


Phenotyping Canola Flowering Using UAV-based Phenomics

Ti Zhang, Hema S. Duddu, Menglu Wang, Seungbum Ryu,
Sally Vail, Rosalind Bueckert, Xulin Guo, Steve Shirtliffe*



Department of Plant Sciences
University of Saskatchewan
2017 Soils and Crops

Canola (*Brassica napus* L.)



- ❖ **Canada:** largest exporter (74% of the export trade)
- ❖ **Billions to Canadian economy**
- ❖ **Product of seeds:** oil with low saturated fats

Introduction



❖ **Canola seed yield**

- Stand density, pod number/plant, seed weight/pod
- Twice flowers than pods
- Good indication of potential pod development and seed yield

❖ **Phenotyping flowering manually**

- Labor-intensive
- Destructive
- Subjective

Introduction (cont.)

❖ UAV-based Phenotyping methods

- Small UAV platforms
- Image sensors
- Hundreds of high-resolution images for phenotyping crop



Fig. 1a) UAV platform



Fig. 1b) Sony RX100 iii

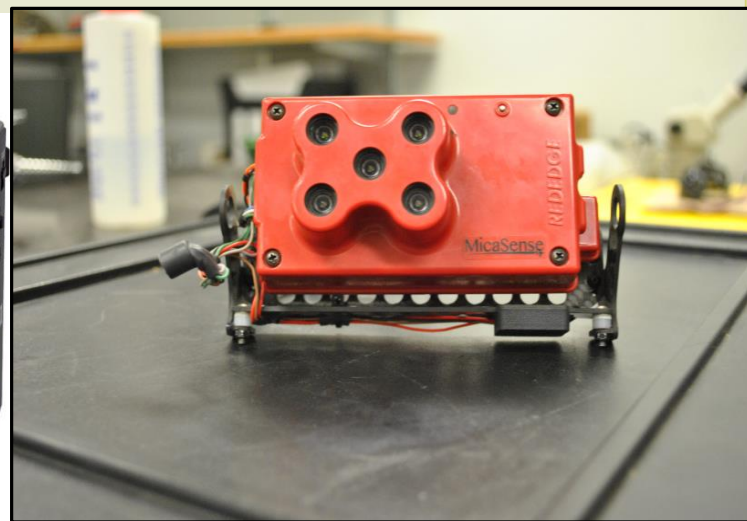


Fig. 1c) Multispectral camera

Introduction (cont.)



