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Agricultural Research Service

# Unmanned Aerial Vehicle-based High-Throughput Phenotyping in Sugar Beet Fields

February 24-27, 2025
ASSBT Biennial Meeting, Long Beach, CA


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# OVERVIEW

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## Background:

- Germplasm trait evaluation is essential to identify genetic sources for sugarbeet breeding, but by manual scoring

**Goal:** UAV-based phenotyping to expedite consistent phenotypic metrics

## Methods:

1) UAV
2) Plot-level metrics
3) Open-source software

## Experiment:

- Sugarbeet root maggot nurseries in St. Thomas and Reynolds ND

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# STITCHING

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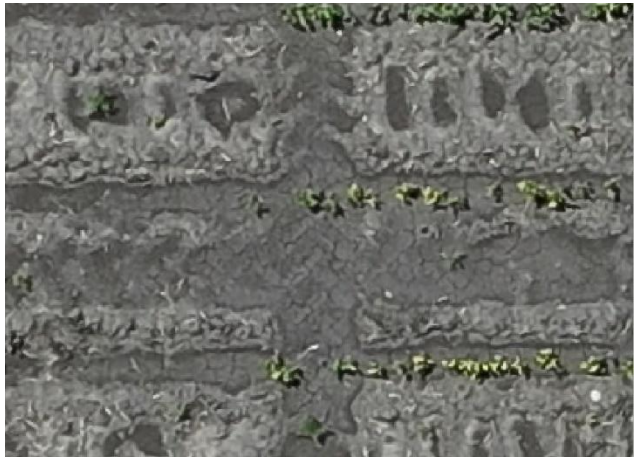
Stitched image



Tile image

DGR (18 sec)

Pix4D (2hr)

(100ft, 20MP, 162 tiles, 1.5GB)

