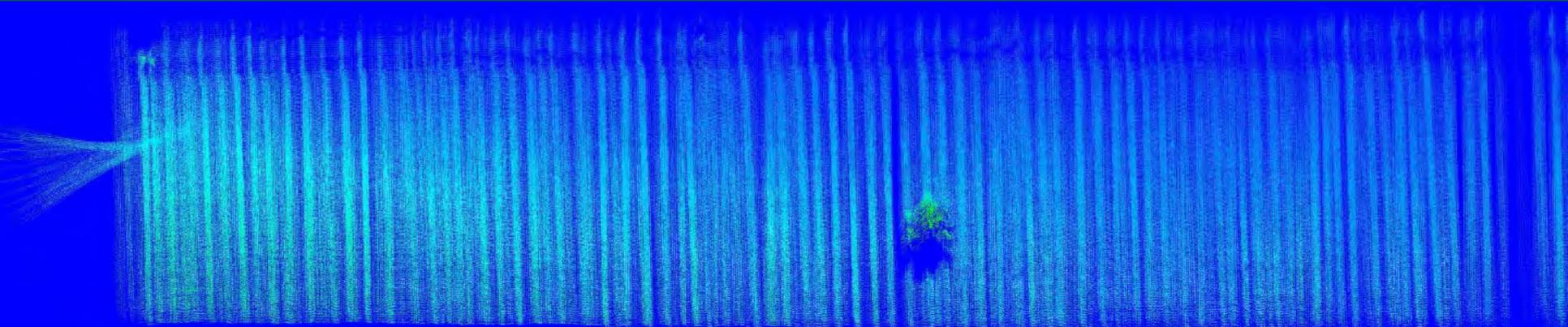
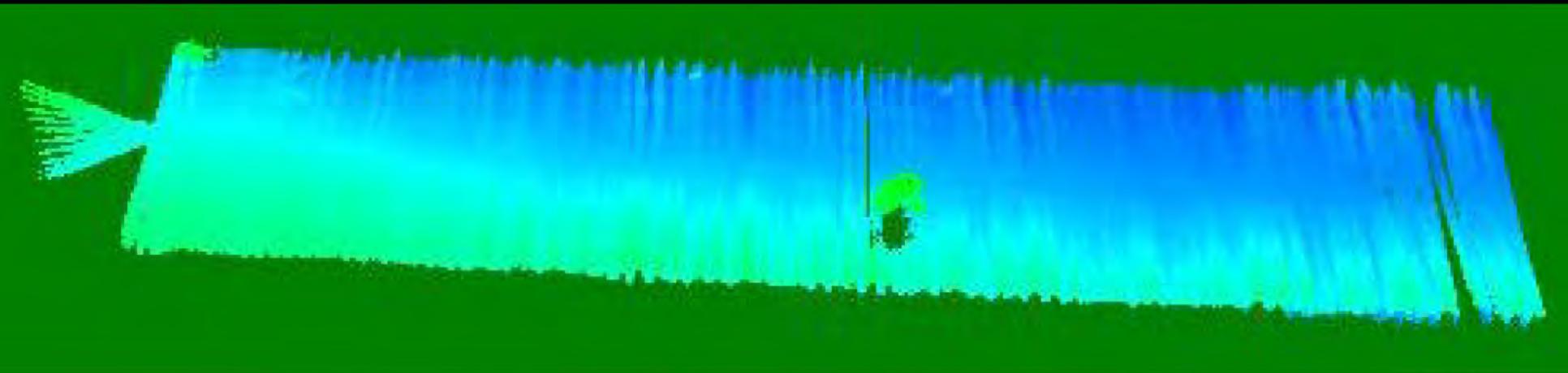
RGB Calculation



Thermal

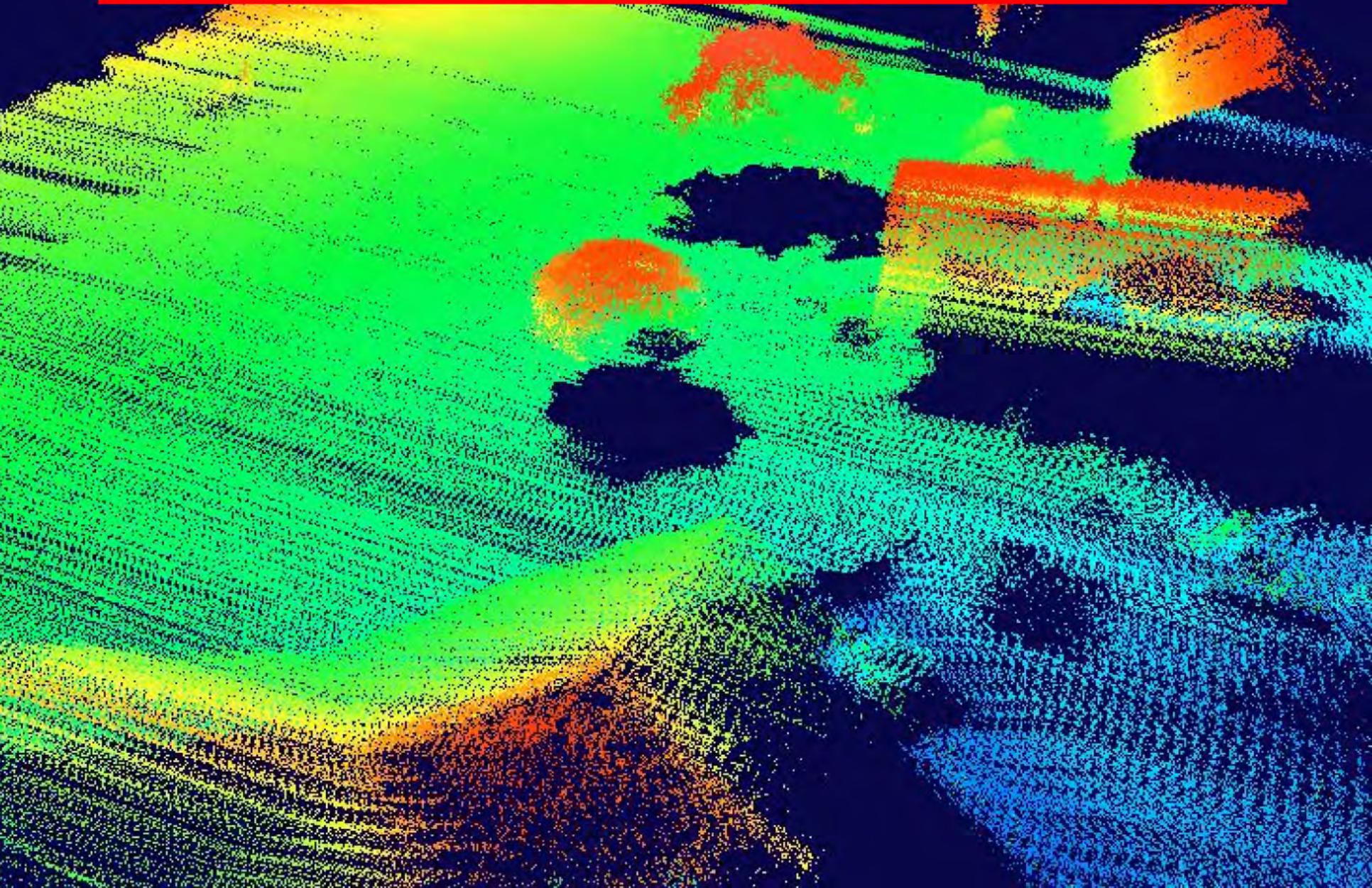


# Laser scanner imagery from UAV for Field M



# Laser scanner imagery from UAV

(microdrone md-1000)