❖ **Novel vs. traditional**

- Cost effective
- Quickly and accurately
- Non-invasive

Principle of Using UAV-based Images

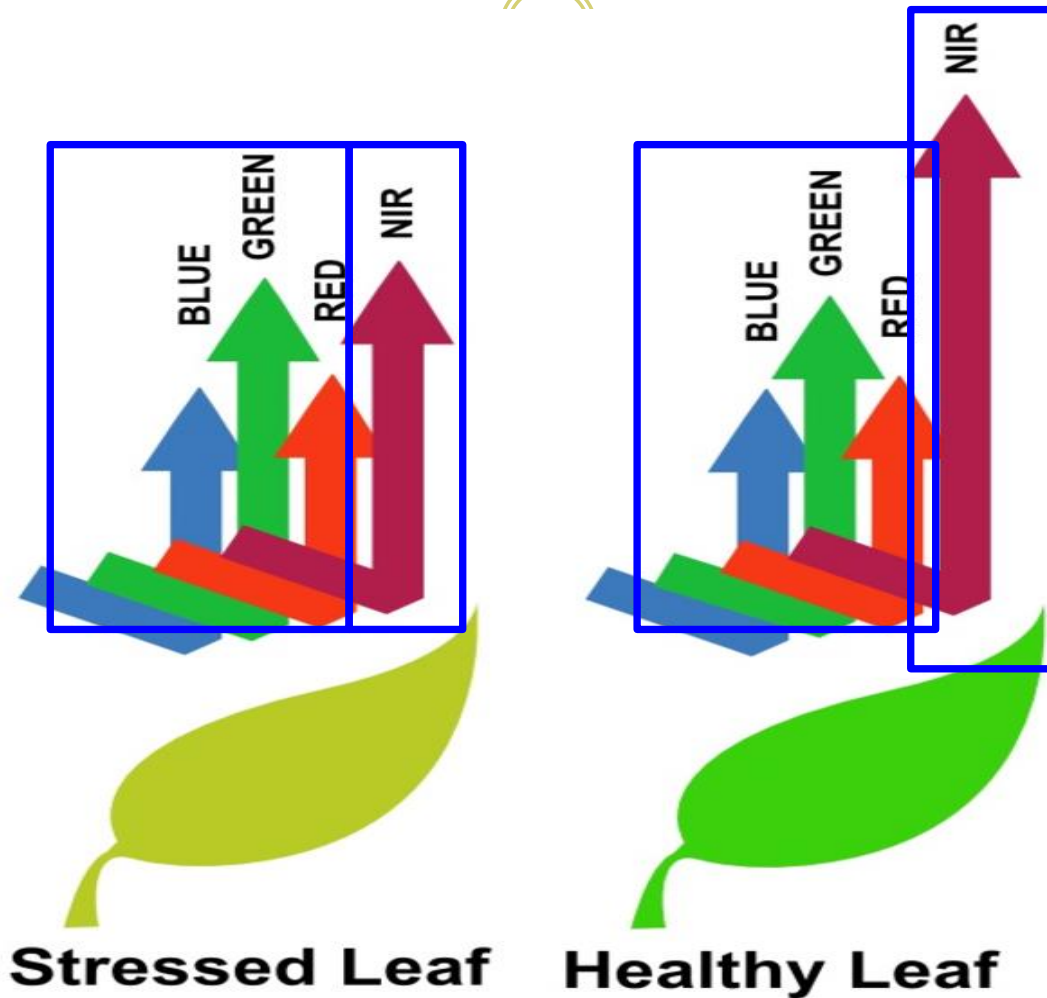


Fig. 2 Reflectance spectral features of healthy and unhealthy leaves.

Objective



- ❖ To investigate the application of **vegetation indices** in detecting canola **flower intensity**

Methods and Materials



➤ Experiment design

- Rectangular lattice design with three rep. **Rep. 3**

➤ Study site-year **Rep. 2**

- AAFC, 2016

➤ Factor **Rep. 1**

- 56 genotypes

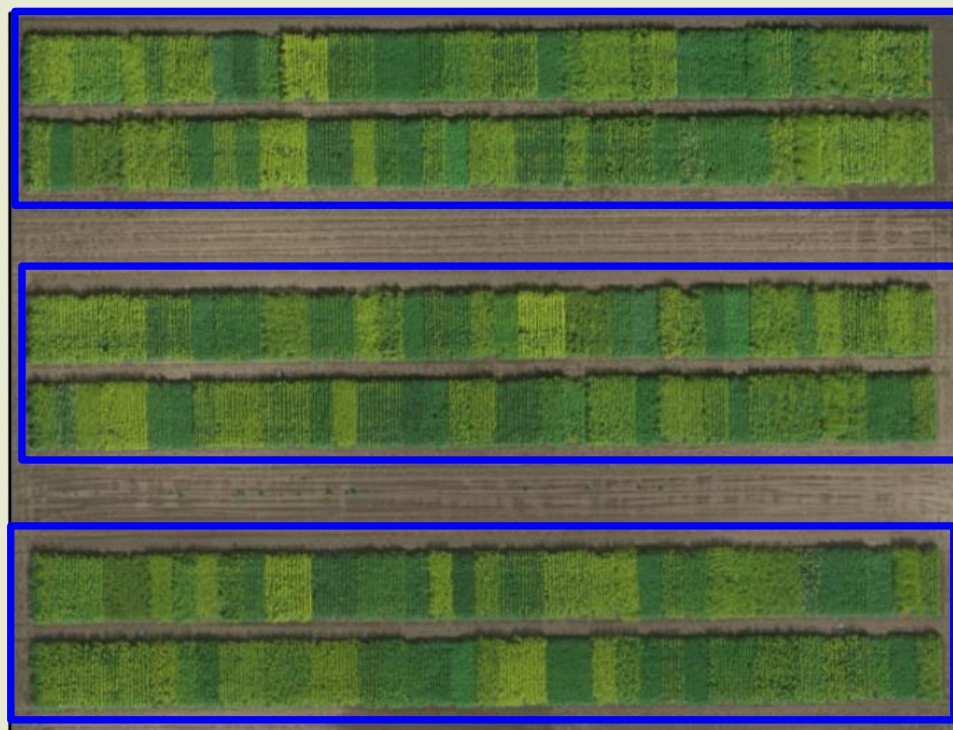


Fig. 3 Plot layout at the Agriculture and Agri-Food Canada Research Farm (52.181196°N, -106.501494°E) near Saskatoon, SK in 2016