Geo-tagged

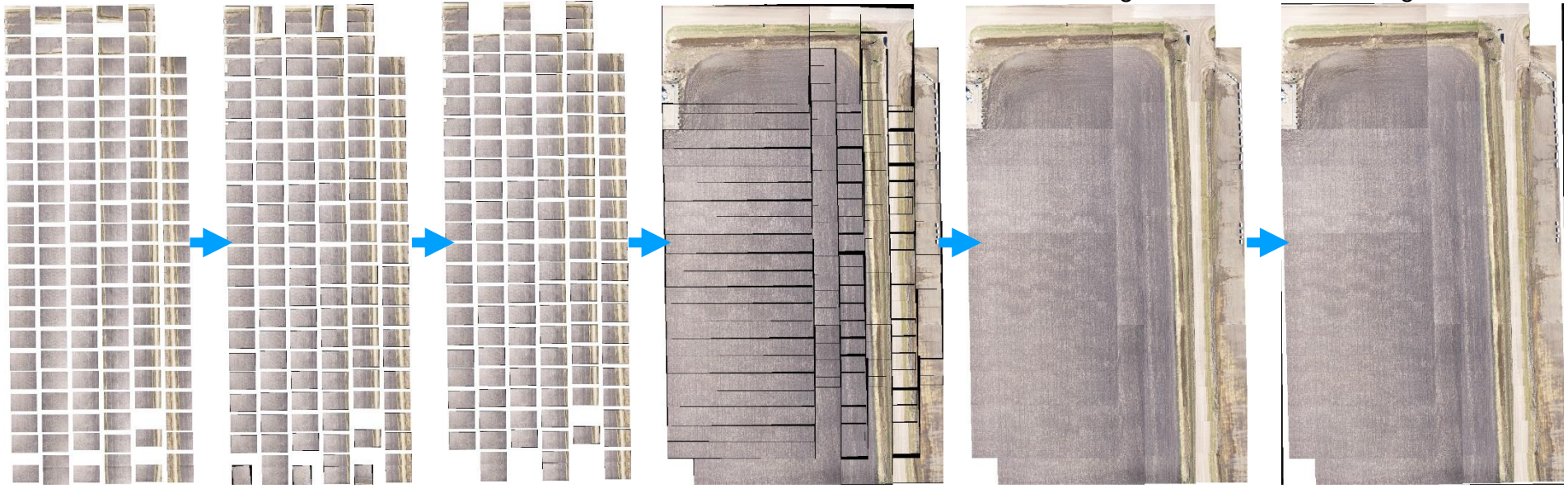
Geo-tagged + orientation

Geo-tagged + orientation-filtered

Geo-tagged + orientation-filtered + GSD

Geo-tagged + orientation-filtered + GSD + straighten

Geo-tagged + orientation-filtered + GSD + straighten + heading



# CALIBRATION

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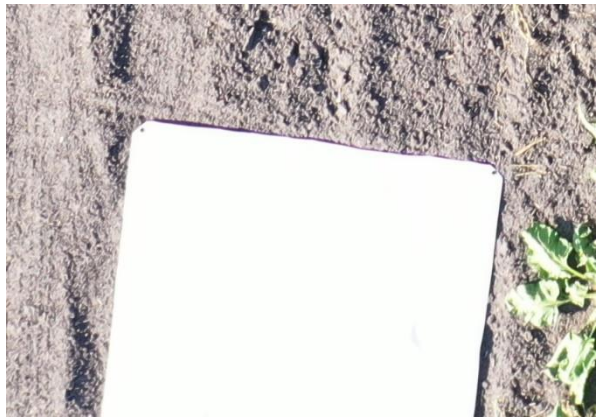
## Parrot Anafi (16MP)

### 32ft, 0.13 in/px


### 100ft, 0.4 in/px

## Mavic 2 Pro (20MP)

### 32ft, 0.1 in/px



### 100ft, 0.31 in/px

# ADAPTIVE GRIDDING

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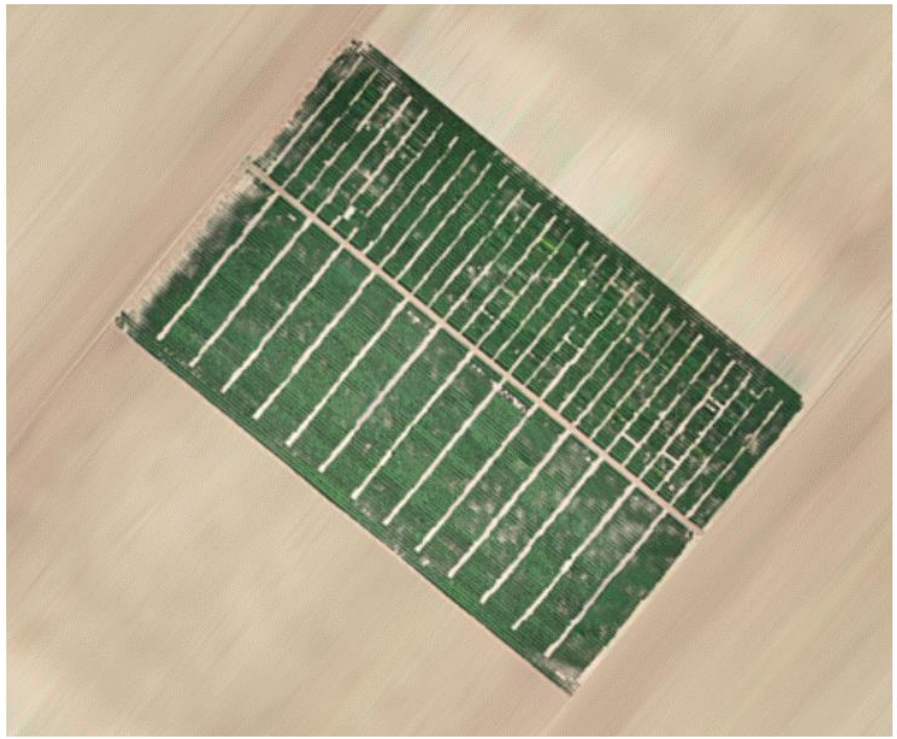
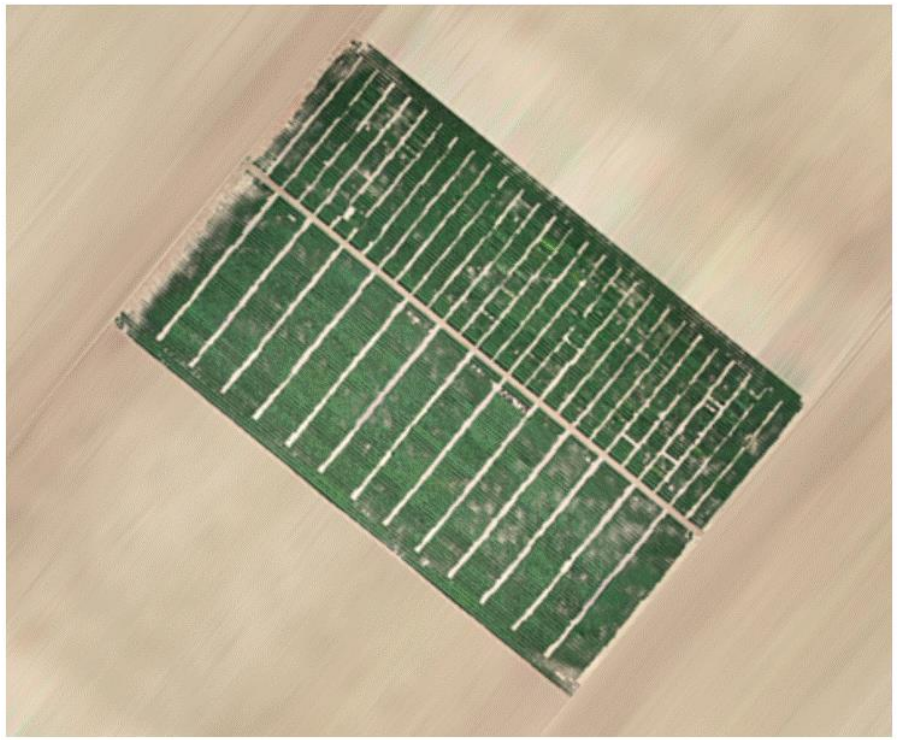
## Image rotation