## Data fusion function

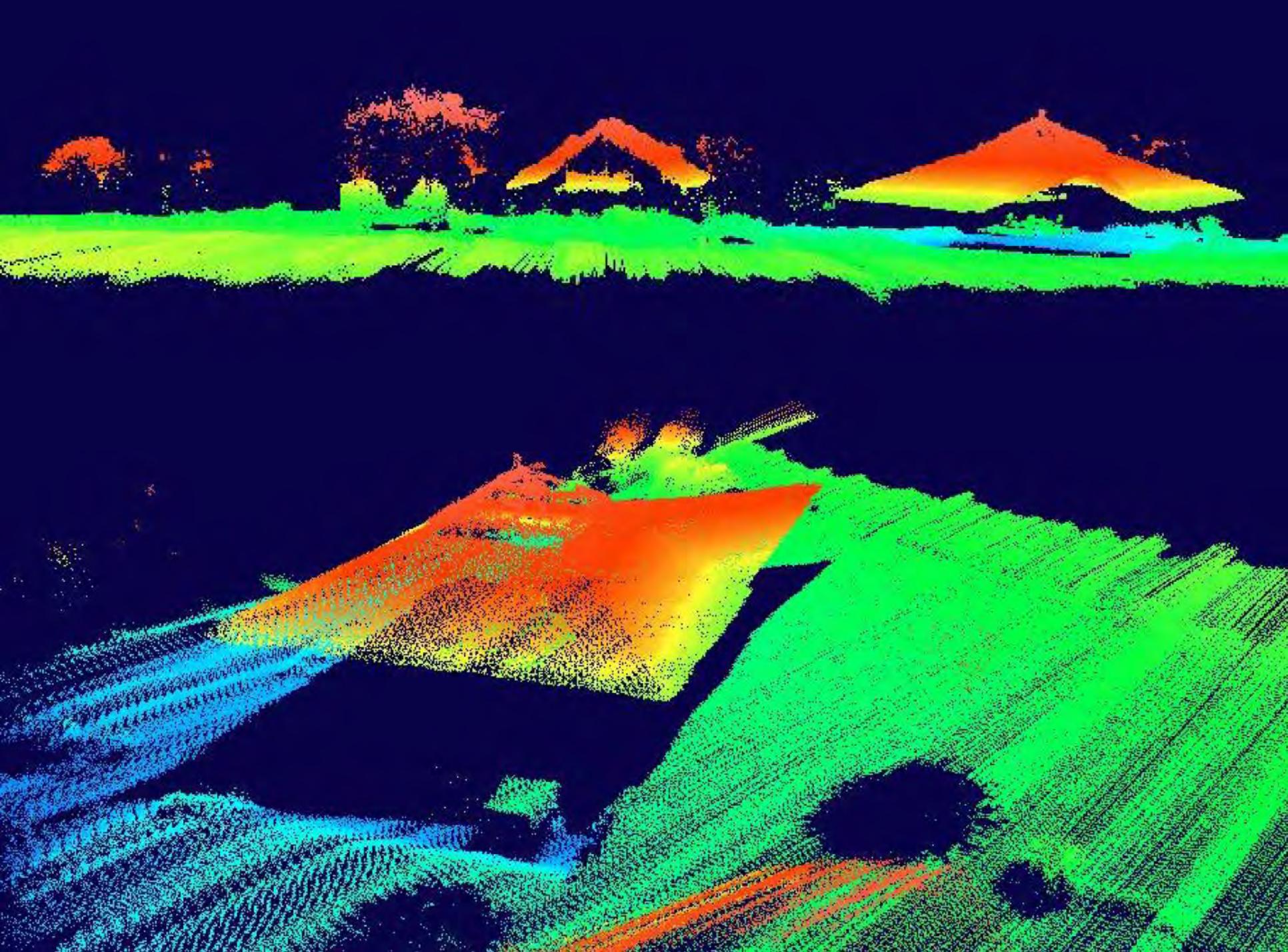
- Time synchronized using GPS time

## Laser data and computed 3D data(x,y,z)

- output (date, time, latitude, longitude, altitude, pitch, roll, azimuth, distance & angle by laser, x, y, z for each scattered points )

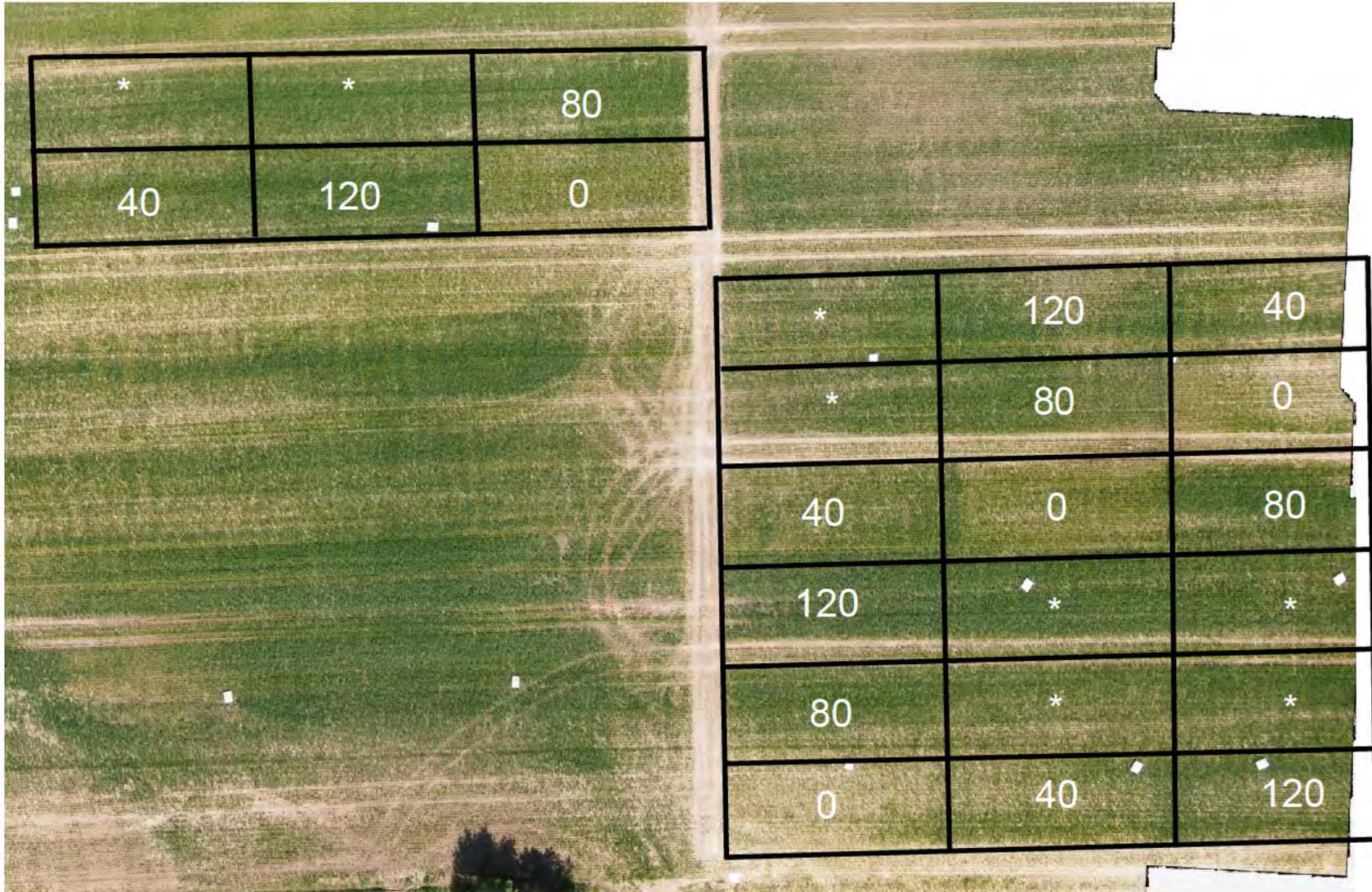
## Output file format

- To text file and shape file.





