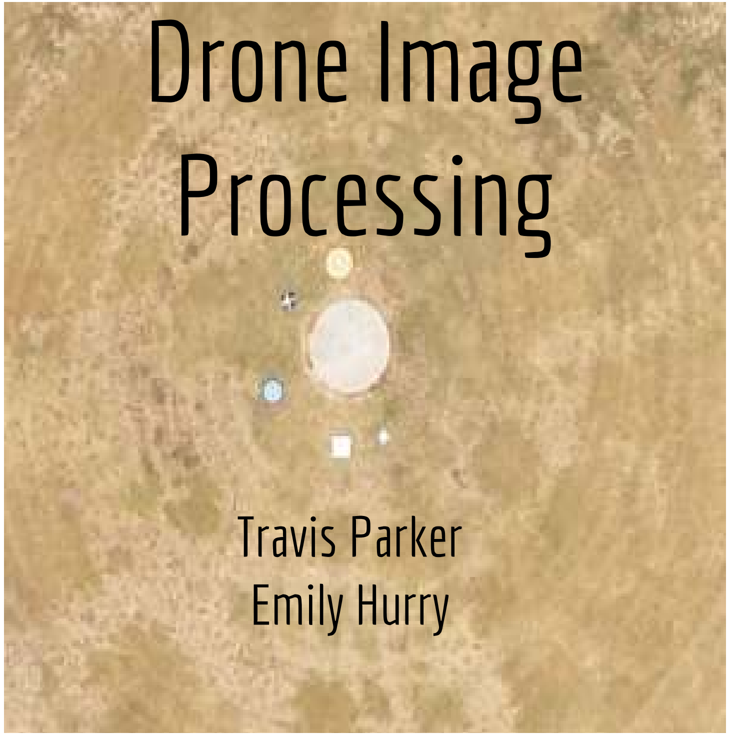


Drone Image Processing

Travis Parker
Emily Hurry

Outline for the day

-Workflow overview

-Case study

-Tutorial

Typical UAS imagery collection and processing workflow

1) Project planning:

   Experimental design, hardware/sensor requirements

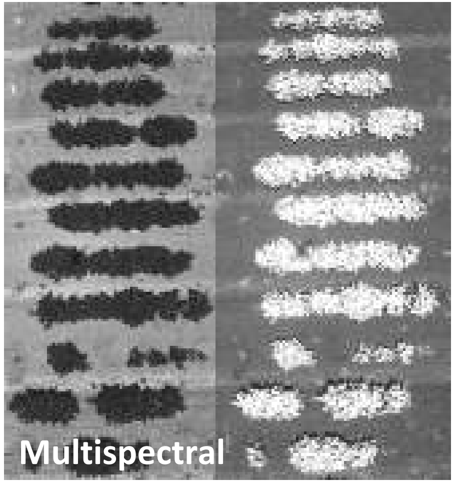
2) Mission/flight planning
3) Imagery collection
4) Imagery processing
5) Post-processing and analysis

Project planning: Choosing the right sensor

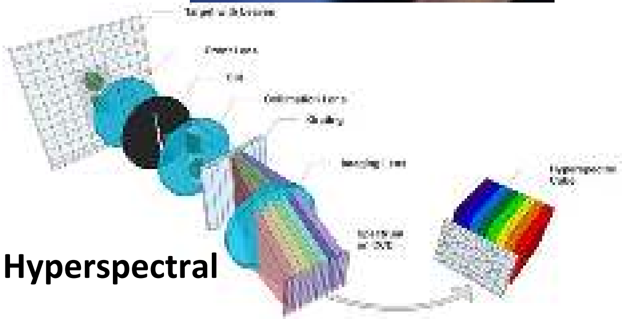
- RGB
- Thermal
- Multispectral
- Hyperspectral
- Lidar

RGB

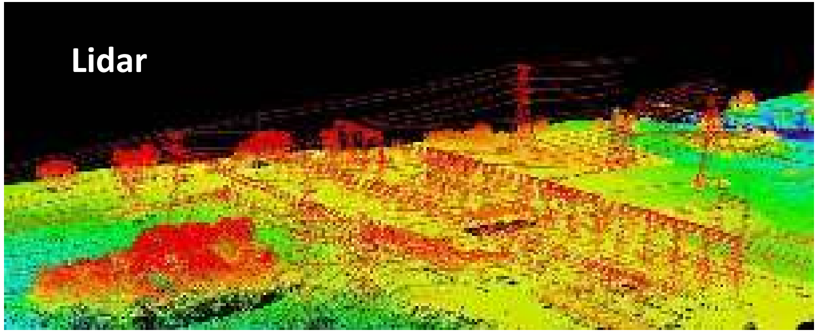
Thermal infrared



Multispectral



Hyperspectral



Lidar

Project planning: Compatibility

Check software and hardware compatibility from workflow's start to finish:

-UAS + camera/sensor + guidance system

-Imagery type + processing service

Project planning: Choosing the right UAV

Main constraint: UAS-sensor compatibility

Variable flight times, stability, ease of use

-particularly notable differences between fixed-wing aircraft and copters

-consumer drones with RGB cameras can be very powerful at <$1000

Ground Control Points

- Should be visible and recognizable
- Location should be carefully referenced
  - High accuracy GPS; less than .5 meter error
  - We use the app KoBo to track data
- Should have at least 4, but no more than ~10
  - 3D models need closer to 9
  - Depends on topography of the area and spread of GCPs

Ground Control Points

- Pix4D likes the following formats
    - ***label,latitude[decimal degrees],longitude[decimal degrees],altitude[meter]***

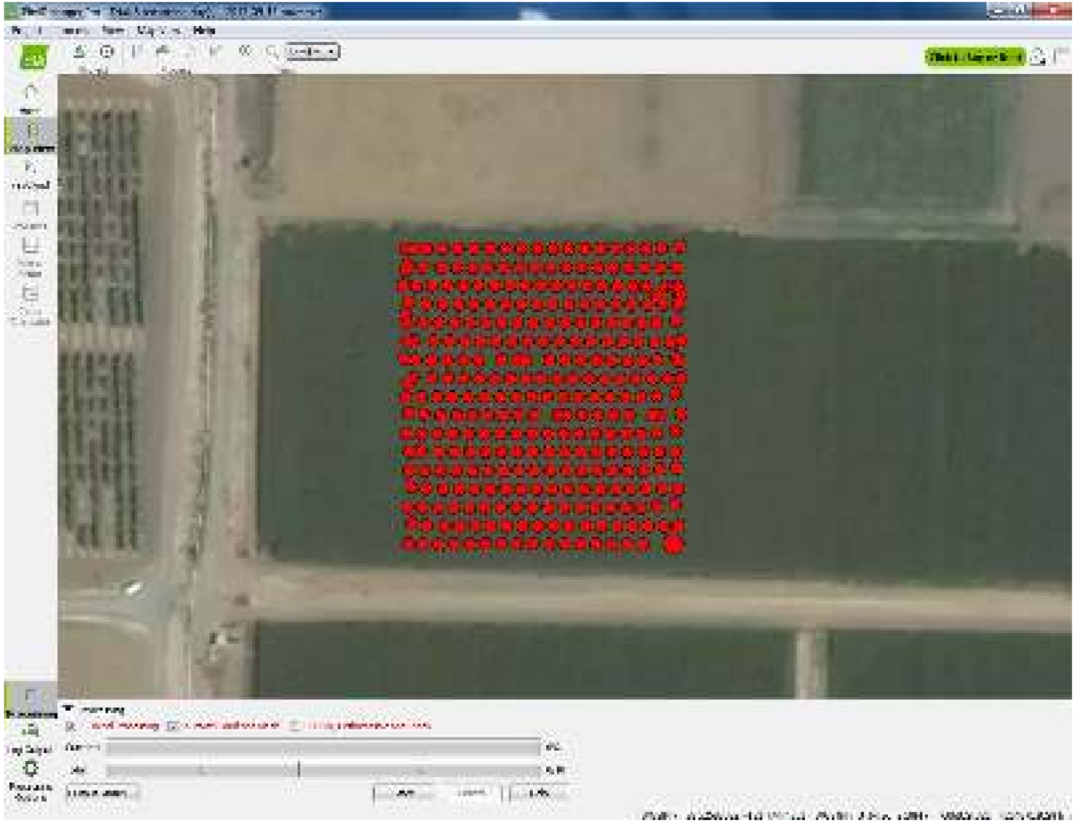
    - ***label,latitude[decimal degrees],longitude[decimal degrees],altitude[meter],Accuracy Horz [meter],Accuracy Vert [meter]***

Must be saved as either .csv or .txt

https://support.pix4d.com/hc/en-us/articles/202558539-Input-Files#label3

Mission planning

- Using a mission planning app facilitates uniform image spacing



Mission planning

- Several options are available, consider which is best for your needs

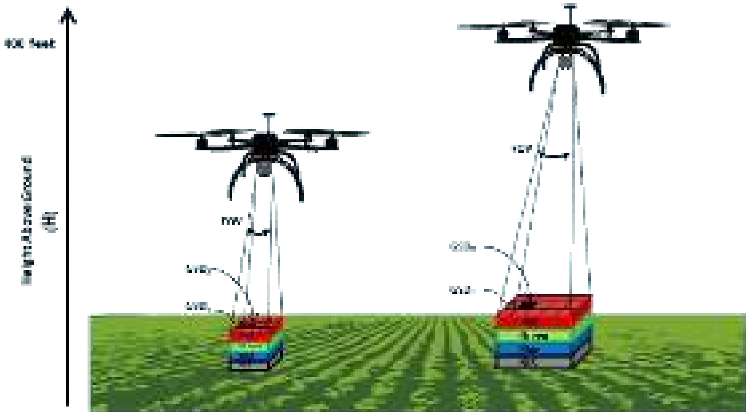
Mission planning

- Considerations before choosing an app
  - Compatibility with device, UAS, cameras
  - Mission resume, repeatability
  - Flexibility vs. ease of use
  - Probability of error

- Most are free or inexpensive, try several

Mission planning

- Trade-offs
  - Higher altitude=more area/time, but lower resolution.