Aerial imagery data collection



❖ Platform and sensors

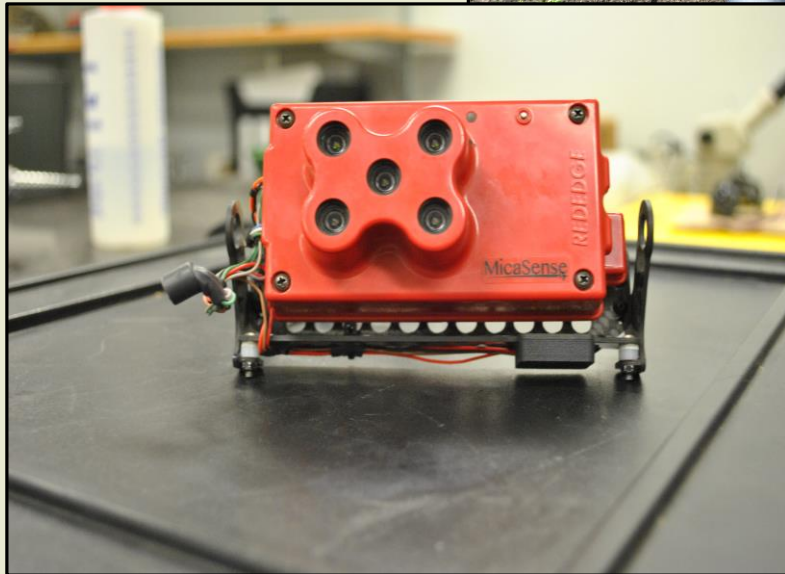


Fig. 4b) Multispectral camera with five bands



Fig. 4c) Modified commercial camera with three bands

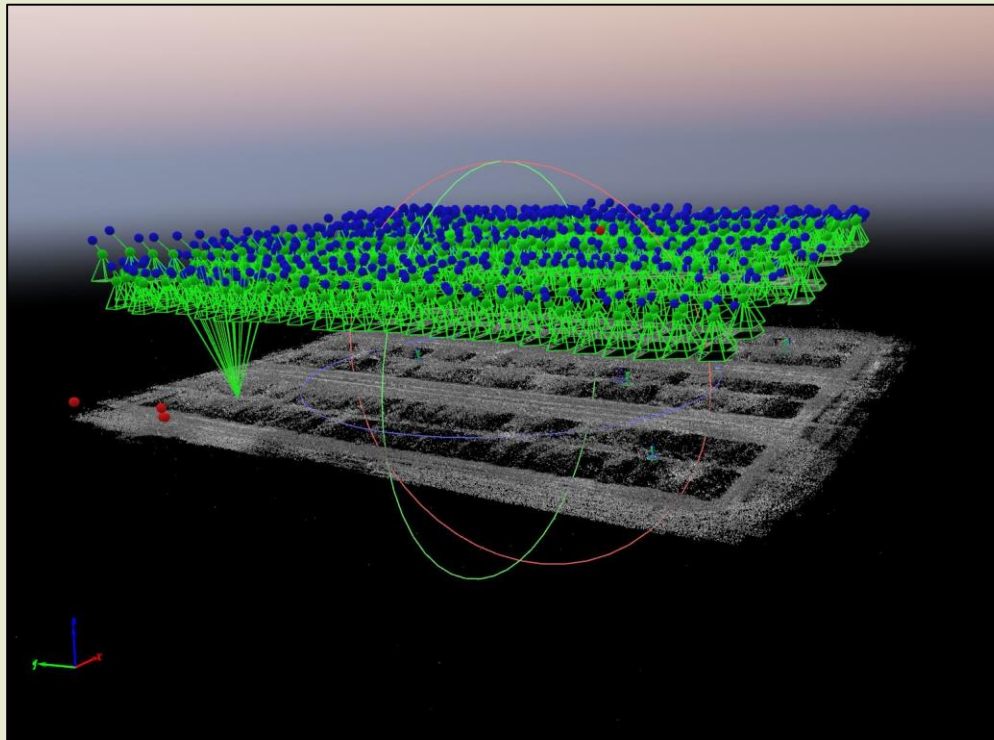
ing



Image processing pipeline

Step 1. Pre-process (Pix4D)

(a) Stitching/mosaic



(b) Calibration



Fig. 5a) Stitching individual images for experimental trial; **b)** radiometric and geometric calibration

Image processing pipeline

Step 2. Data extraction (ArcGIS)