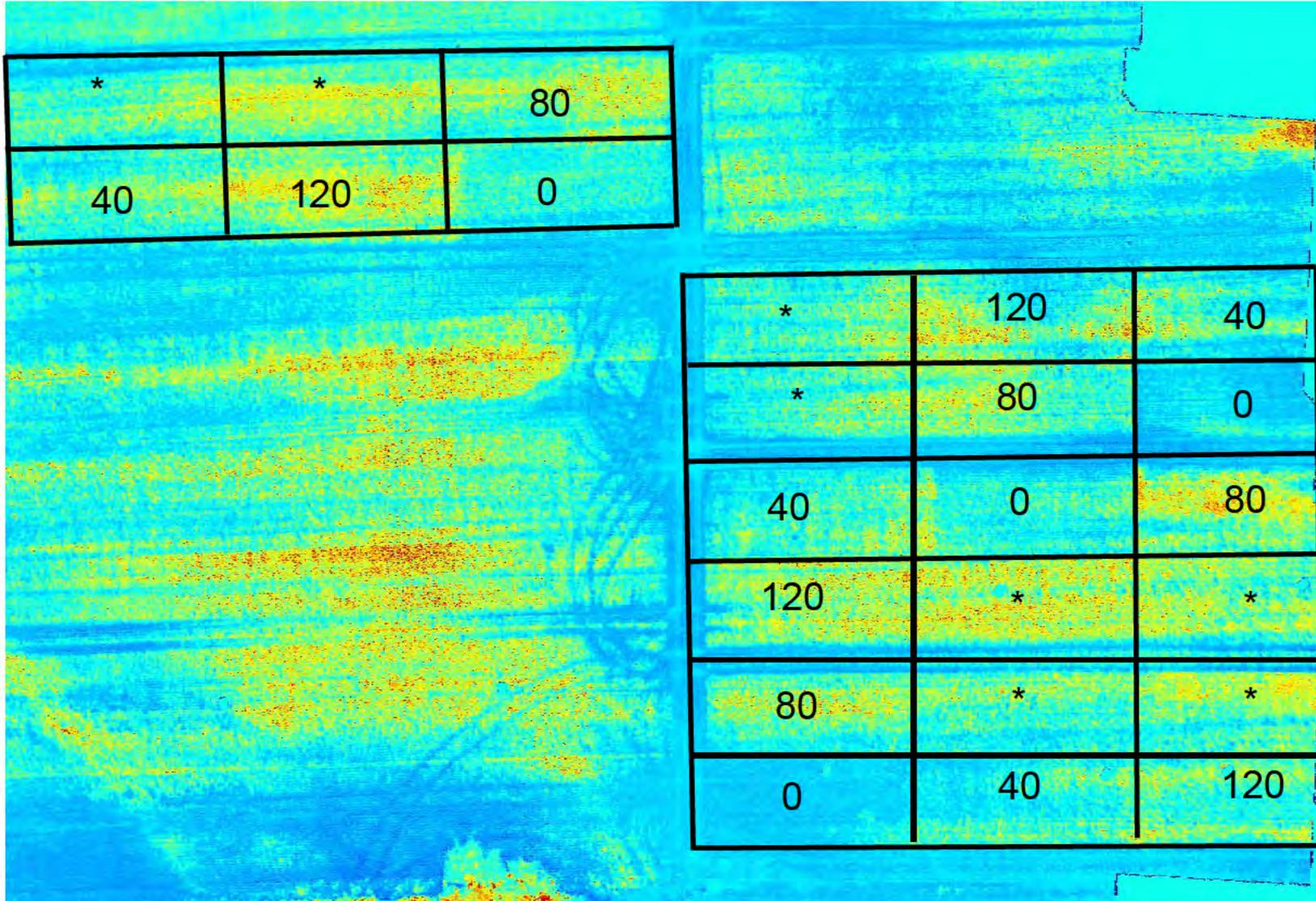
# 5/30/14 N Trial





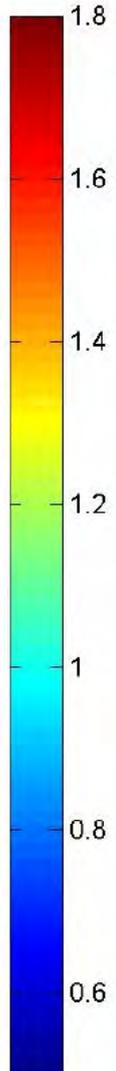
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# 5/30/14 N Trial - RVI