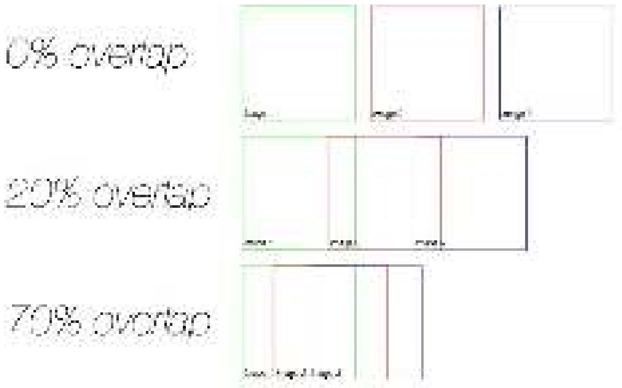


Altitude: 40m; Overlap: 75/85; Time: 9m 21s

Altitude: 80m; Overlap: 75/85; Time: 4m

Mission planning

- Trade-offs
  - Higher overlap increases stitching quality, but reduces area/time
  - Ideal overlap depends on mapped surface



Altitude: 80m; Overlap: 75/85; Time: 4m 12s

Altitude: 80m; Overlap: 70/70; Time: 3m

Imagery collection

Imagery processing

-Pix4D

-Agisoft Photoscan

-DroneDeploy, Maps Made Easy, Precision Mapper, others

-OpenDroneMap, MicMac

-Many others

Post-processing and analysis

GIS software:

-ArcGIS

-QGIS

-ENVI and

Imagery manipulation:

-Photoshop

-GIMP

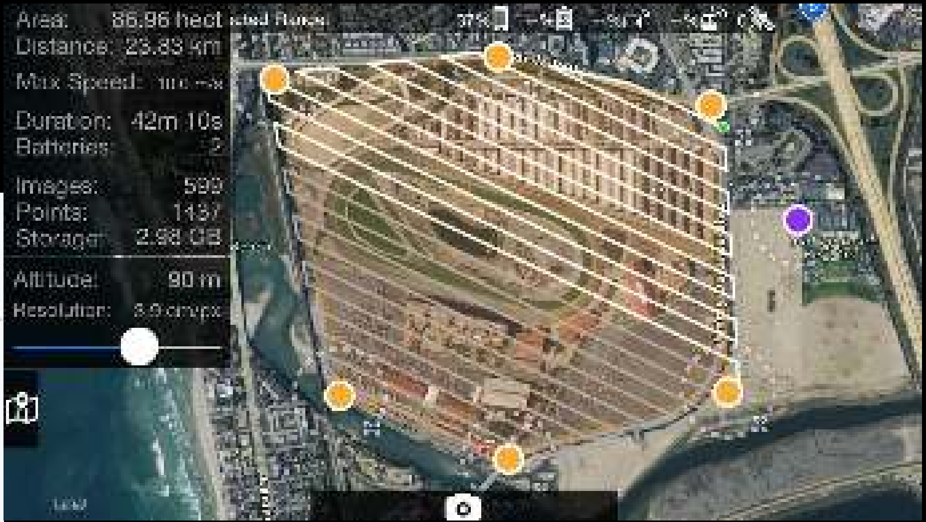
Point cloud analysis tools

R

Case study: Genetics of early season growth rate

2016 Project

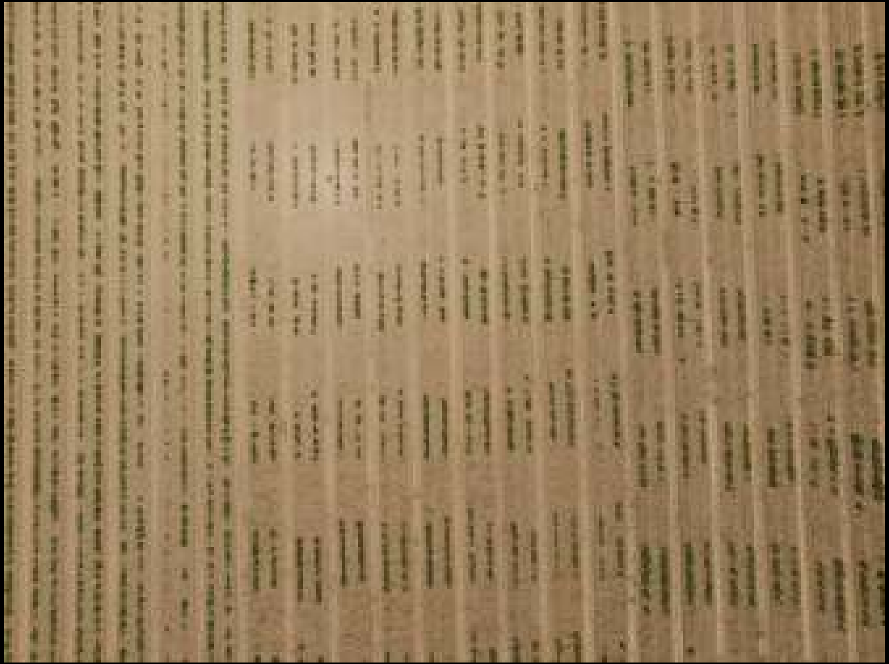
DJI Phantom 3 Pro



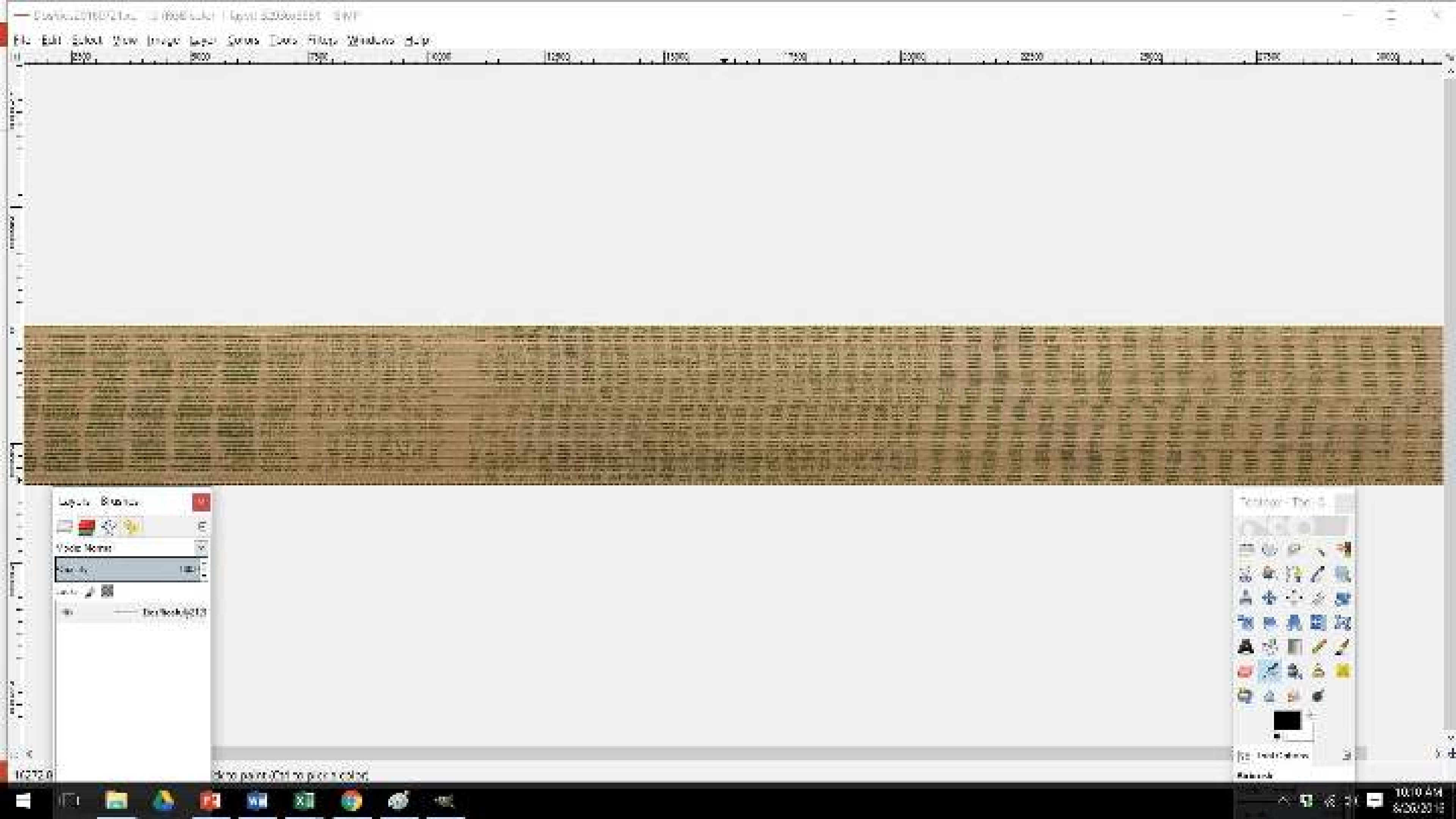
MAPS
MADE EASY

Map Pilot

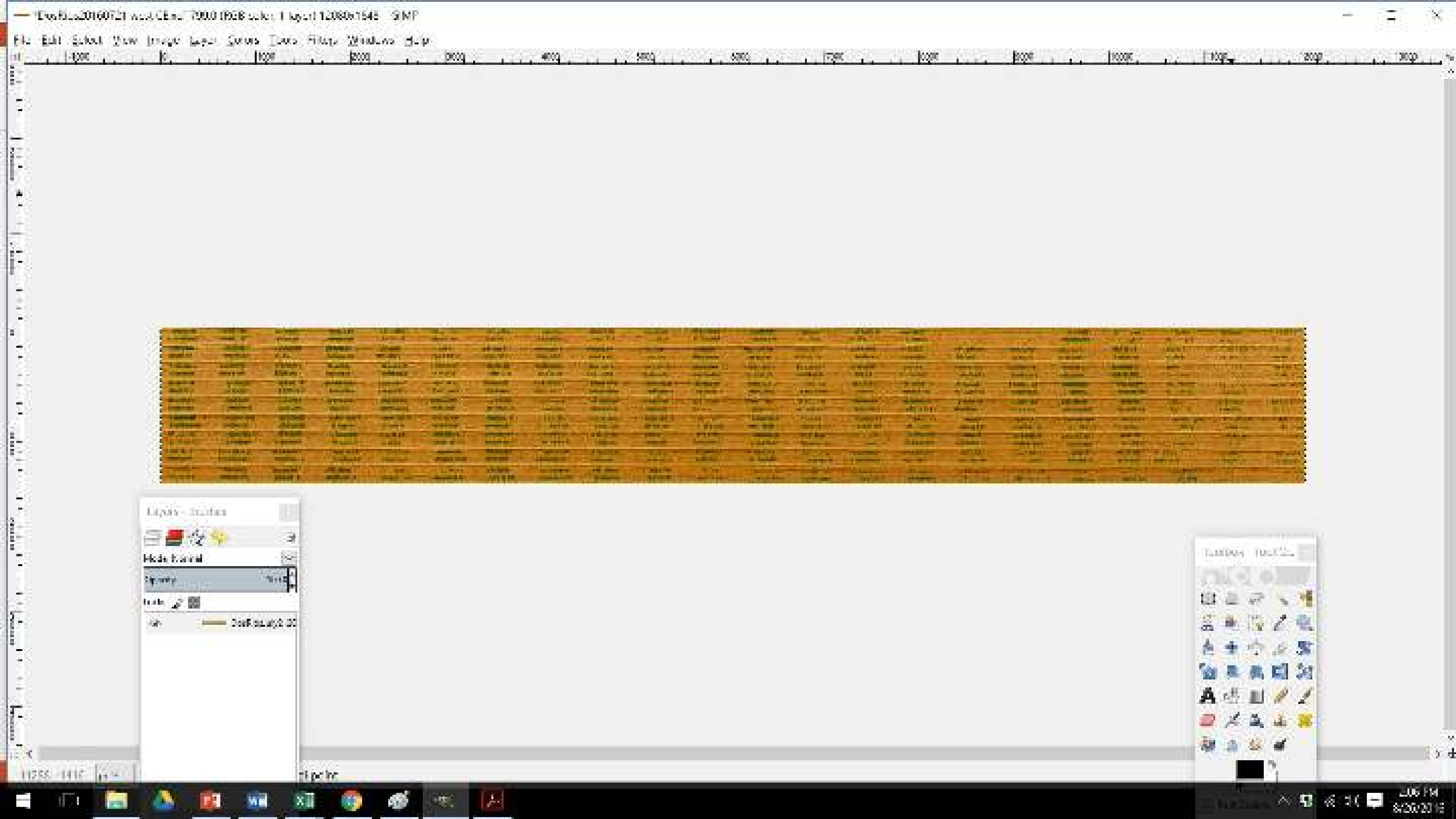
Raw images:

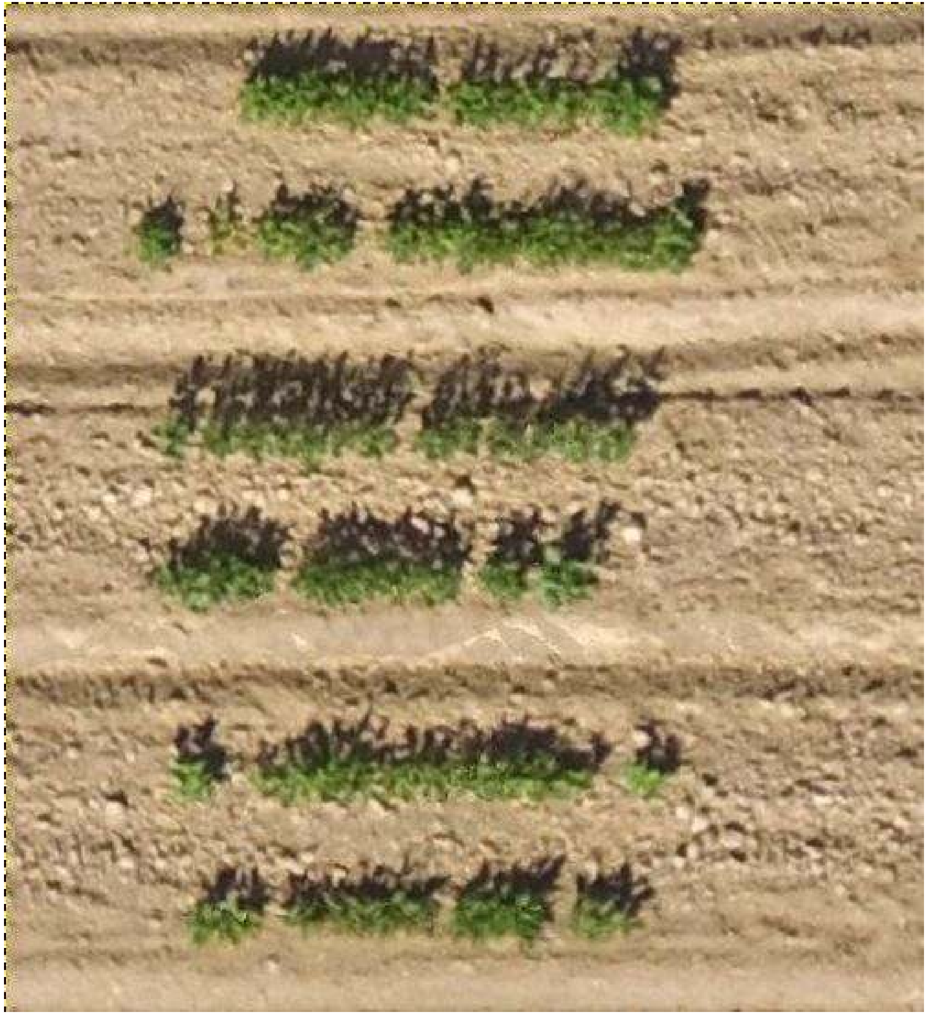


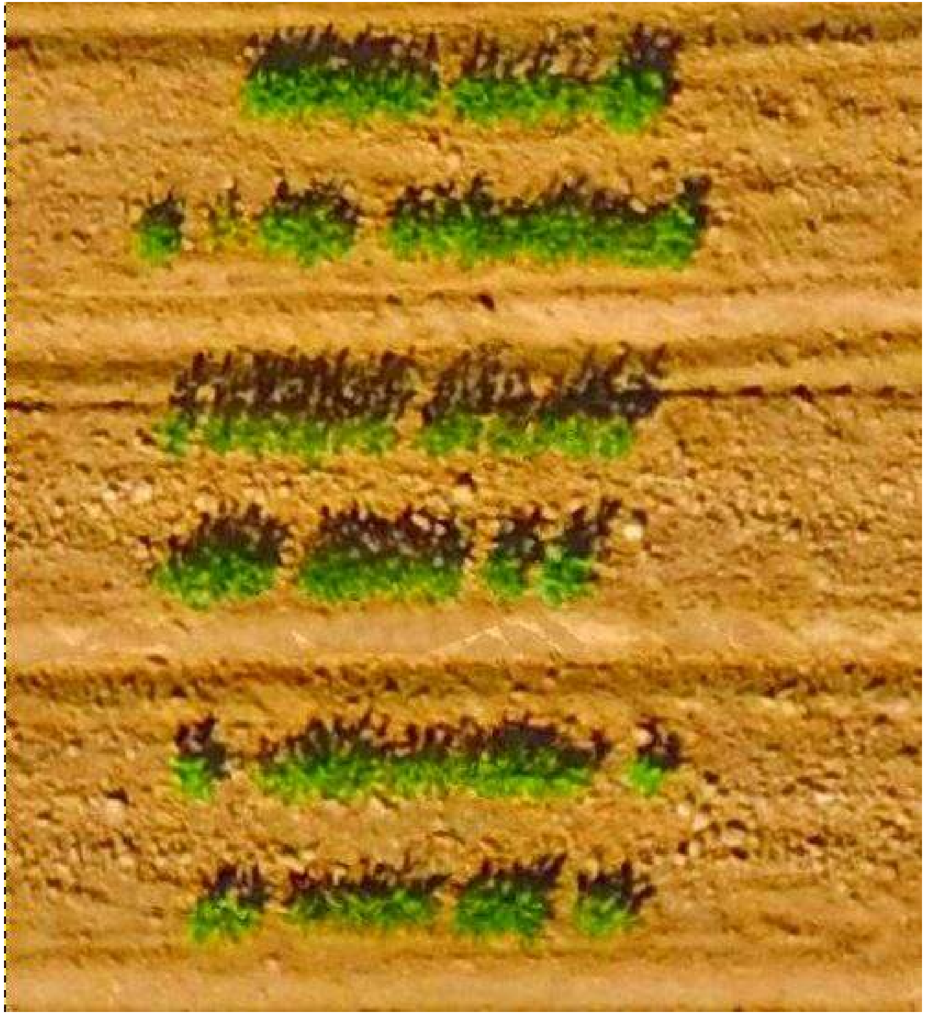
Weekly imagery at Dos Rios ranch

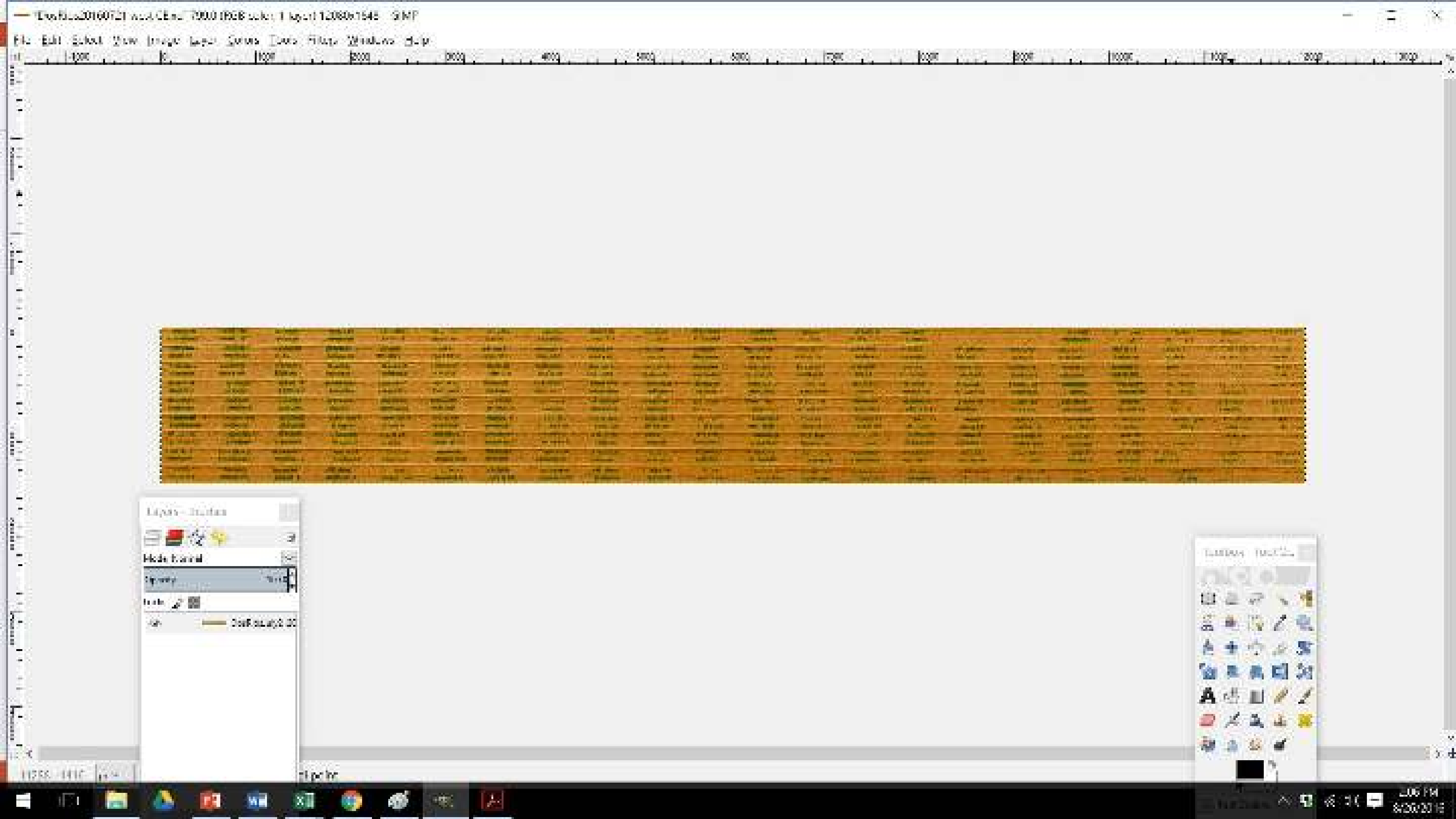

File Edit Select View Image Layer Colors Tools Filters Windows Help

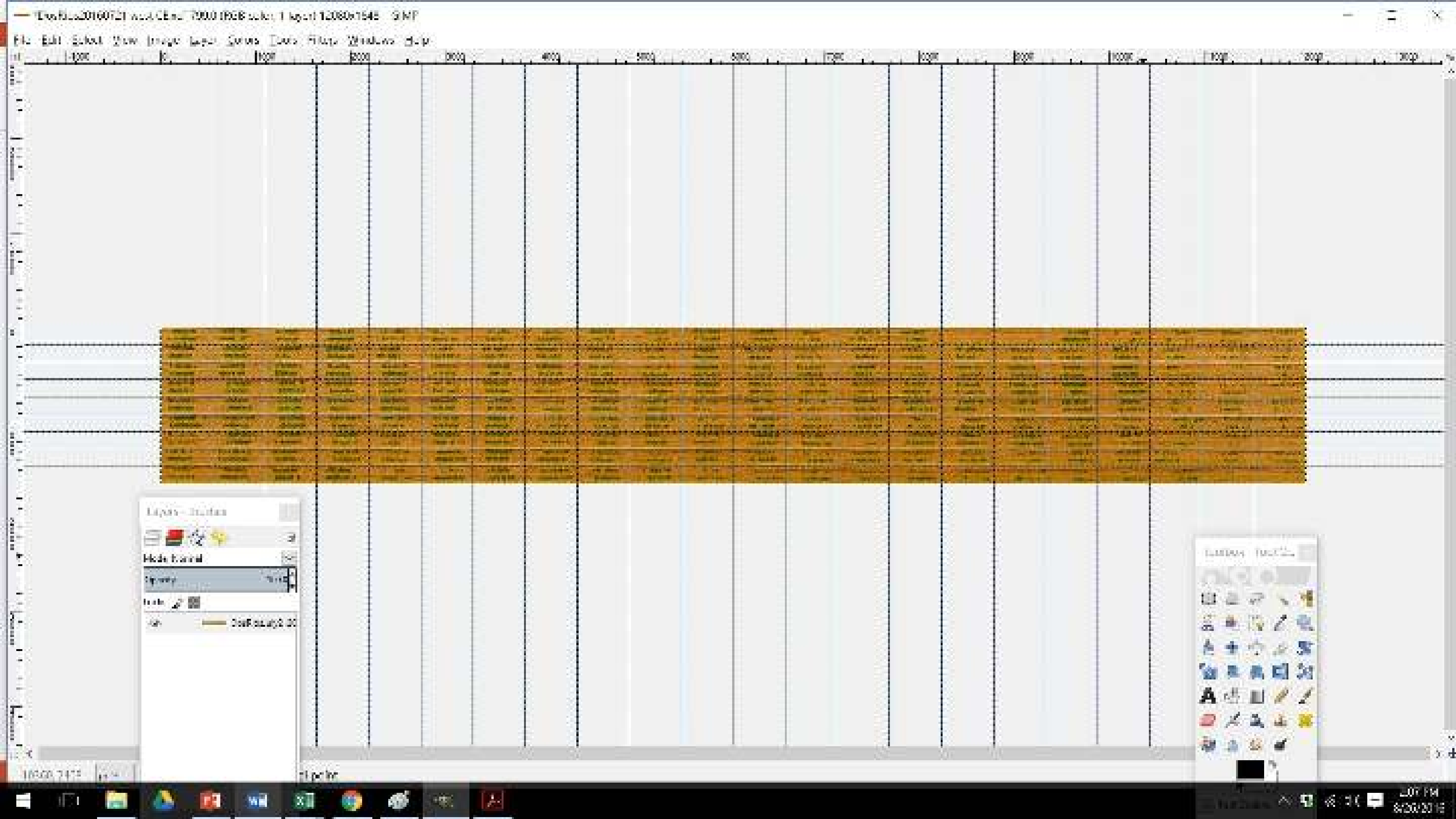

File Edit Select View Image Layer Colors Tools Filters Windows Help

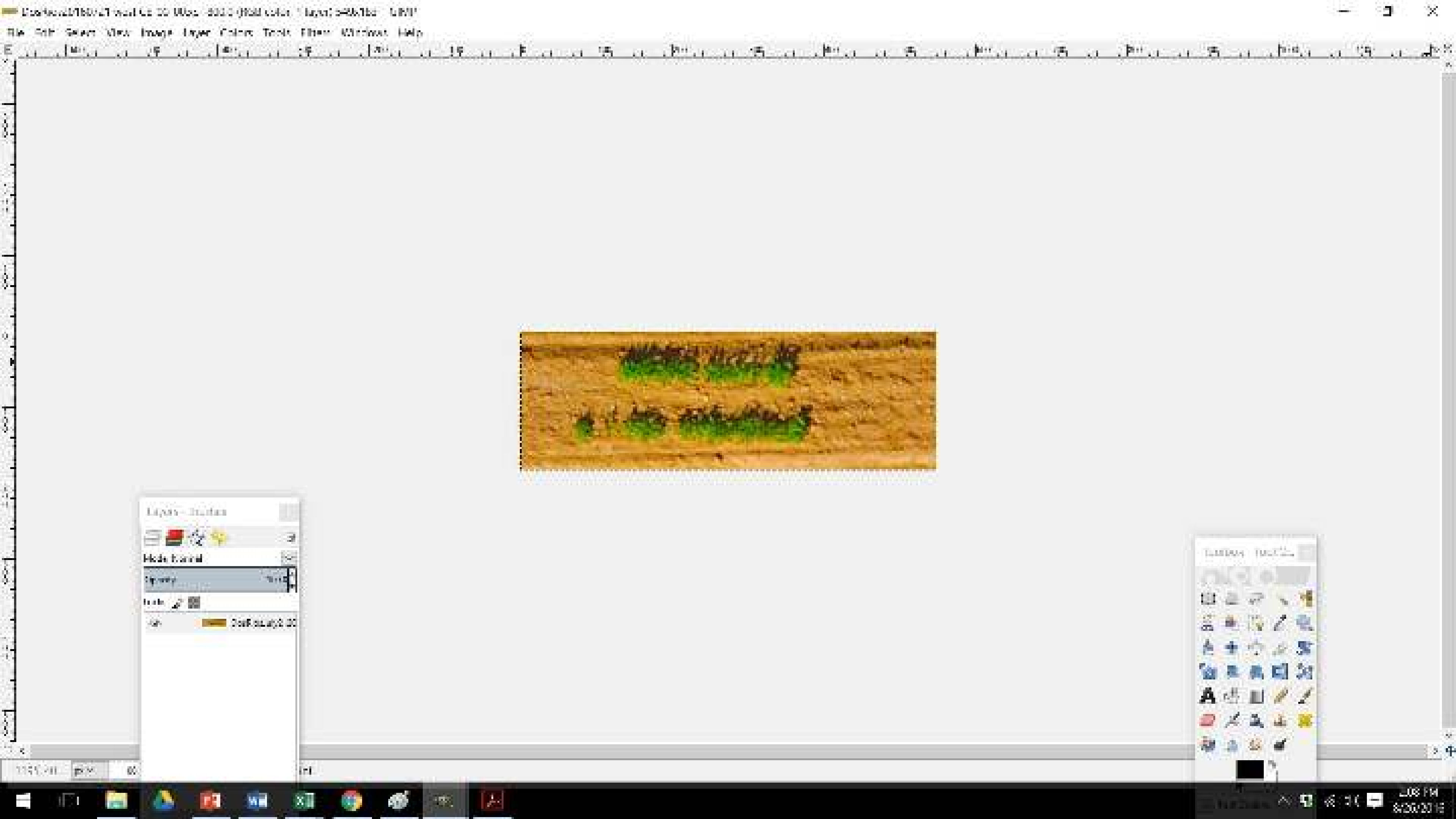

File Edit Select View Image Layer Colors Tools Filters Windows Help






File Edit Select View Image Layer Colors Tools Filters Windows Help


GIMP