## Adaptive Gridding
by ROI rotation



# IMAP DEMO

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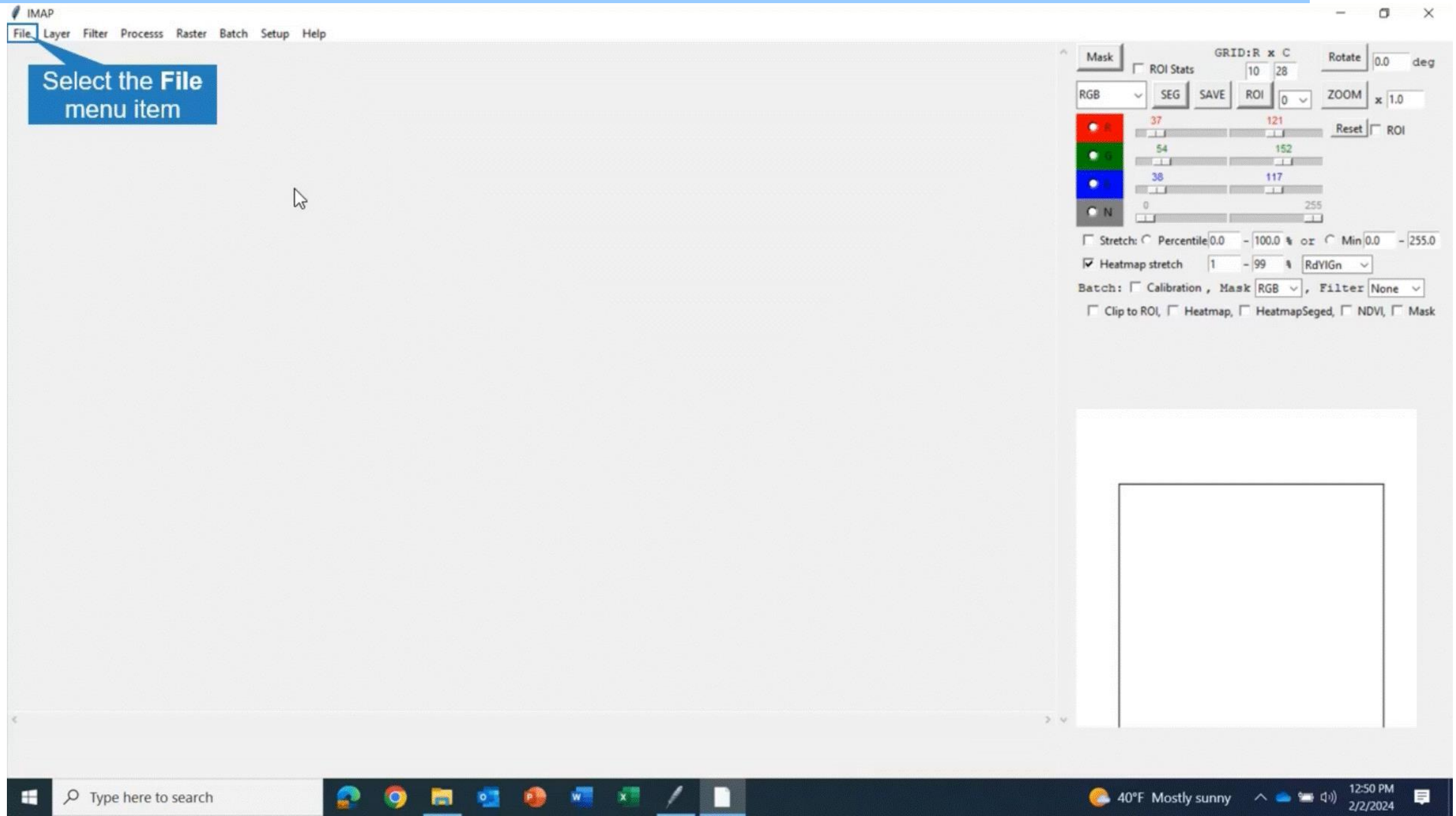