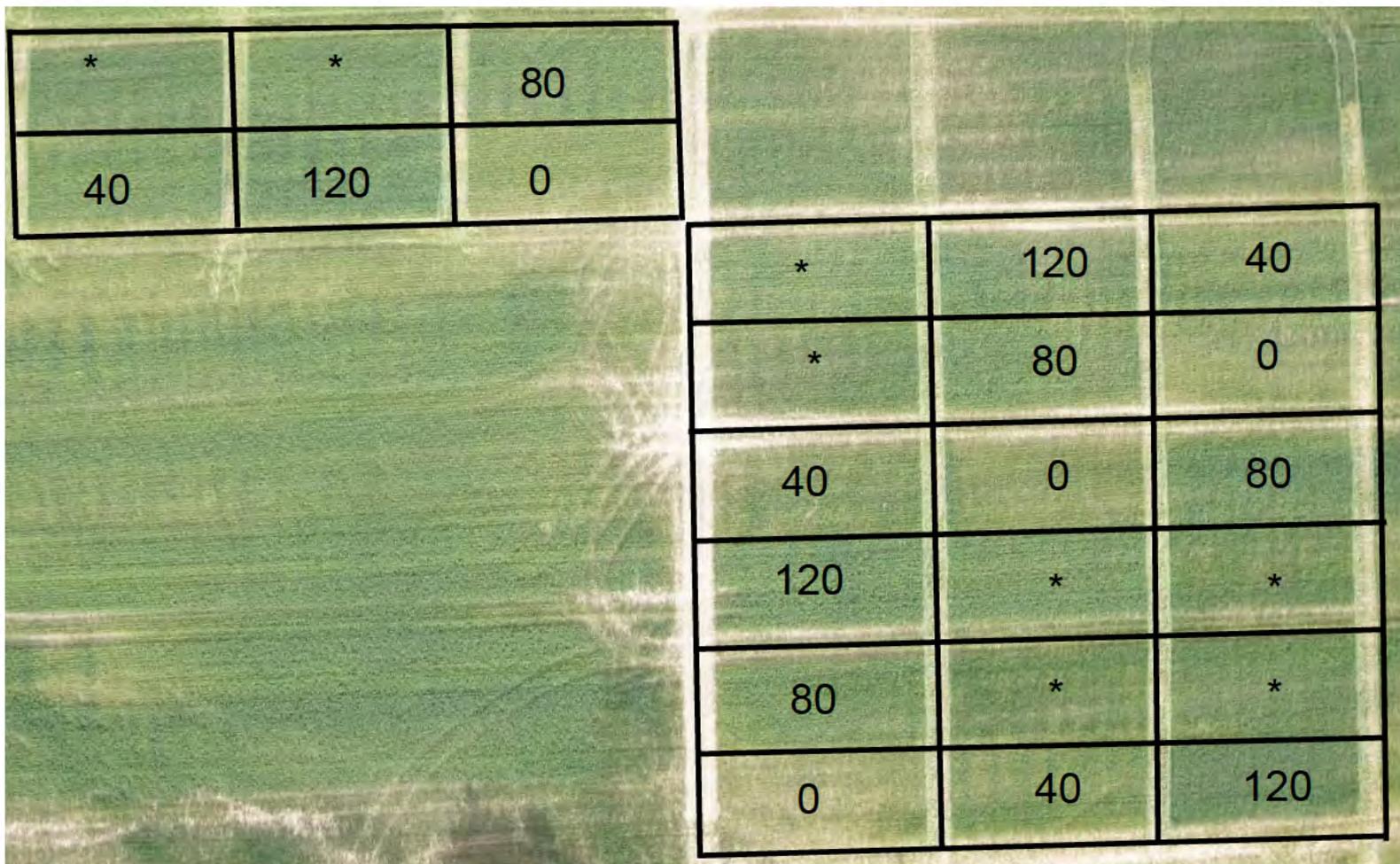
*	*	80
40	120	0

*	120	40
*	80	0
40	0	80
120	*	*
80	*	*
0	40	120



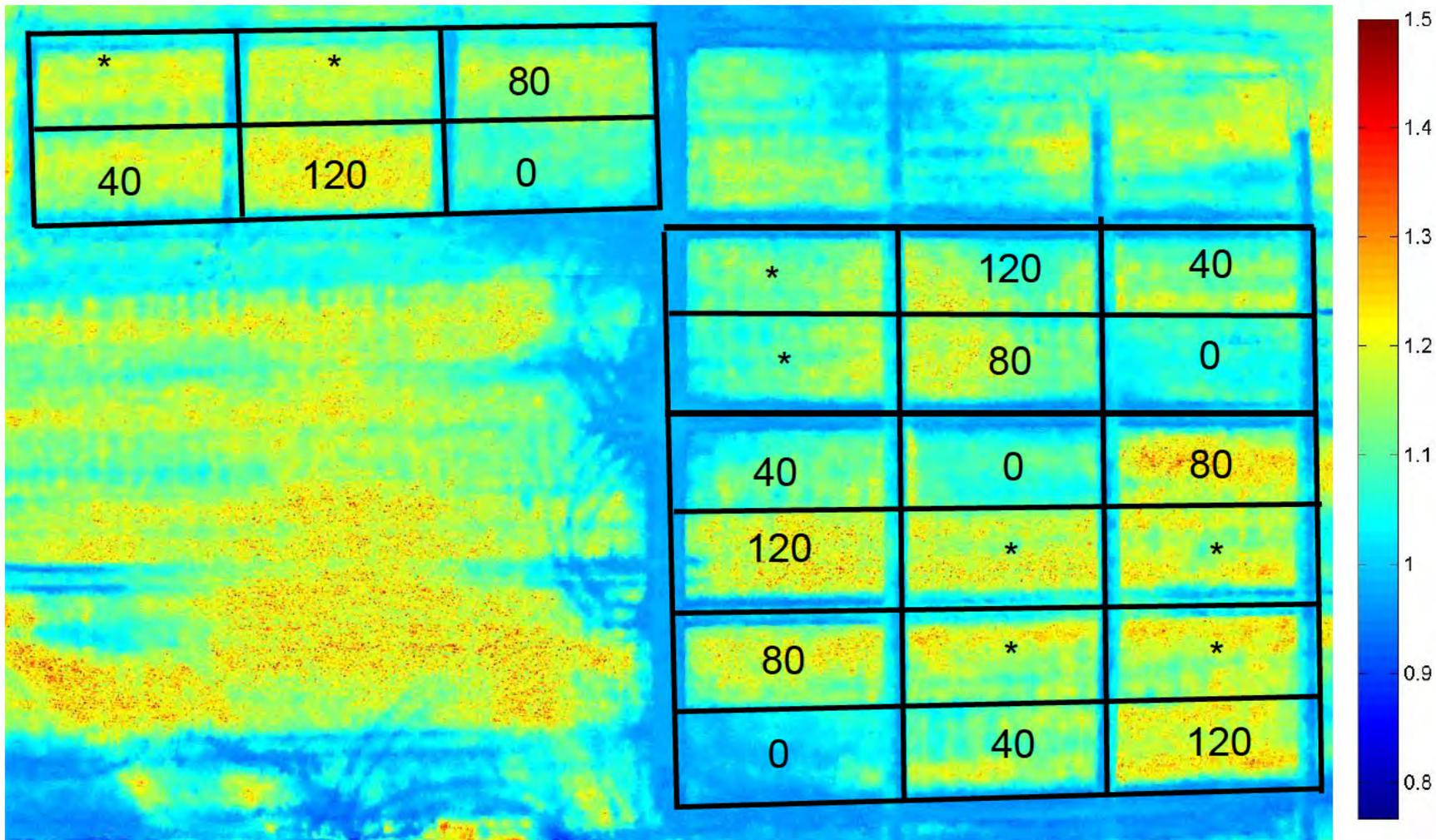


# 6/12/14 N Trial

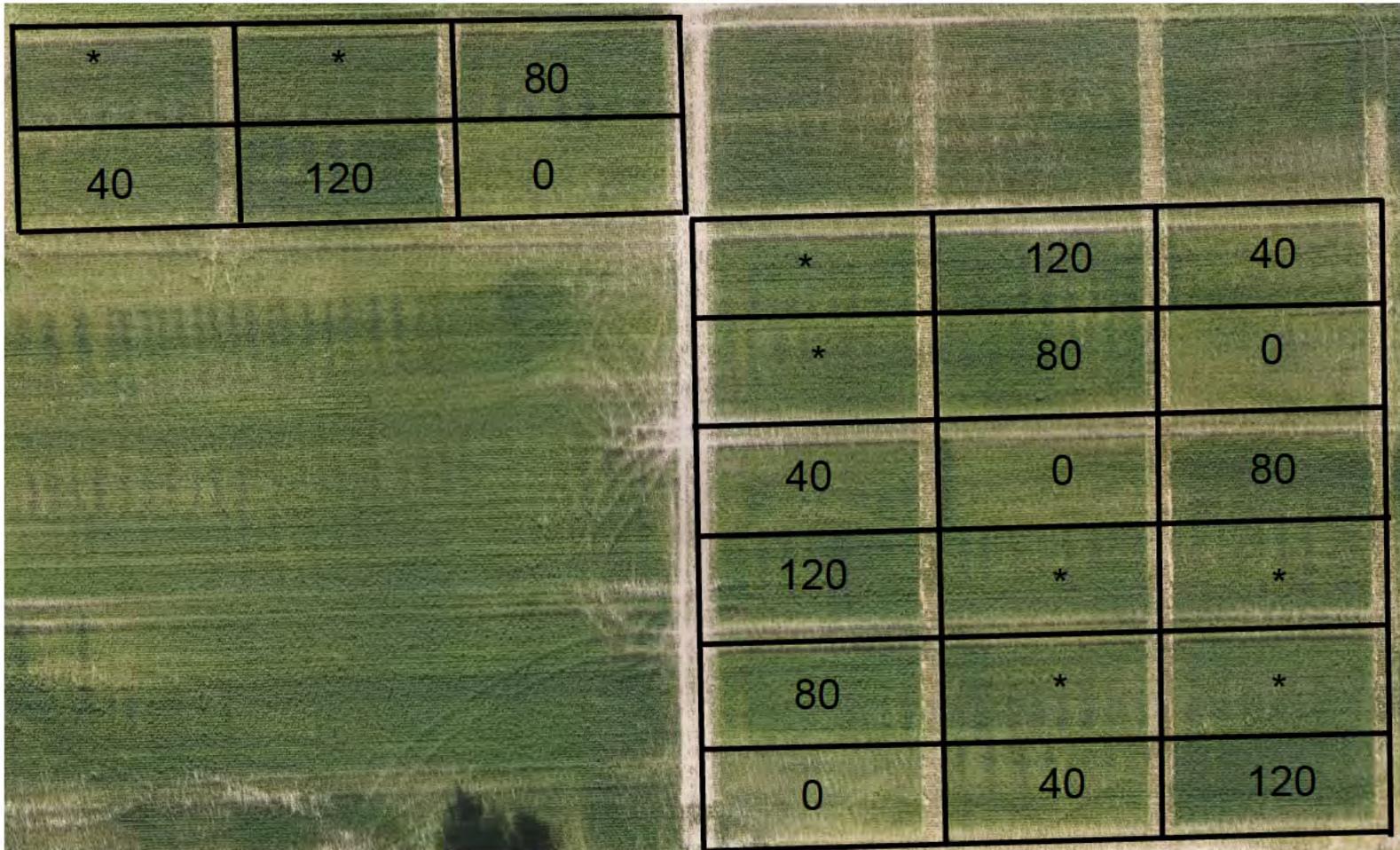




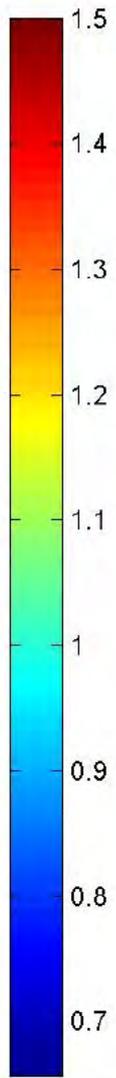
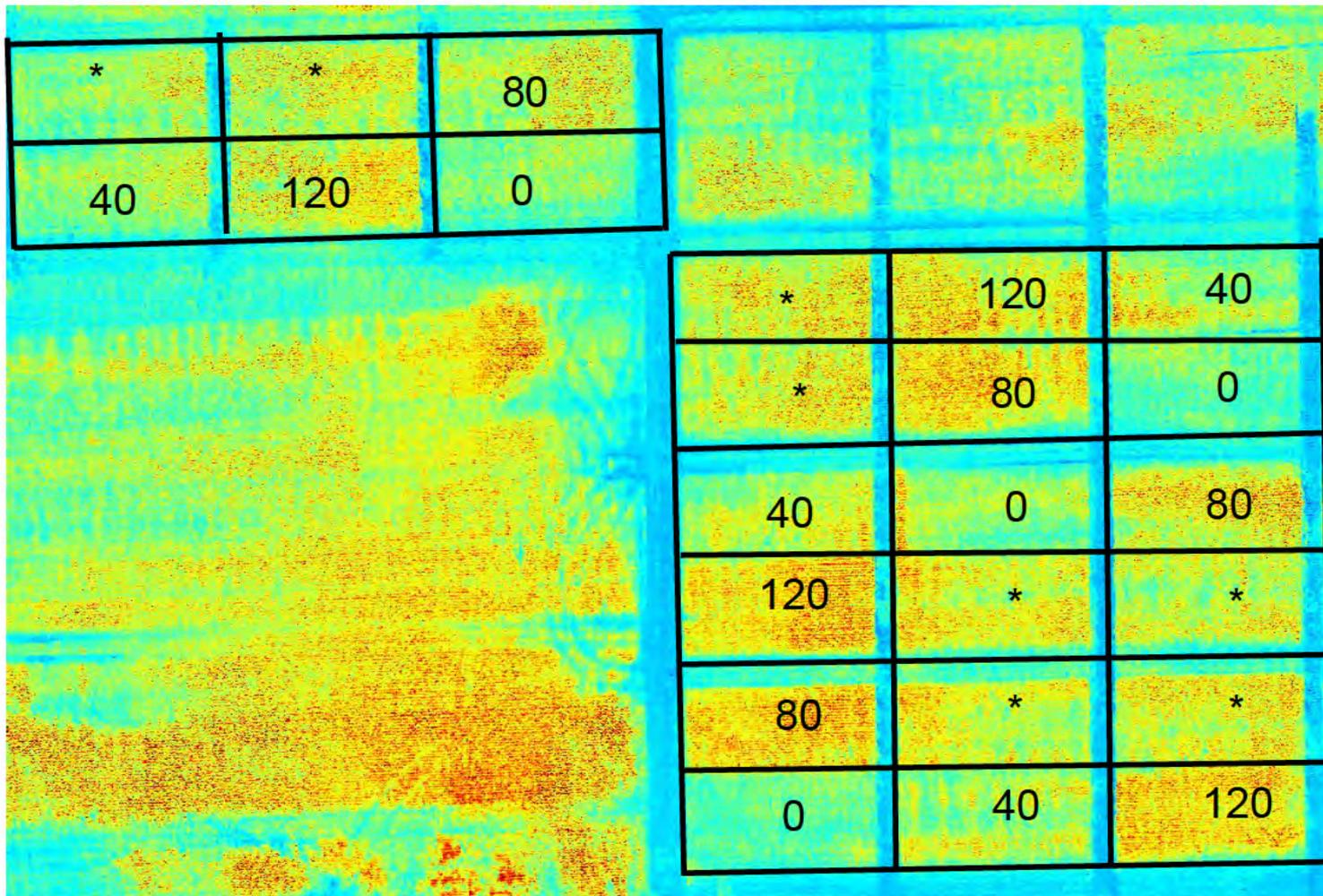
# 6/12/14 N Trial - RVI



# 6/27/14 N Trial



# 6/27/14 N Trial - RVI



# Winter Wheat Fungicide and Palisade Efficacy Trials



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- Fusarium Head Blight (*Fusarium graminearum*)
- Leaf Rust (*Puccinia triticina*)
- Septoria Leaf Spot (*Septoria tritici*)
- Stagonospora Leaf Blotch (*Stagonospora nodorum*)



Location: Deckerville, MI

Elevation: 771 ft

Lat: 43.506207°

Long: -82.788400°



Planted: 10/3/13

Seed rate: 1.8 m/ac

Variety: Ambassador soft winter wheat

Plot Size: 18 x 65 ft

N rate: 110 and 155 lbs/ac

Soil Type: Parkhill silt loam

Fungicides: Aproach Prima, Aproach, Prosaro, Stratego,

Baythr, Priaxor, Caramba

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# Winter Wheat Fungicide and Palisade Trials



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- Fusarium Head Blight (*Fusarium graminearum*)
- Leaf Rust (*Puccinia triticina*)
- Septoria Leaf Spot (*Septoria tritici*)
- Stagonospora Leaf Blotch (*Stagonospora nodiflora*)

Foliar  
fungicide  
efficacy

Palisade  
rate and  
timing  
+ N rate

Head blight  
fungicide  
efficacy



## Experiment:

- Varied time, rate, and mixes of 7 fungicides
- **Diseased plots vs. controls were of interest to us**