File Edit Select View Image Layer Colors Tools Filters Windows Help
Mode Normal
Opacity


File Edit Select View Image Layer Colors Tools Filters Windows Help
Mode Normal

Open an image
Auto settings
Analyse with current settings
Save analysis
Rotate image 180 deg
Delete background
Batch Processing
Select batch source Folder
Select batch output Folder
Start Batch with current settings
Use auto settings
Open output csv file
Label Pixels
Processing Speed
Only one Leaf component

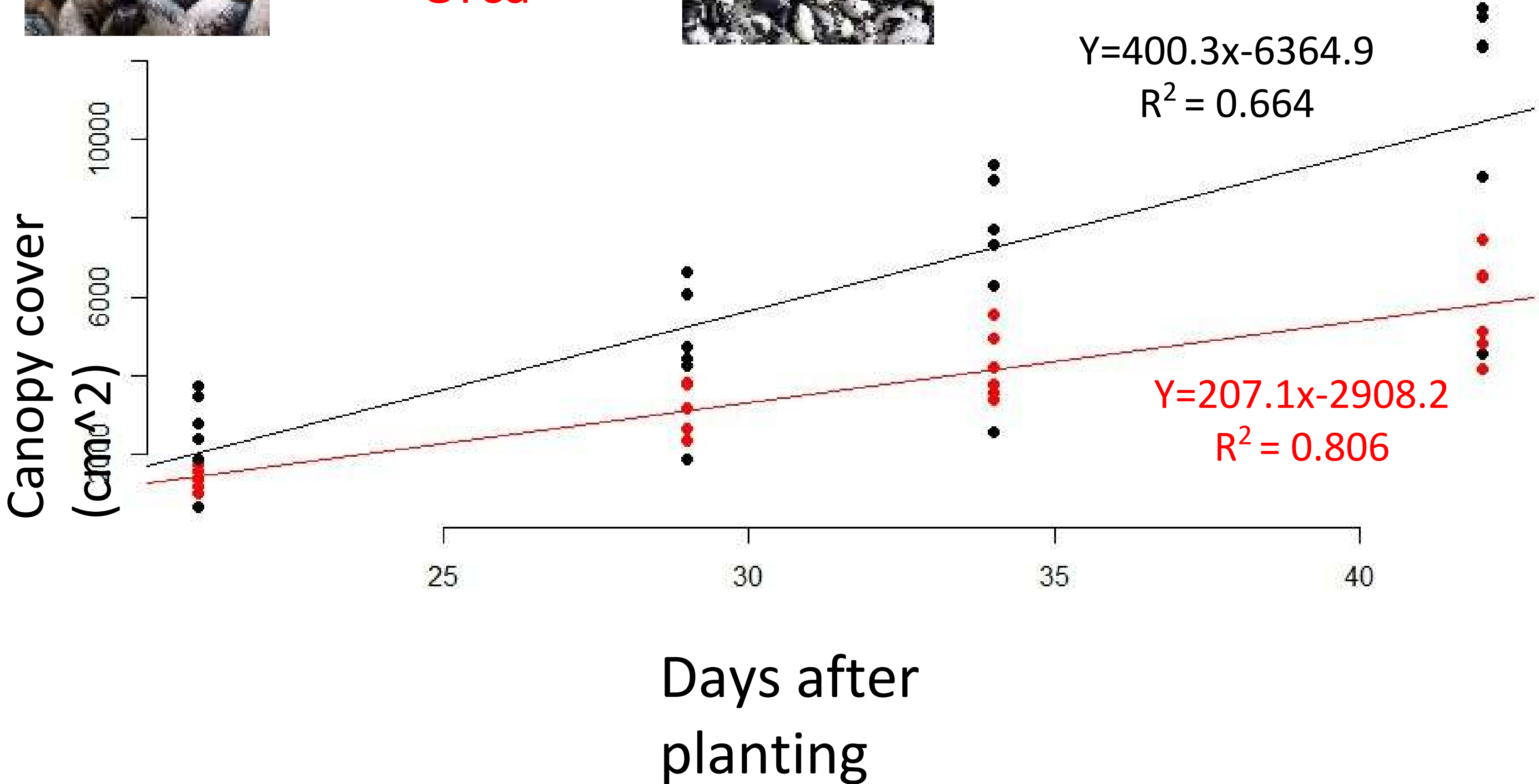
Visual comparison (42 DAP)