- Plot segmentation
- Vegetation indices
- Pixel classification

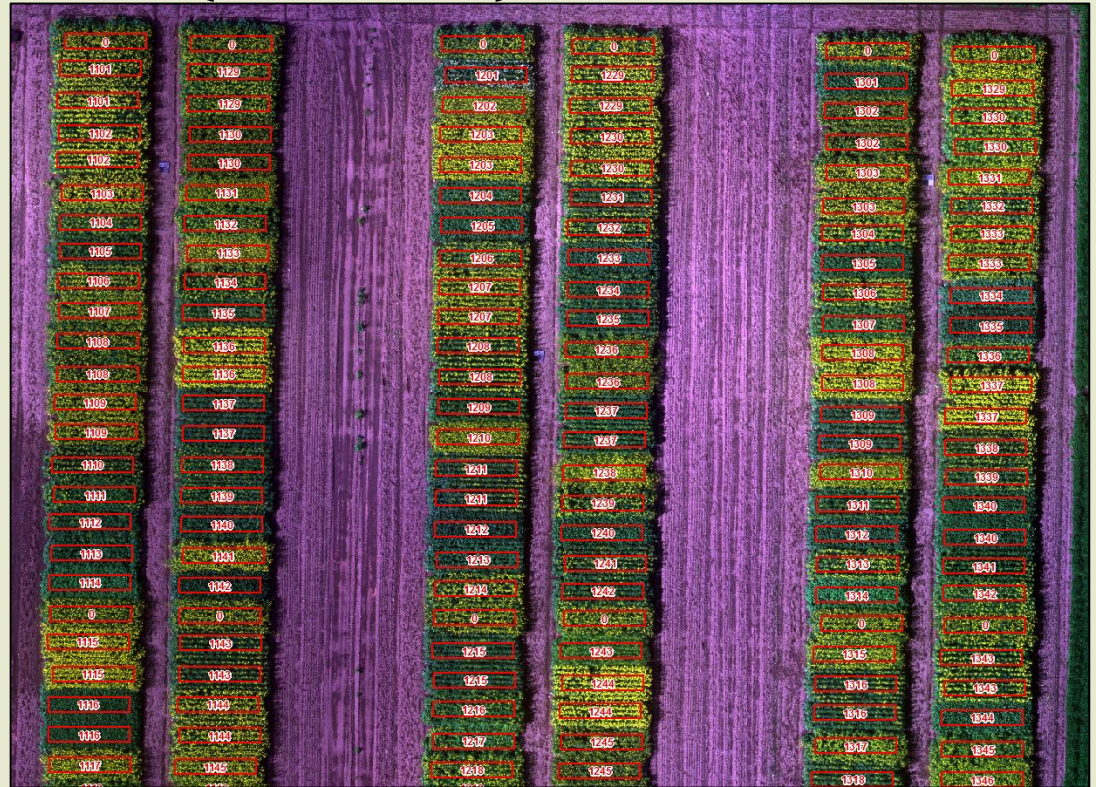


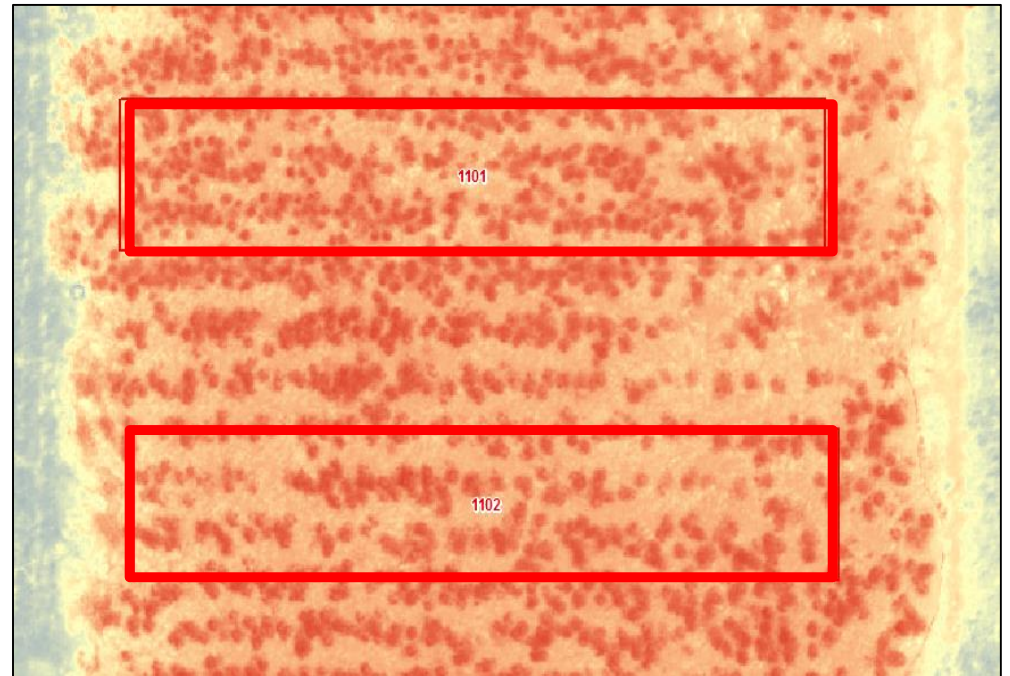
Fig. 6 Calibrated orthomosaic images

Vegetation Indices



❖ NDYI = Digital yellowness estimation

$$\text{NDYI} = \frac{\text{GREEN} - \text{BLUE}}{\text{GREEN} + \text{BLUE}}$$



Ground Reference Collection

❖ Collection dates:

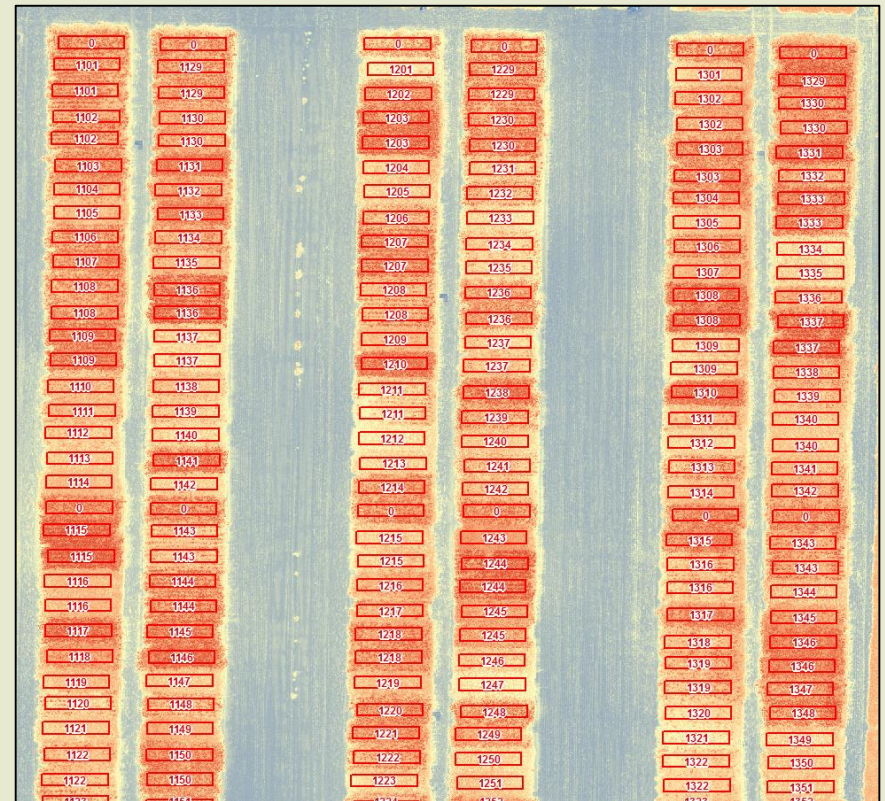
- July 8, 15, 22, 29

- August 5, 12, 19



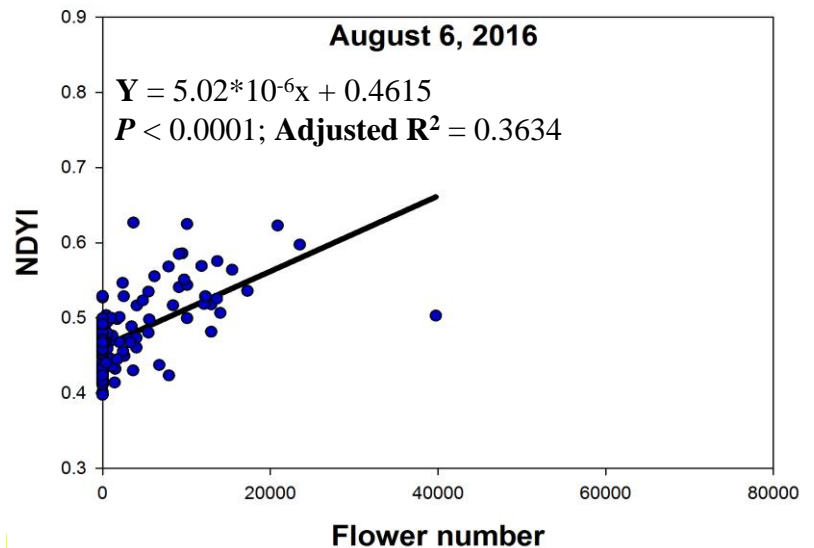
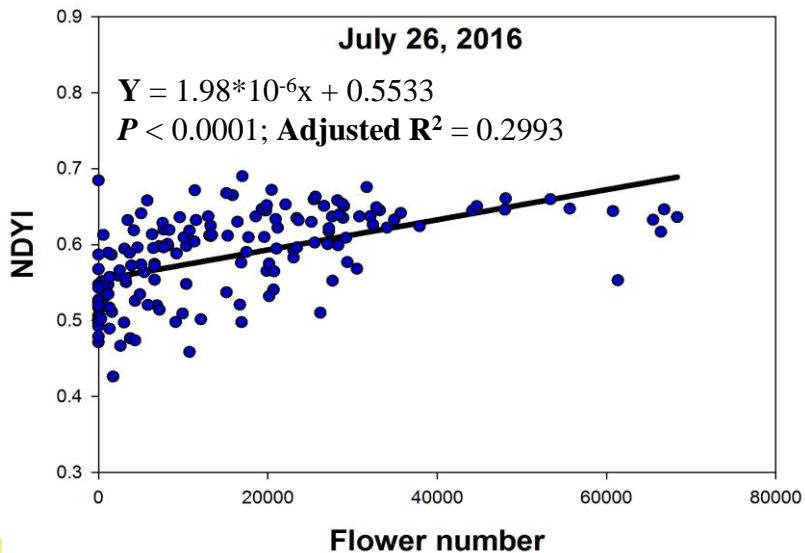