## Experiment:

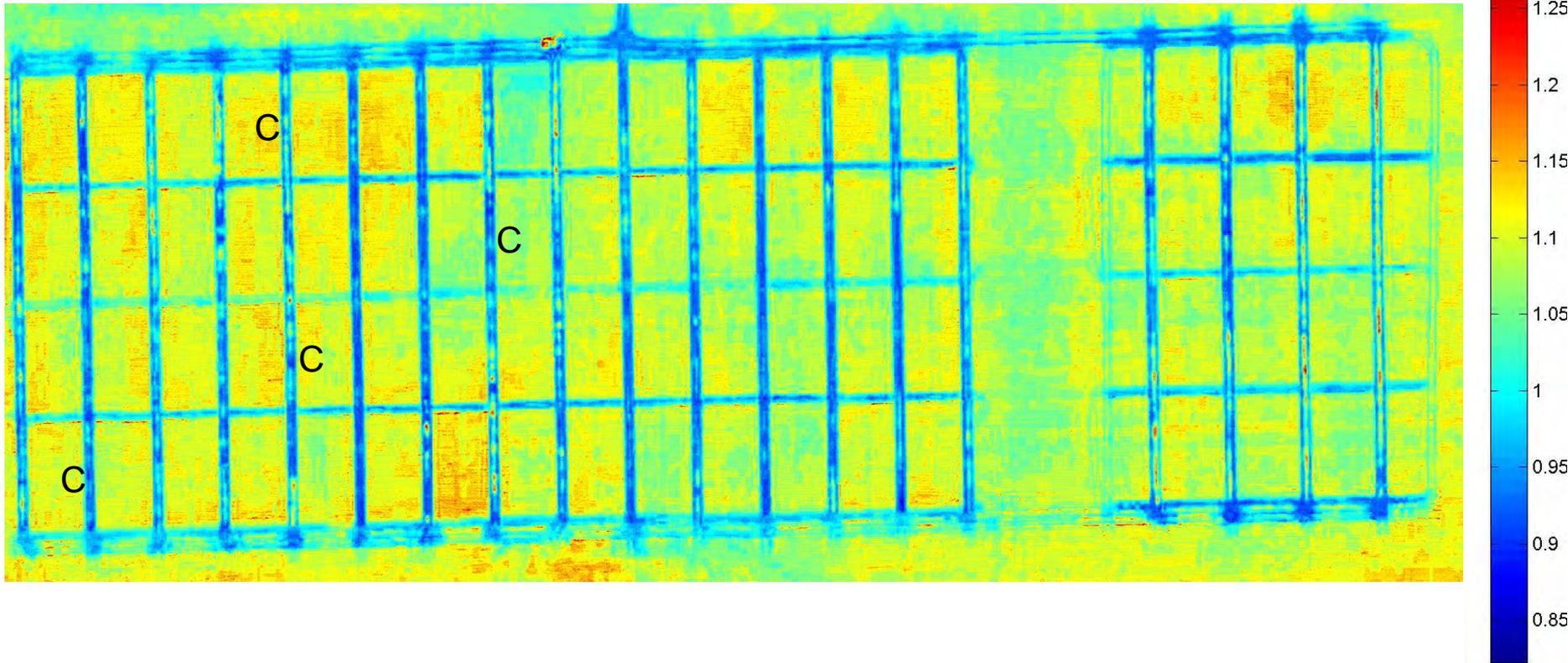
- Varied Palisade growth regulator rate and timing of application and Nitrogen (110/155 lbs/ac)
- **Lodging was of interest to us**

## Experiment:

- Varied inoculated with non inoculated and fungicide treatment timing
- **Detection of head blight via drone was of interest to us**



# 6/27/14 Fungicide Efficacy Trials



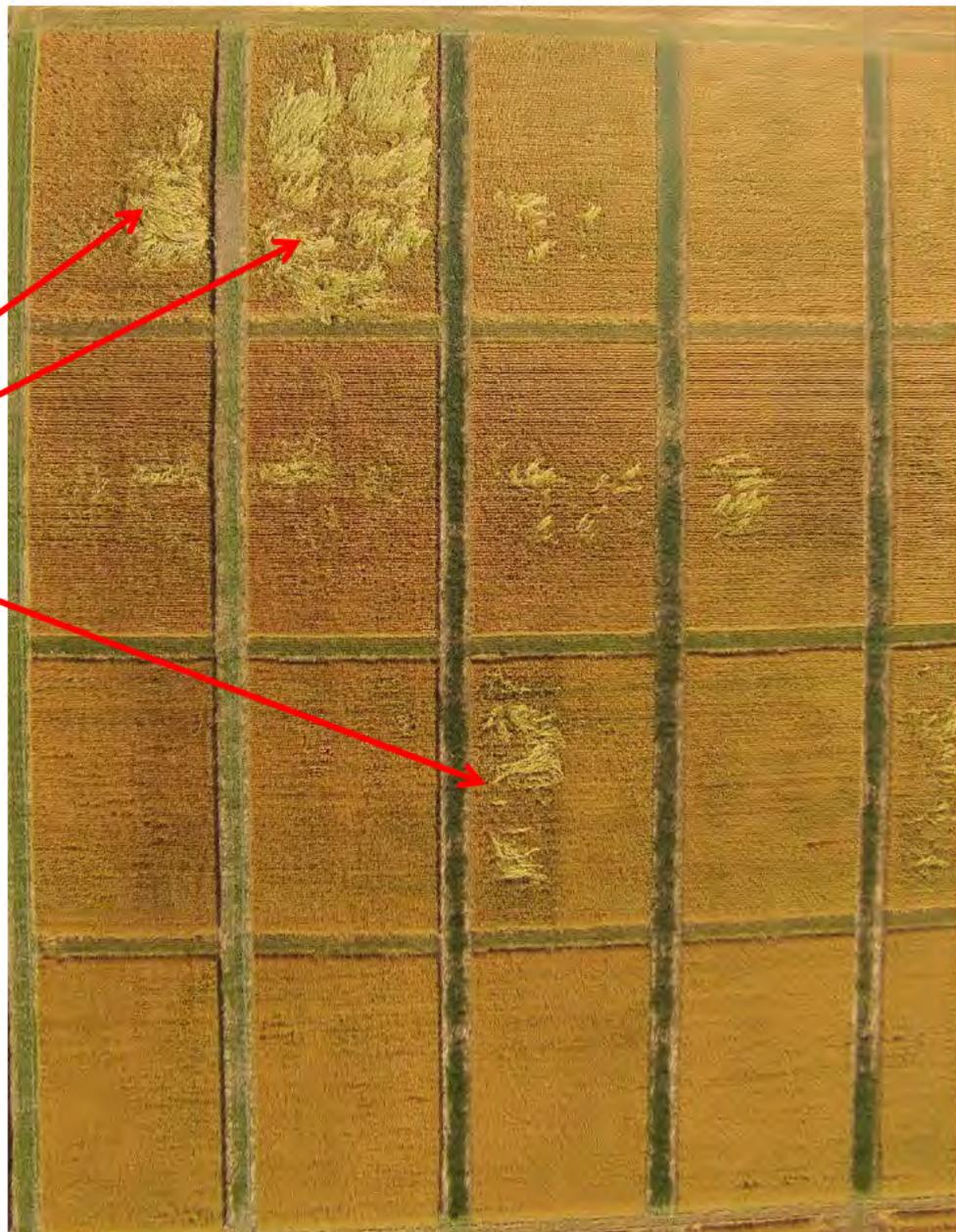


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# Palisade Efficacy Trials

No significant lodging seen in Palisade growth regulator trials.