Orca

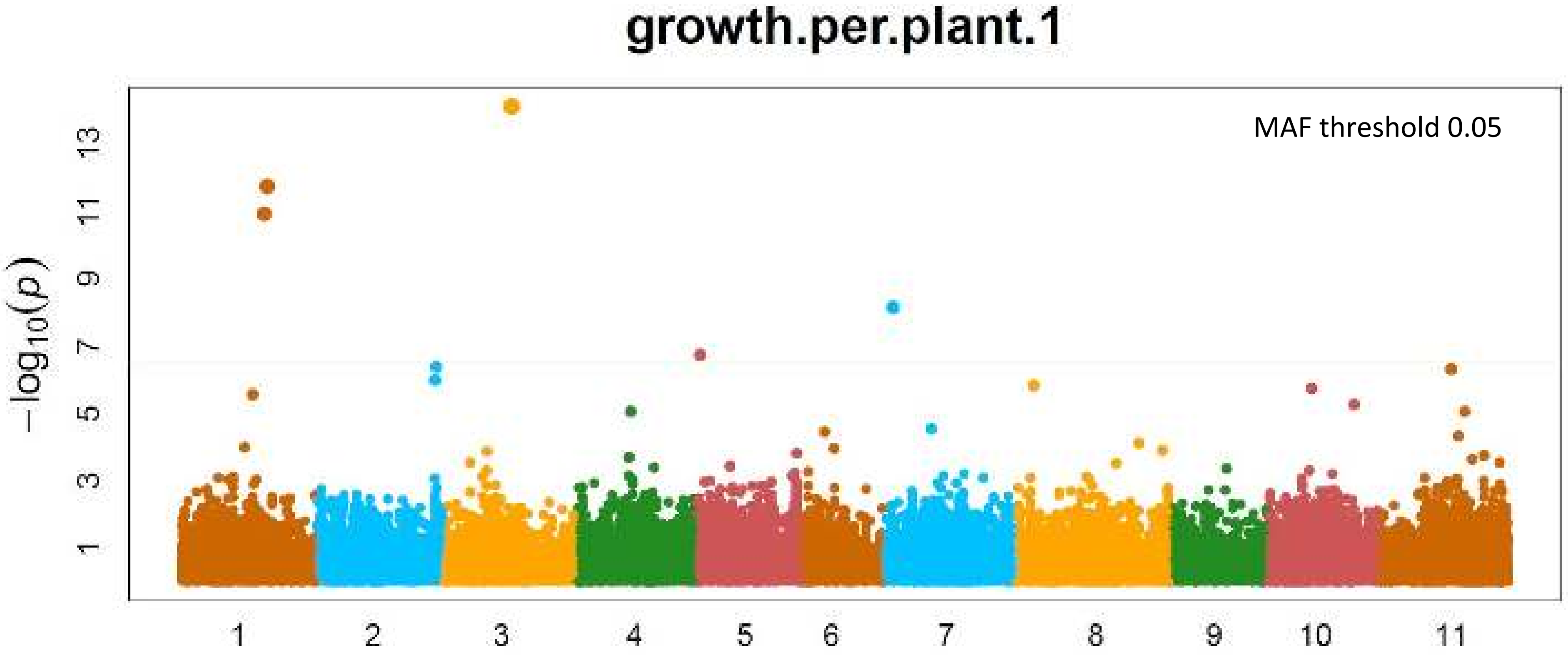
Black Nightfall

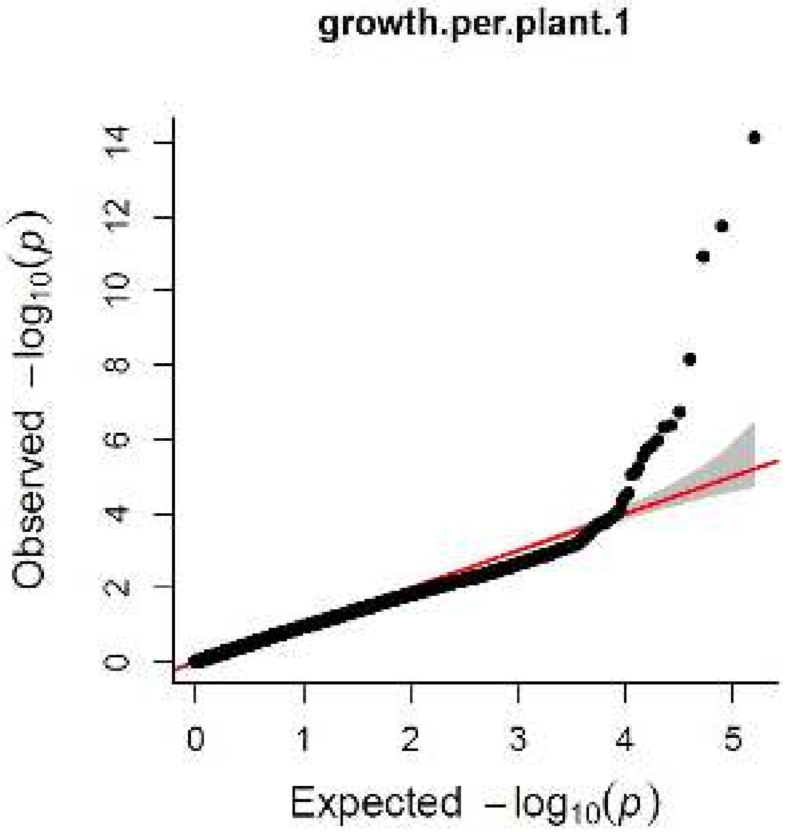
‘Black Nightfall’

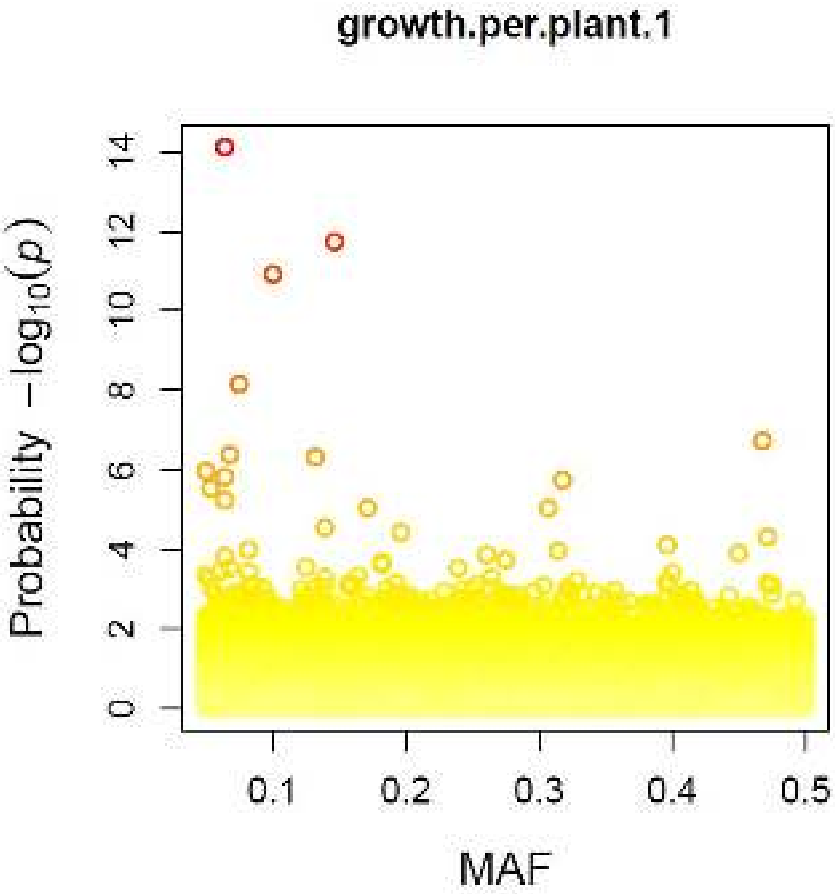
‘Orca’



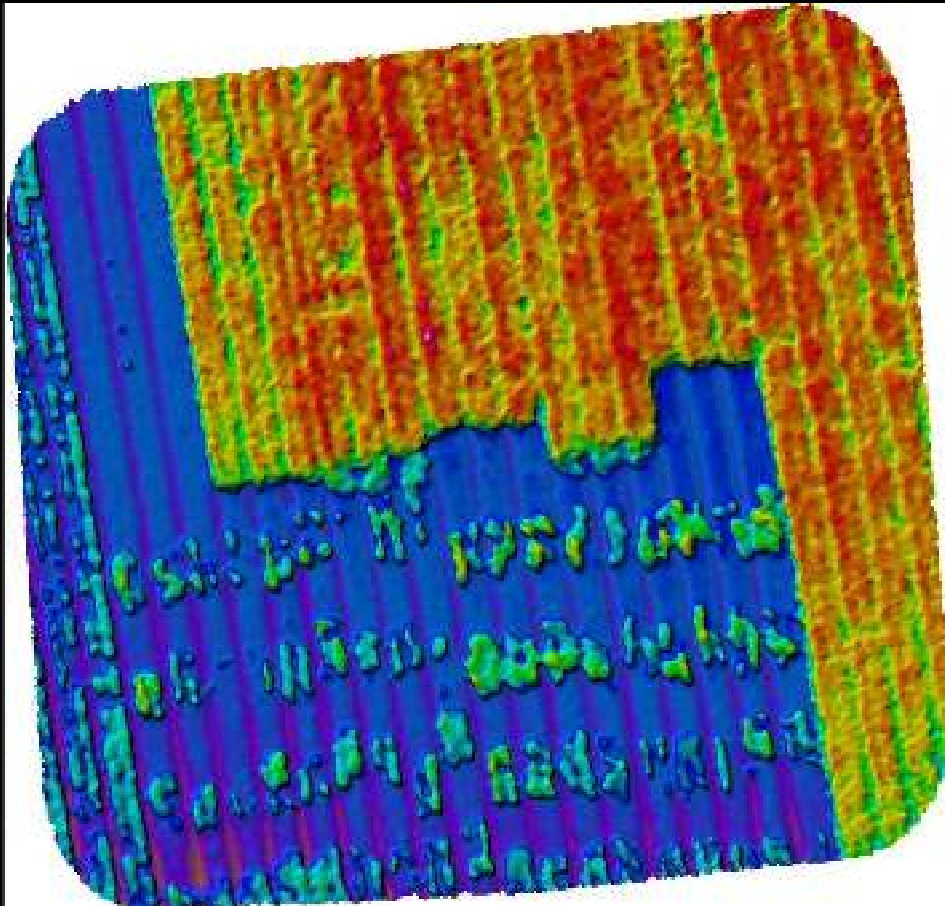
After correcting for the number emerging!

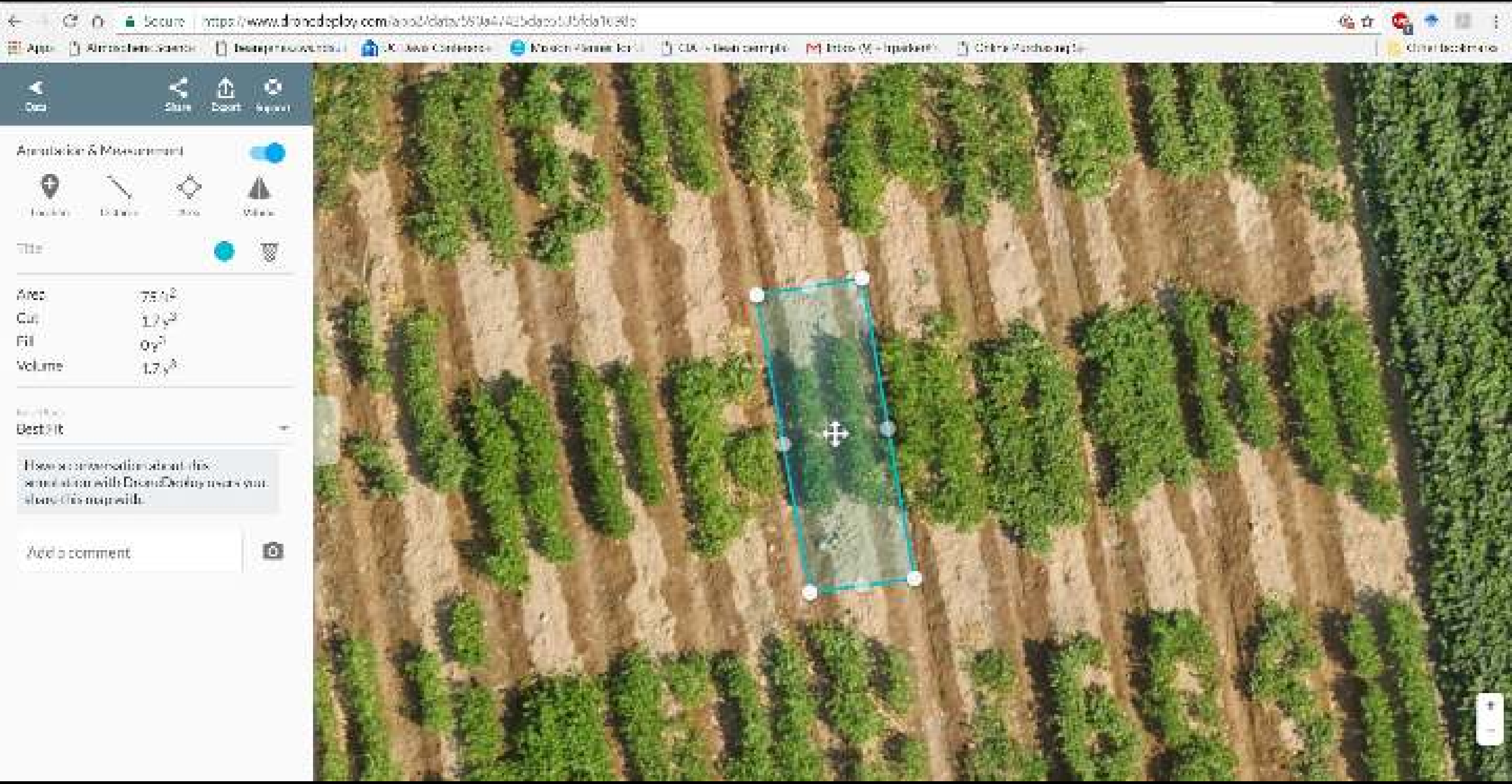



growth.per.plant.1
Observed $-\log_{10}(p)$
Expected $-\log_{10}(p)$
0
2
4
6
8
10
12
14
0
1
2
3
4
5


growth.per.plant.1
Probability $-\log_{10}(p)$
MAF
0
2
4
6
8
10
12
14
0.1
0.2
0.3
0.4
0.5