# RESULT - REYNOLDS, ND

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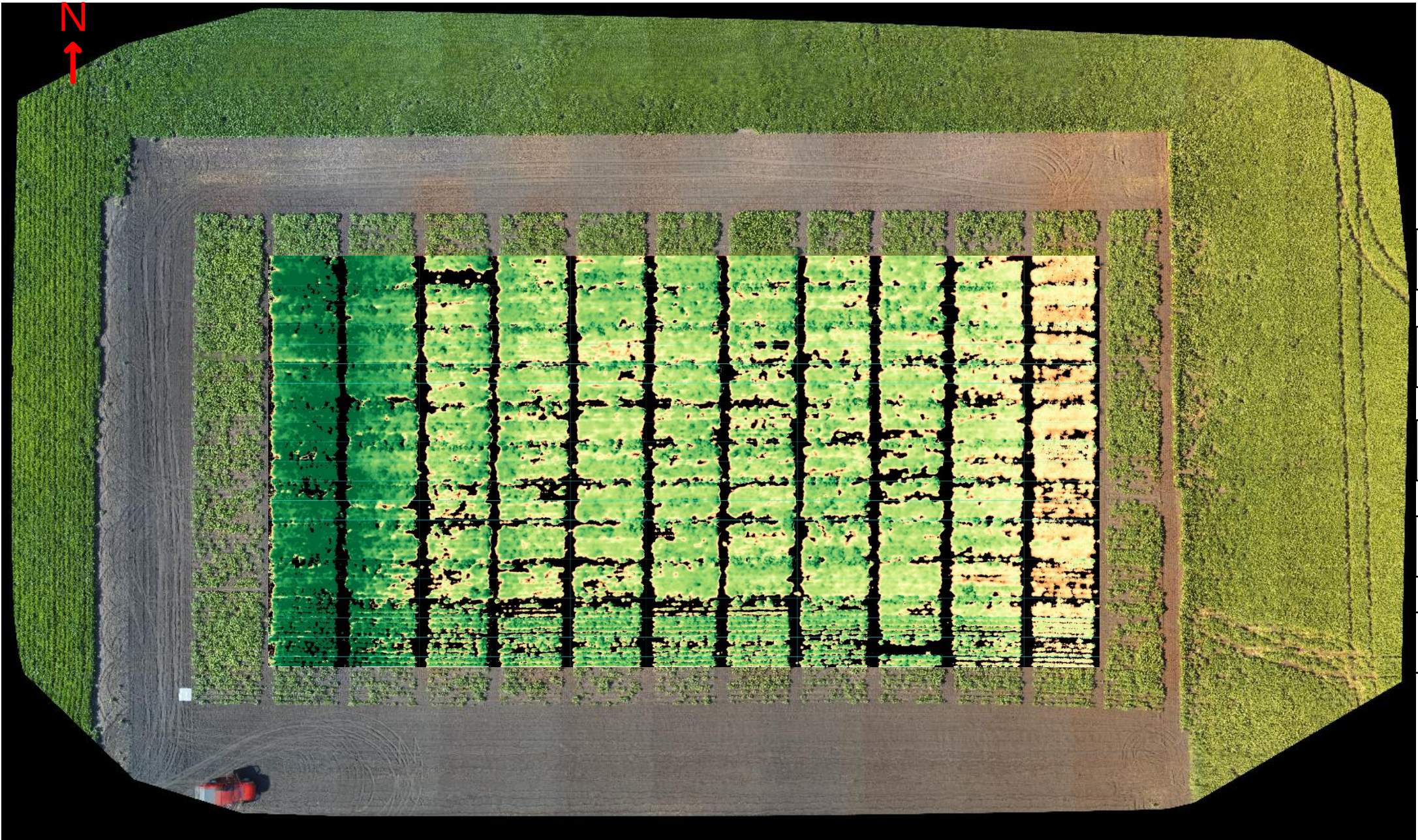