However, significant lodging in foliar fungicide treatments when fungicide rates were high

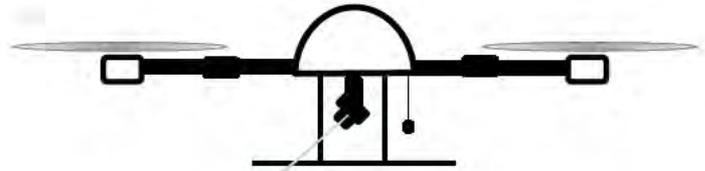


# Head Blight Fungicide Efficacy

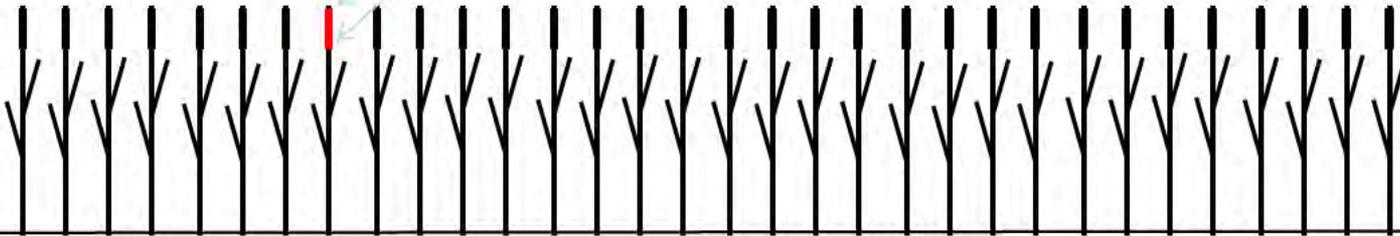


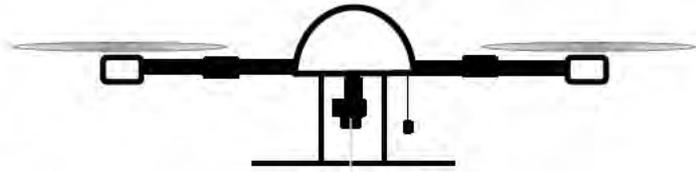
At a  $\sim 45^\circ$  angle, heads with strong signs of disease are likely to be detected.



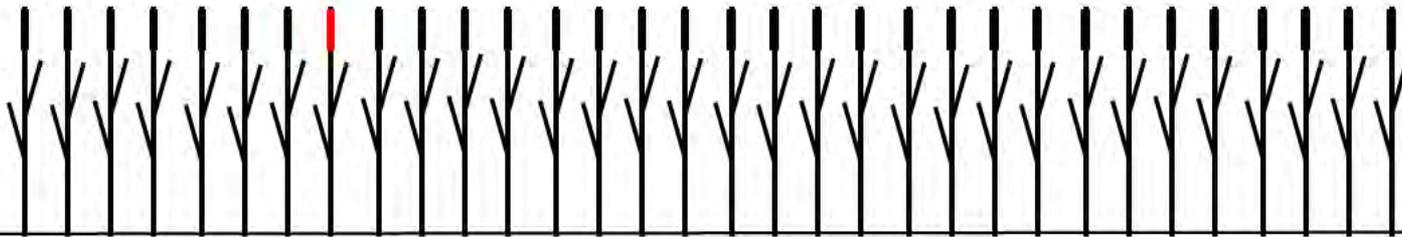


Angled shots provide the opportunity of catching the largest surface area displaying disease



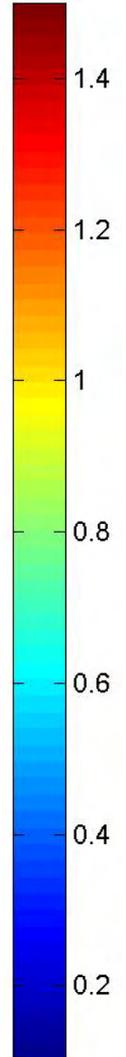
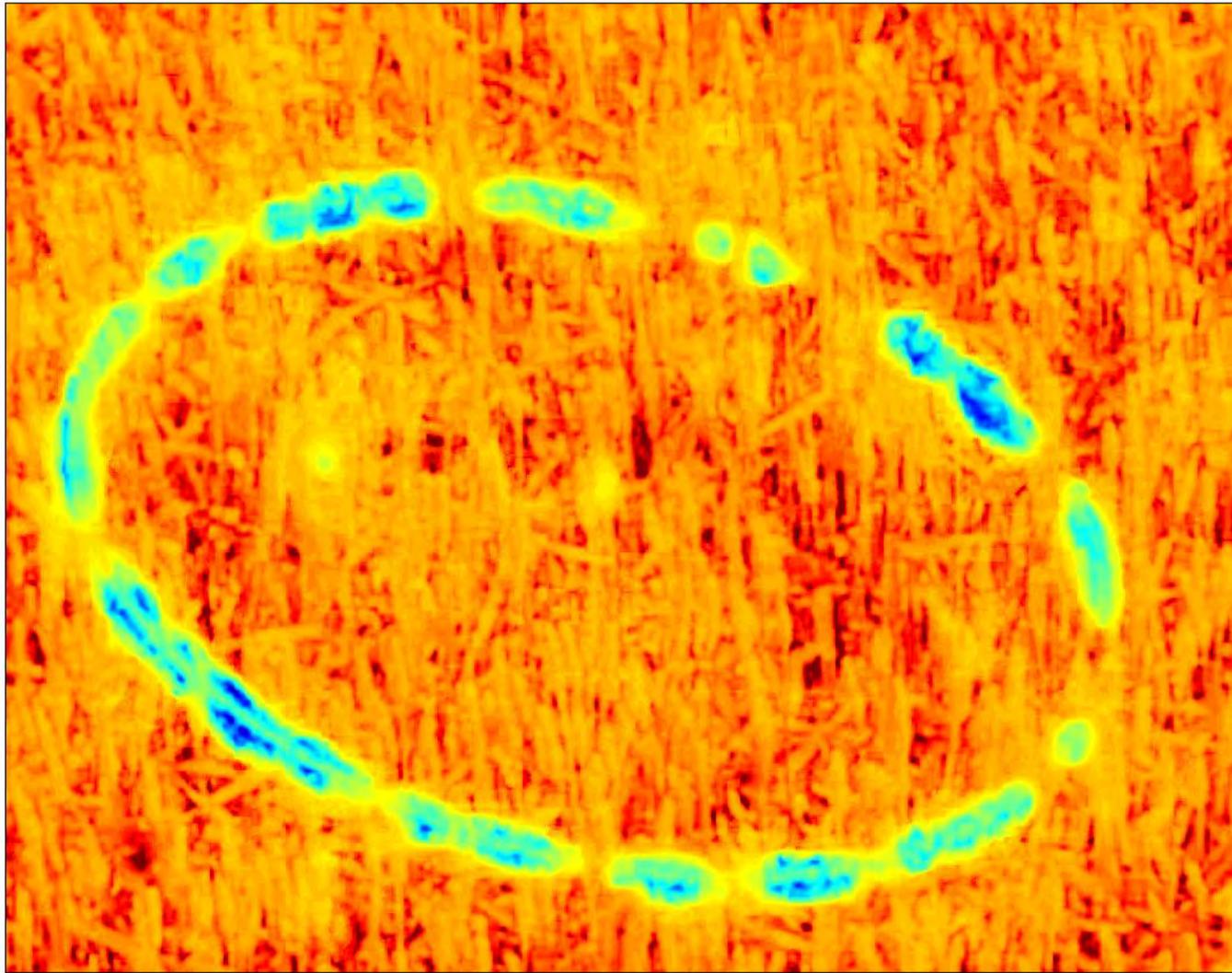