3D modeling




Secure
Share
Export
Area
Cut
Fill
Volume
Best Fit
Add a comment

Anova: Single Factor, HEIGHT BASED ON DRONE IMAGERY (8-18)						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	282.6559	47.10932	7.301282		
Column 2	6	245.3834	40.89723	48.97779		
Column 3	6	288.7727	48.12878	121.144		
Column 4	5	257.9092	51.58184	21.14039		
Column 5	7	393.3417	56.19167	22.34569		
Column 6	6	267.1747	44.52912	24.72147		
Column 7	6	432.8275	72.13792	77.83961		
Column 8	6	305.0202	50.8367	75.25917		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3862.203	7	551.7433	11.06334	1.1E-07	2.249024
Within Groups	1994.852	40	49.87131			
Total	5857.056	47				

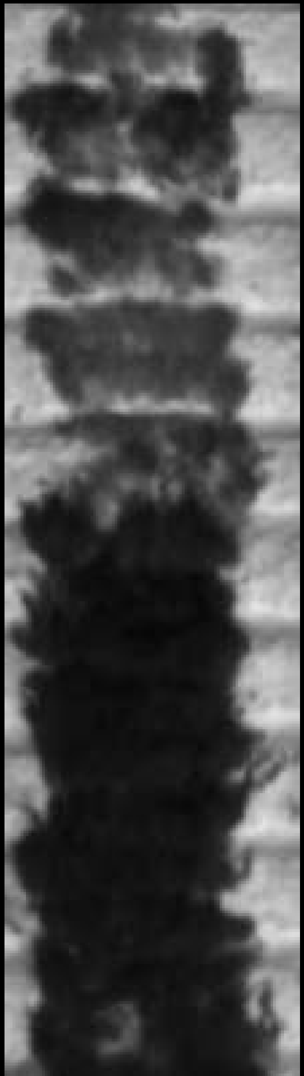
Anova: Single Factor, HAND- MEASURED HEIGHT (9-12)						
SUMMARY						
Groups	Count	Sum	Average	Variance		
Column 1	6	247.65	41.275	2.41935		
Column 2	6	232.41	38.735	13.38707		
Column 3	6	247.65	41.275	17.25803		
Column 4	5	220.345	44.069	2.338705		
Column 5	7	304.8	43.54286	11.13669		
Column 6	6	283.21	47.20167	18.97846		
Column 7	6	293.37	48.895	10.80643		
Column 8	6	229.87	38.31167	26.07522		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	598.4793	7	85.49704	6.566621	3.48E-05	2.249024
Within Groups	520.7977	40	13.01994			
Total	1119.277	47				

R^2=0.66

Drone-based model may be better at separating height by genotype than hand-measurement