Calibration

NDVI

Segmentation

Heatmap

Filtered Vege

# RESULT - ST. THOMAS, ND

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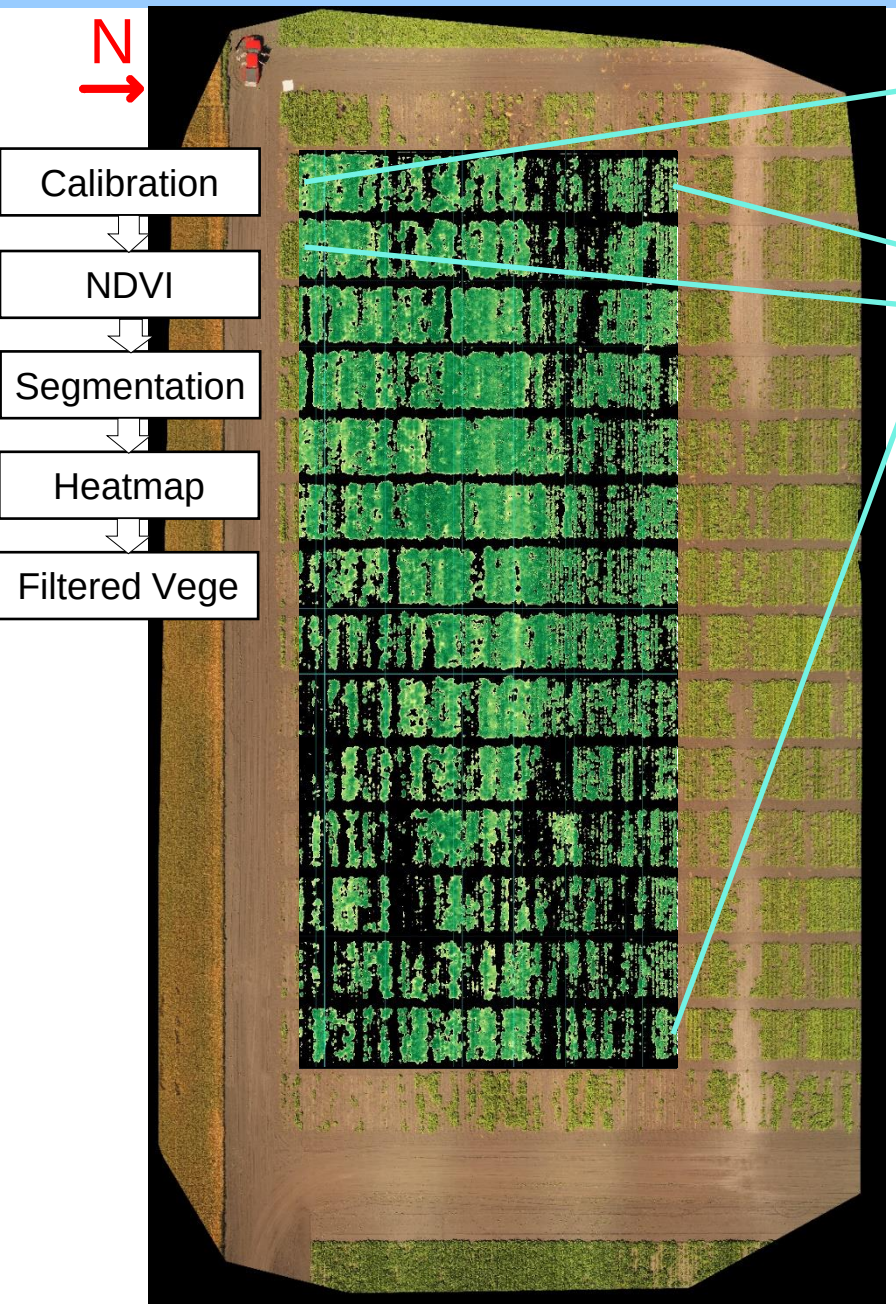
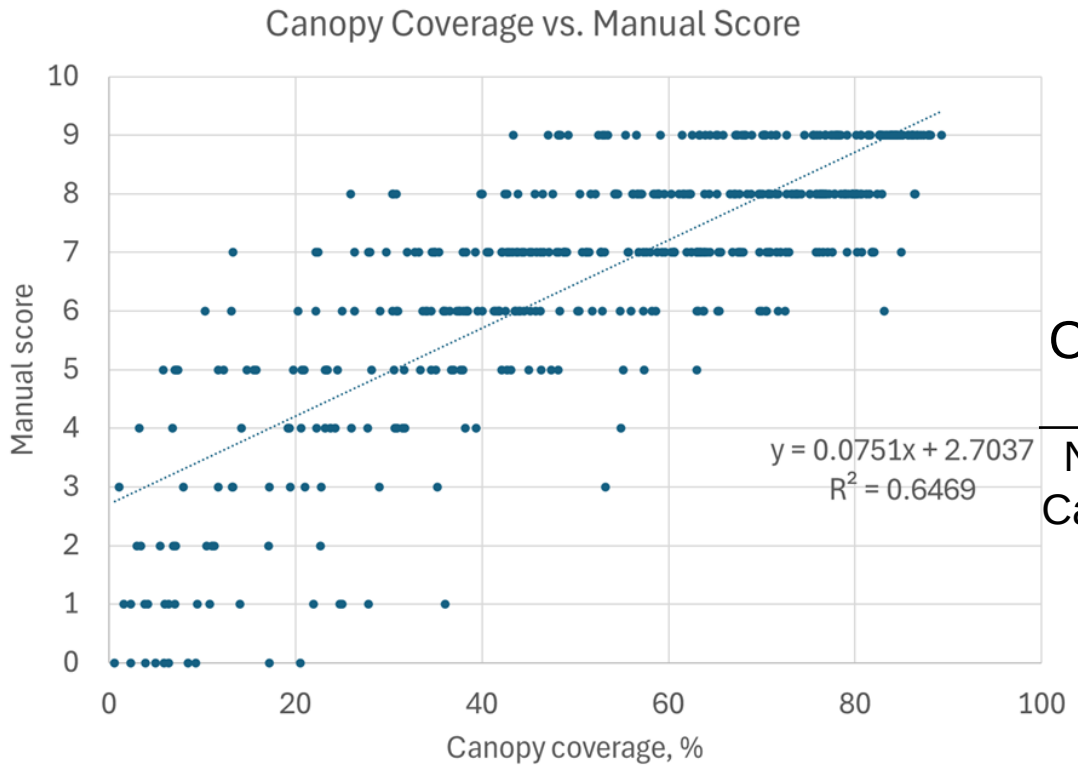