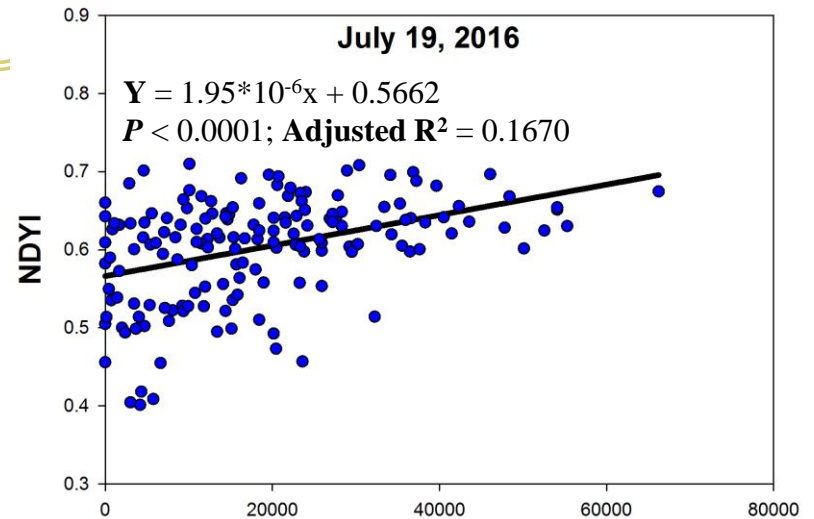
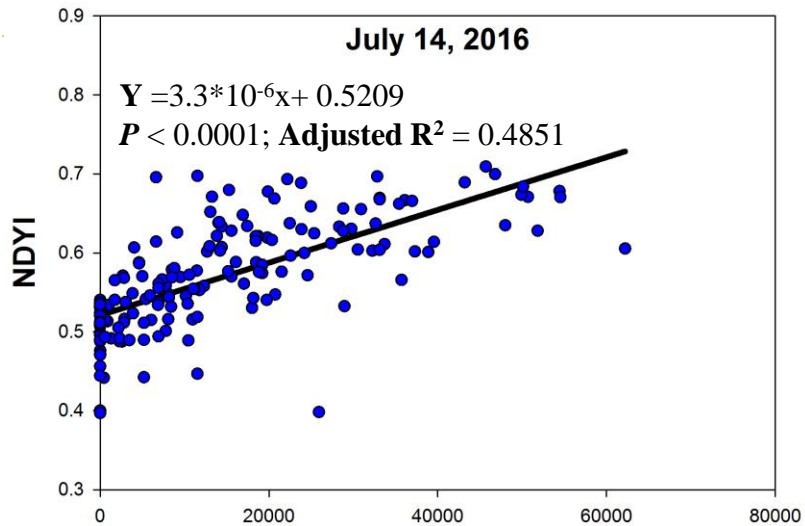
Fig. 7 Manually count flower number in the field.