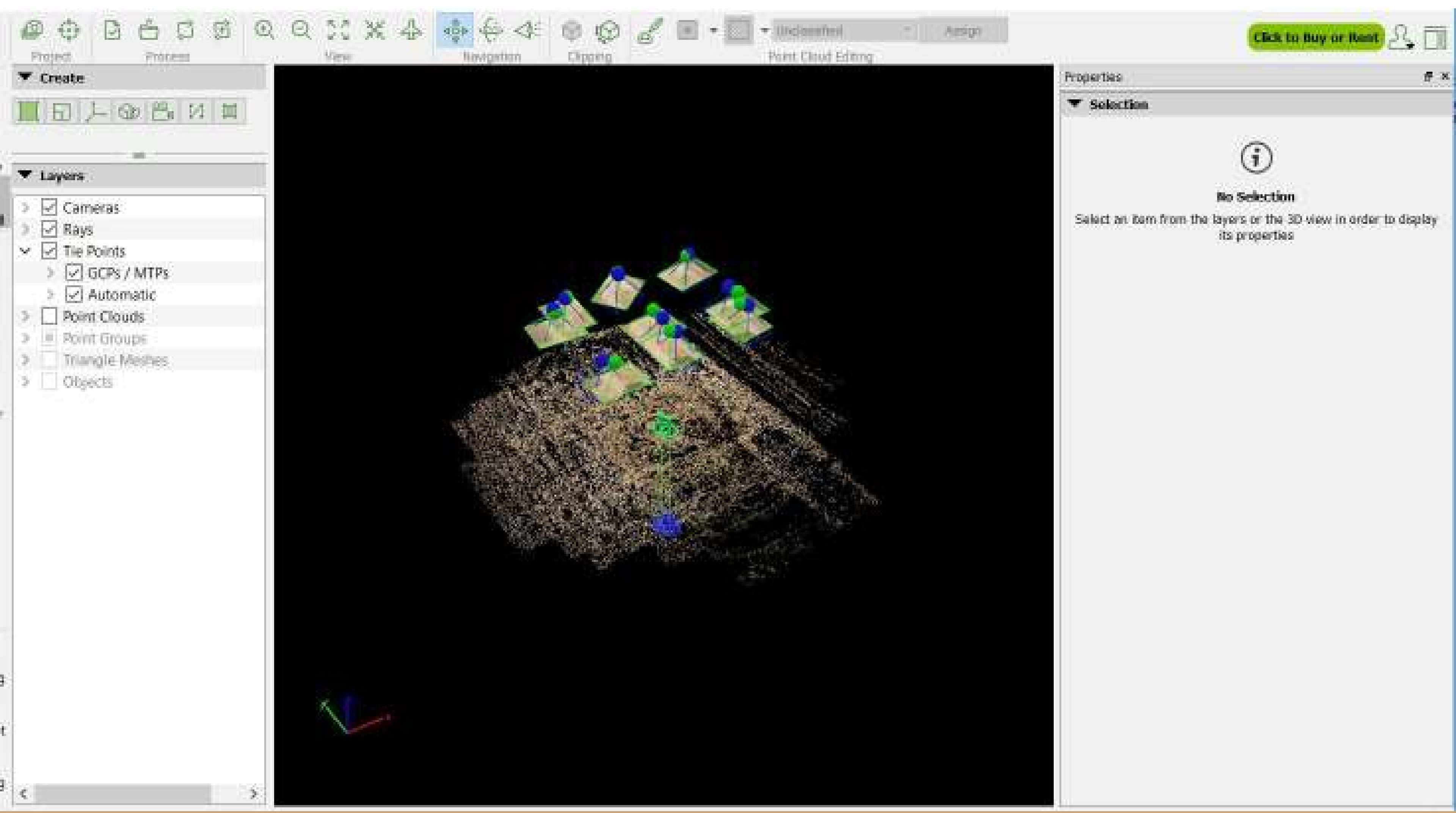
R^2=0.53

Thermal model

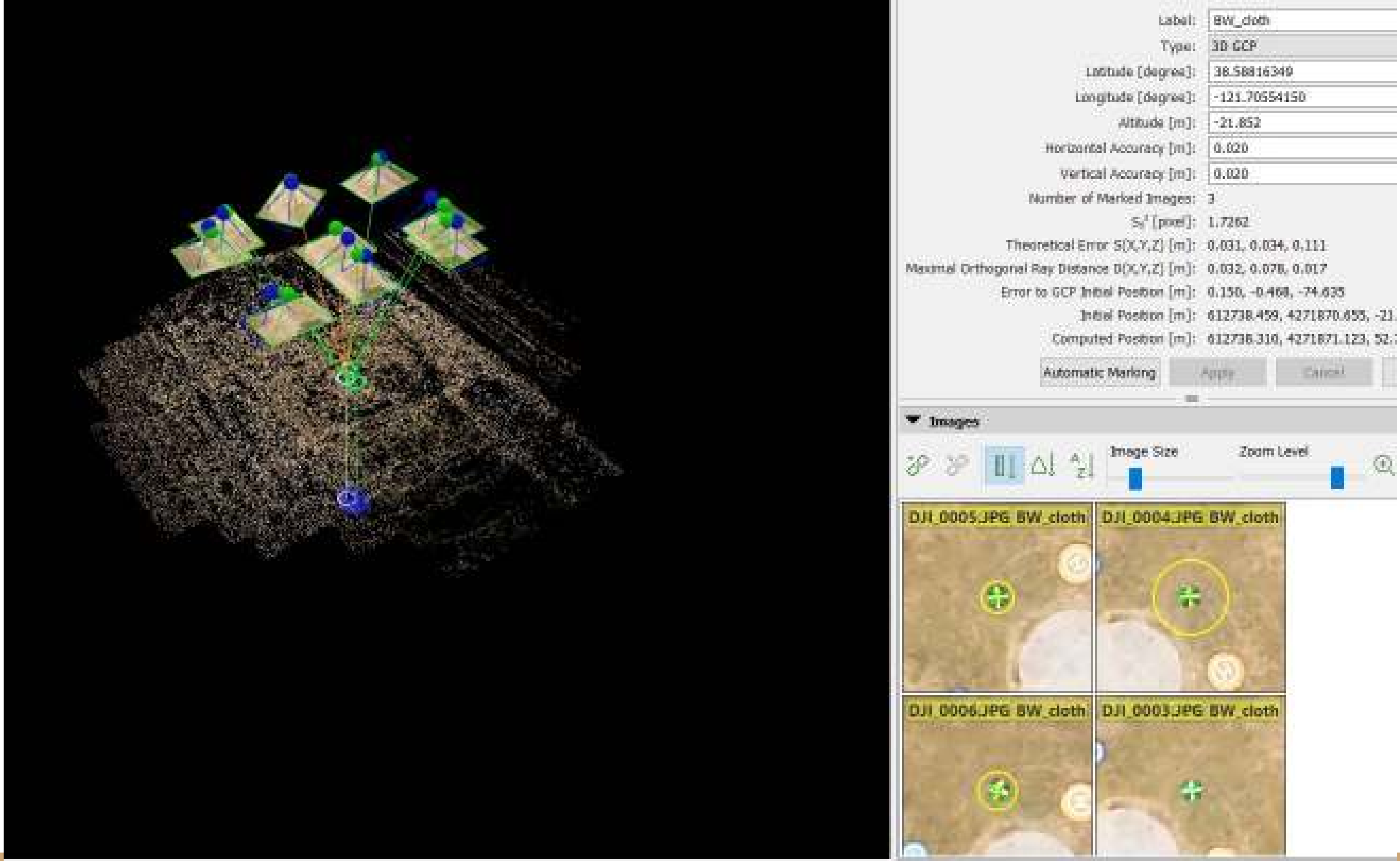


CDC Nighthawk	Common bean
JM-24	Common bean
Santa Fe	Common bean
Amadeus 77	Common bean
UI-111	Common bean
CA BE 46	Cowpea
CA BE 46	Cowpea
CA BE 46	Cowpea
CA BE 46	Cowpea
CA BE 46	Cowpea

Uploading Data into Pix4D and Georeferencing Demo



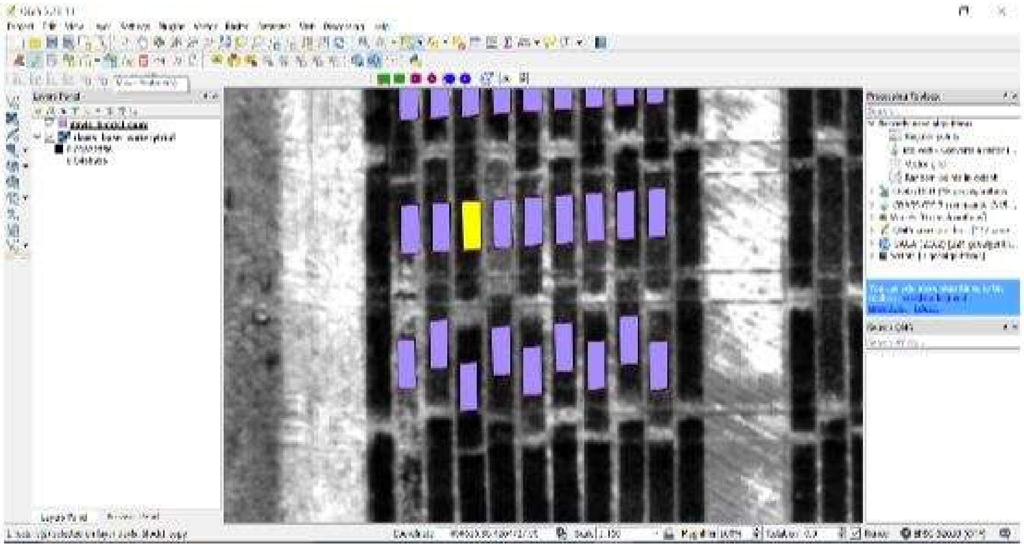
Project
Process
View
Navigation
Clipping
Point Cloud Editing
Assign
Click to Buy or Rent
Create
Layers
Cameras
Rays
Tie Points
GCPs / MTPs
Automatic
Point Clouds
Point Groups
Triangle Meshes
Objects
Properties
Selection
No Selection
Select an item from the layers or the 3D view in order to display its properties

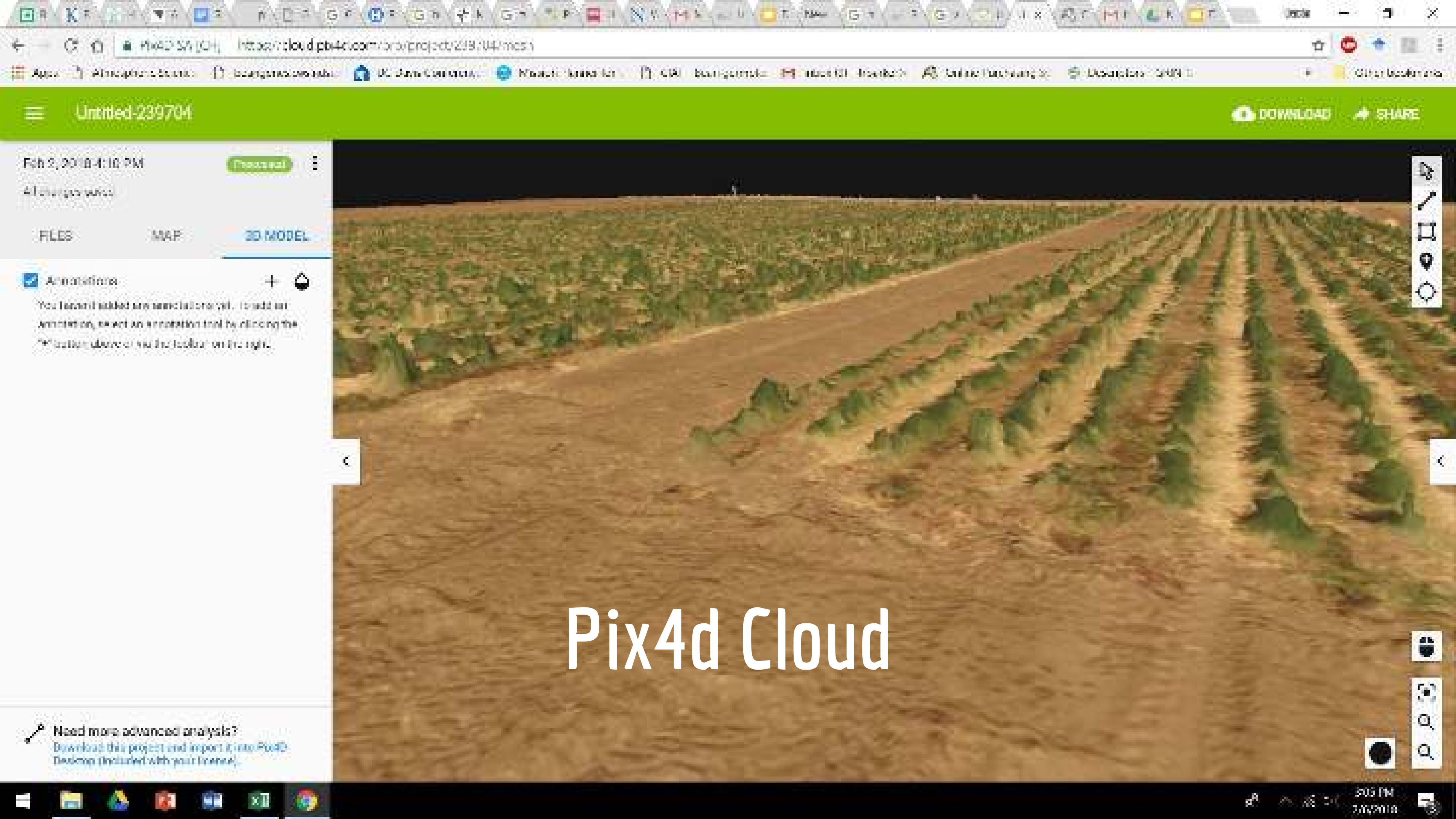


Label: BW_cloth
Type: 3D GCP
Latitude [degree]: 38.58816349
Longitude [degree]: -121.70554150
Altitude [m]: -21.852
Horizontal Accuracy [m]: 0.020
Vertical Accuracy [m]: 0.020
Number of Marked Images: 3
Theoretical Error S(X,Y,Z) [m]: 0.031, 0.034, 0.111
Maximal Orthogonal Ray Distance D(X,Y,Z) [m]: 0.032, 0.078, 0.017
Error to GCP Initial Position [m]: 0.150, -0.468, -74.635
Initial Position [m]: 612738.459, 4271870.655, -21.
Computed Position [m]: 612738.310, 4271871.123, 52.
Automatic Marking
Apply
Cancel
Images
Image Size
Zoom Level
DJI_0005.JPG BW_cloth
DJI_0004.JPG BW_cloth
DJI_0006.JPG BW_cloth
DJI_0003.JPG BW_cloth

Using your tif in QGIS

- Useful for adding vector layers on top of your output
- Can be used to georeference other imagery through Tie Points
- Can convert your tiff into other file types




Untitled-239704
DOWNLOAD
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FILES
MAP
3D MODEL
Annotations
Need more advanced analysis?
Download this project and import it into Pix4D Desktop (included with your license).
Pix4d Cloud

Your Turn!

Feel free to also explore Pix4d Example sets!

Download

Example Data - RGB Images - quick download

Emily - Pix4D Post Processing Instructions. .docx

OR

Using Pix4d Cloud Instructions