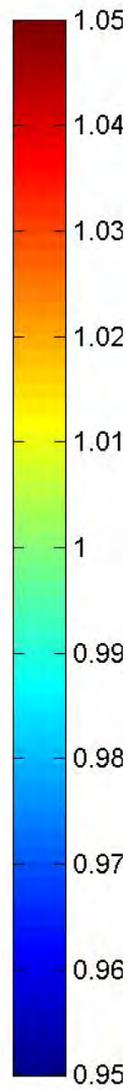
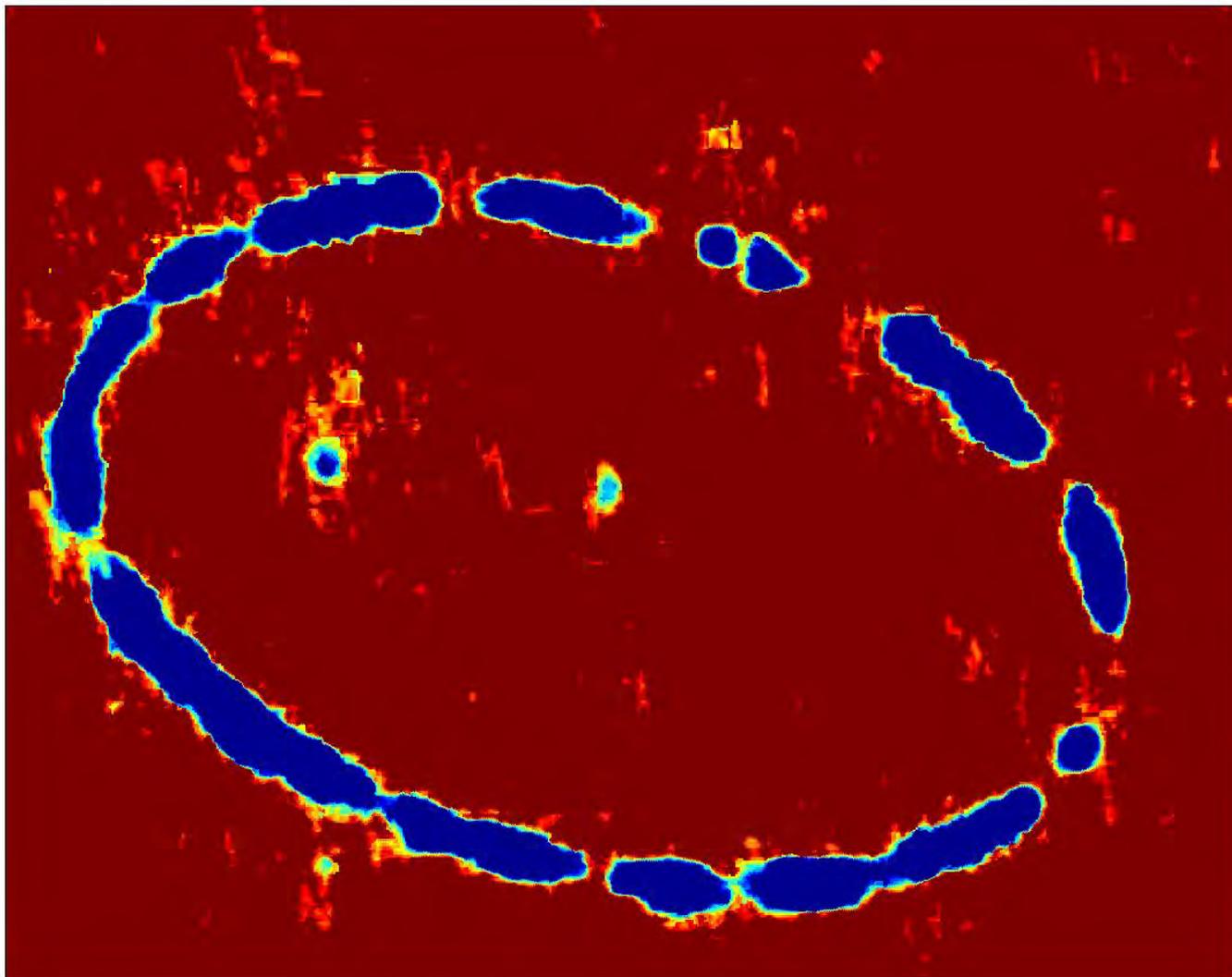
Shots at zenith have a lower potential of detecting disease

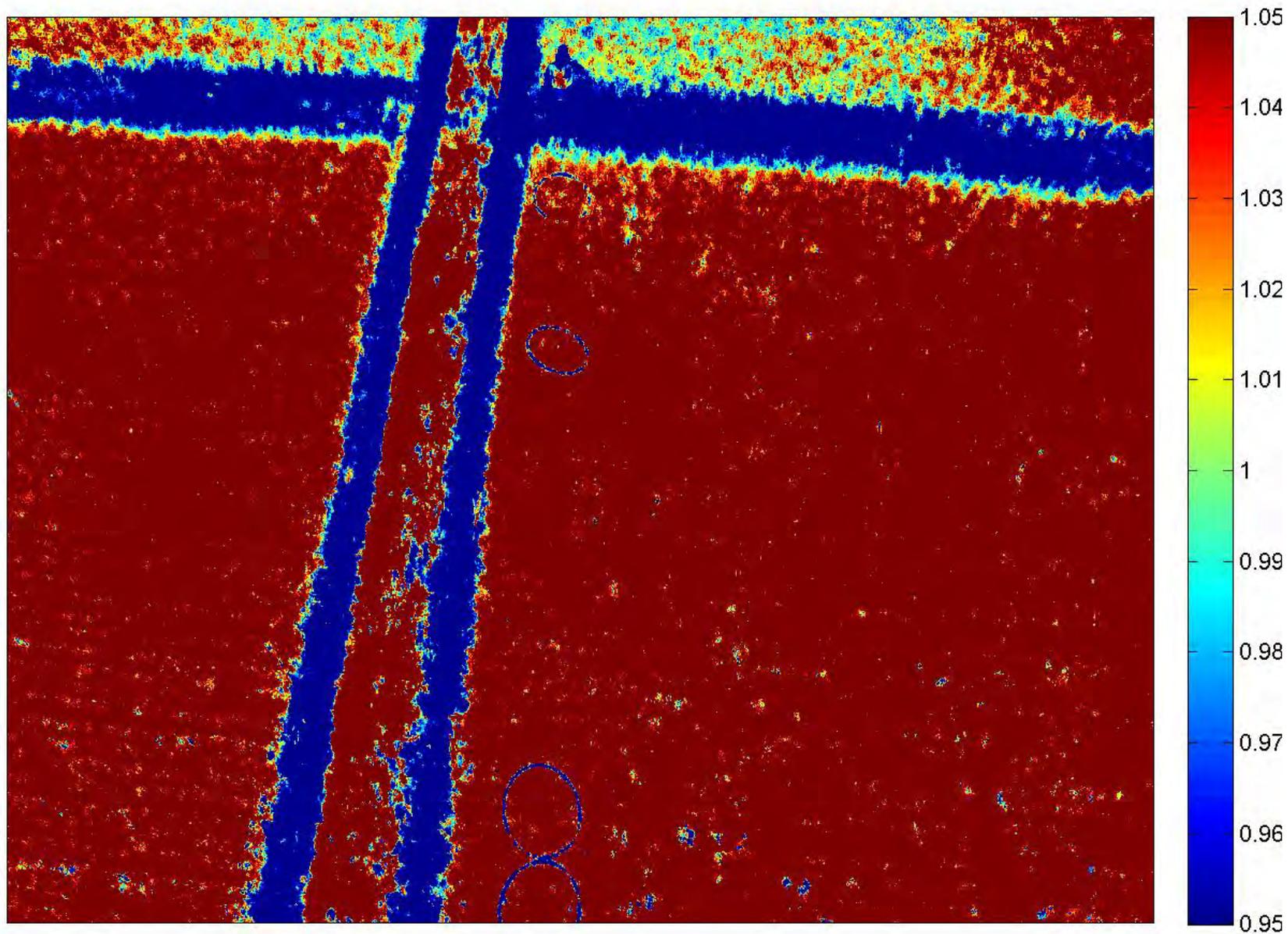


At a  $\sim 90^\circ$  angle, heads with strong signs of disease are not as likely to be detected.









# Assessing Winter Damage to Wheat



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Ice-smothered  
areas



Poster  
board



30 ft



# Conclusion

Images from UAV and airborne were able to show spatial variability across treatments and fields using various sensors.

Vegetation indices maps need to be converted in information that are useful to farmers for the UAV to be helpful.

# Acknowledgements

Special thanks to Ryan and Martin Nagelkirk



**MICHIGAN CORN**



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