Regression: flower intensity vs. NDVI



yn_14072016
Value
High: 1
Low: -1

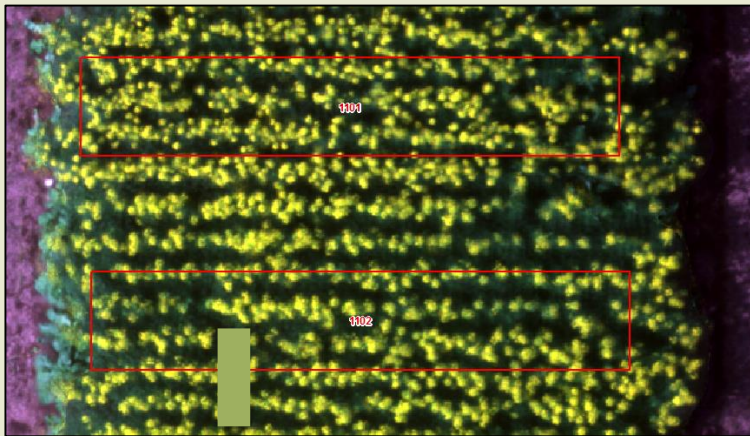
Flowering intensity vs. **NDYI**



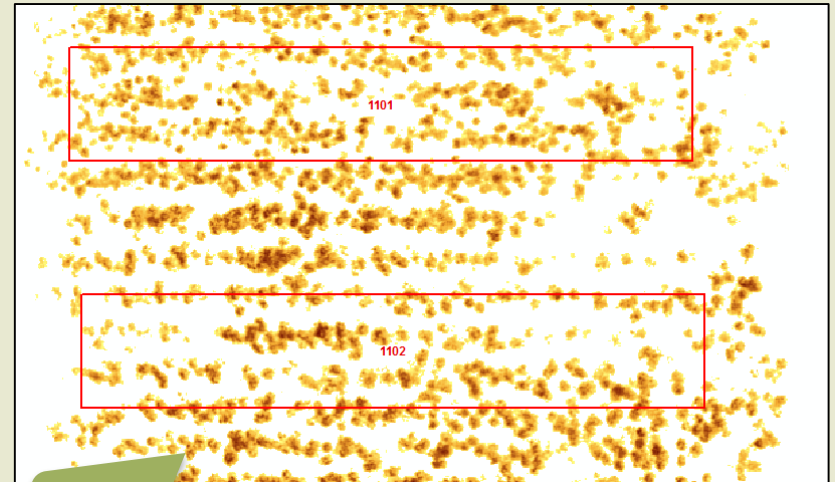
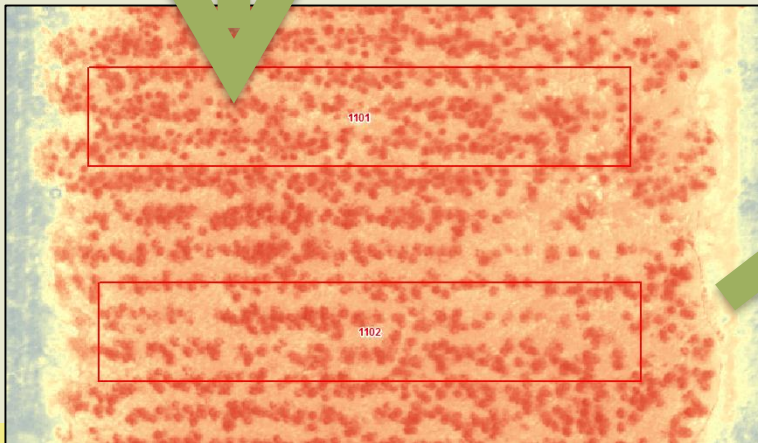
Pixel Classification: threshold methods