| Iter | Row | Col | cnt_Fgnd | cnt_ROI | %Canopy | R [%] | G [%] | B [%] | NDVI |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 61588 | 87847 | 70.11 | 12.73 | 12.74 | 5.44 | 0.712 |
| 2 | 1 | 2 | 76374 | 88668 | 86.13 | 12.29 | 12.68 | 4.95 | 0.744 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 44 | 1 | 44 | 50167 | 87847 | 57.11 | 14.04 | 13.91 | 5.61 | 0.697 |
| 45 | 2 | 1 | 69406 | 87847 | 79.01 | 12.58 | 13.03 | 4.85 | 0.746 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| 616 | 14 | 44 | 26461 | 87847 | 30.12 | 14.03 | 14.09 | 6.2 | 0.712 |




Correlation, R=

| | Reynolds | St. Thomas |
|---|---|---|
| NDVI | 0.46 | 0.63 |
| Canopy | 0.10 | 0.80 |

# SUMMARY

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- UAV-based plant phenotyping to facilitate the breeding pipeline
- Deployed adaptive gridding successfully
- Published open-source analytic software, IMAP

## Future Work:

- Deploy Auto-Trac planter for field alignment
- Expand UAV and IMAP for other stress identification (CLS, weed, etc.)
- Enhance direct geo-referencing of UAV images