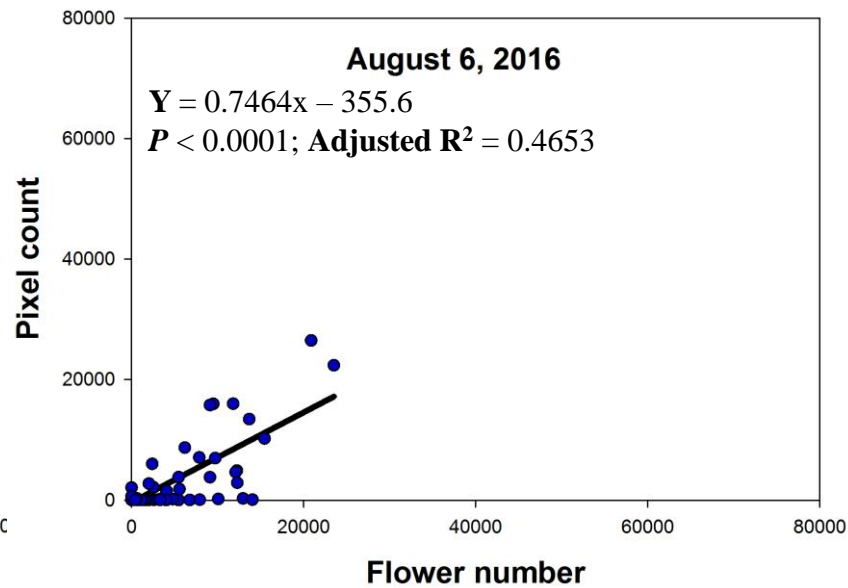
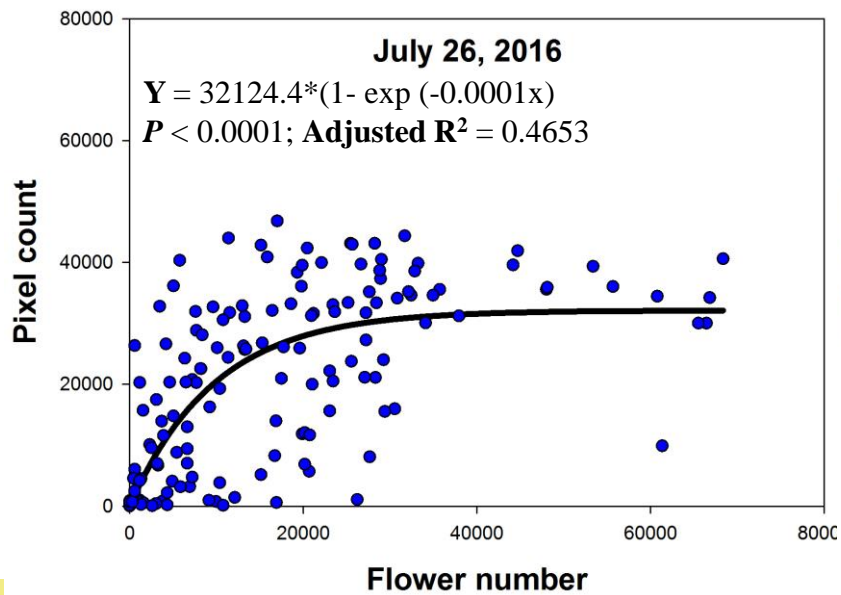
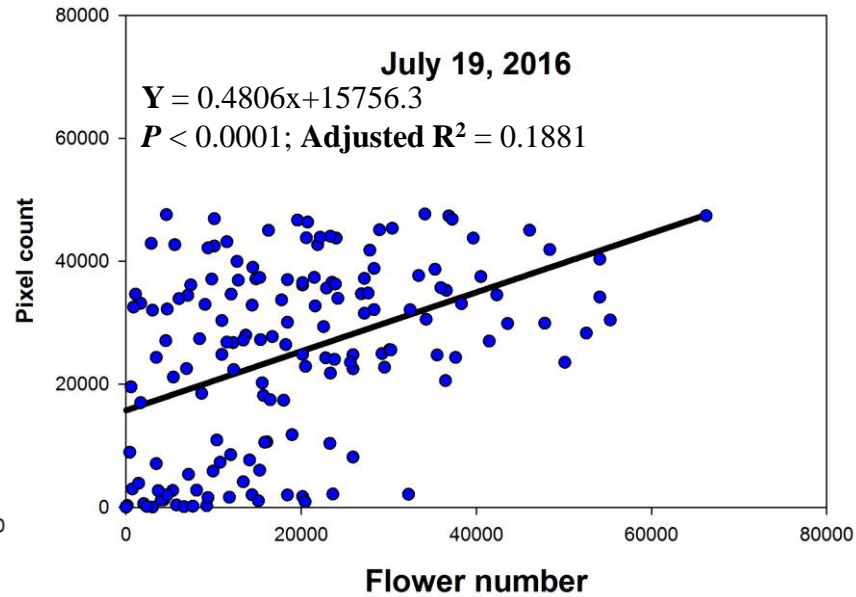
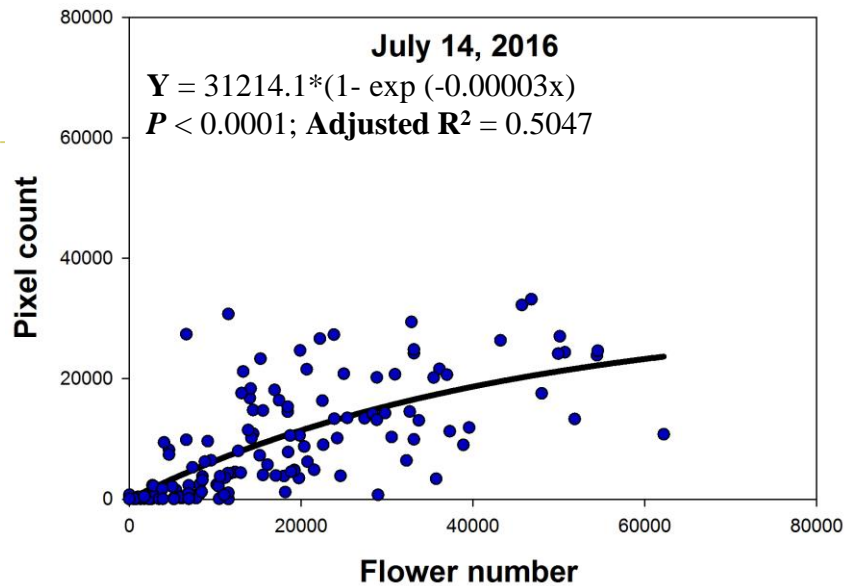
(a) Calibrated orthomosaic image



(b) Calculate NDYI



(c) Extract pixels using threshold value



Conclusion



❖ **Achievements based on objectives**

- Vegetation indices/pixel classification in detecting flower

❖ **Take-home message**

- NDYI works better in peak flowering timing
- Threshold methods improved ability of detecting flower

Acknowledgements



❖ Supervisor

Dr. Steve Shirtliffe



❖ Committee Members

Dr. Sally Vail

Dr. Rosalind Bueckert

Dr. Xulin Guo

Dr. Yuguang Bai



❖ Agronomy Weed Group



THANKS

