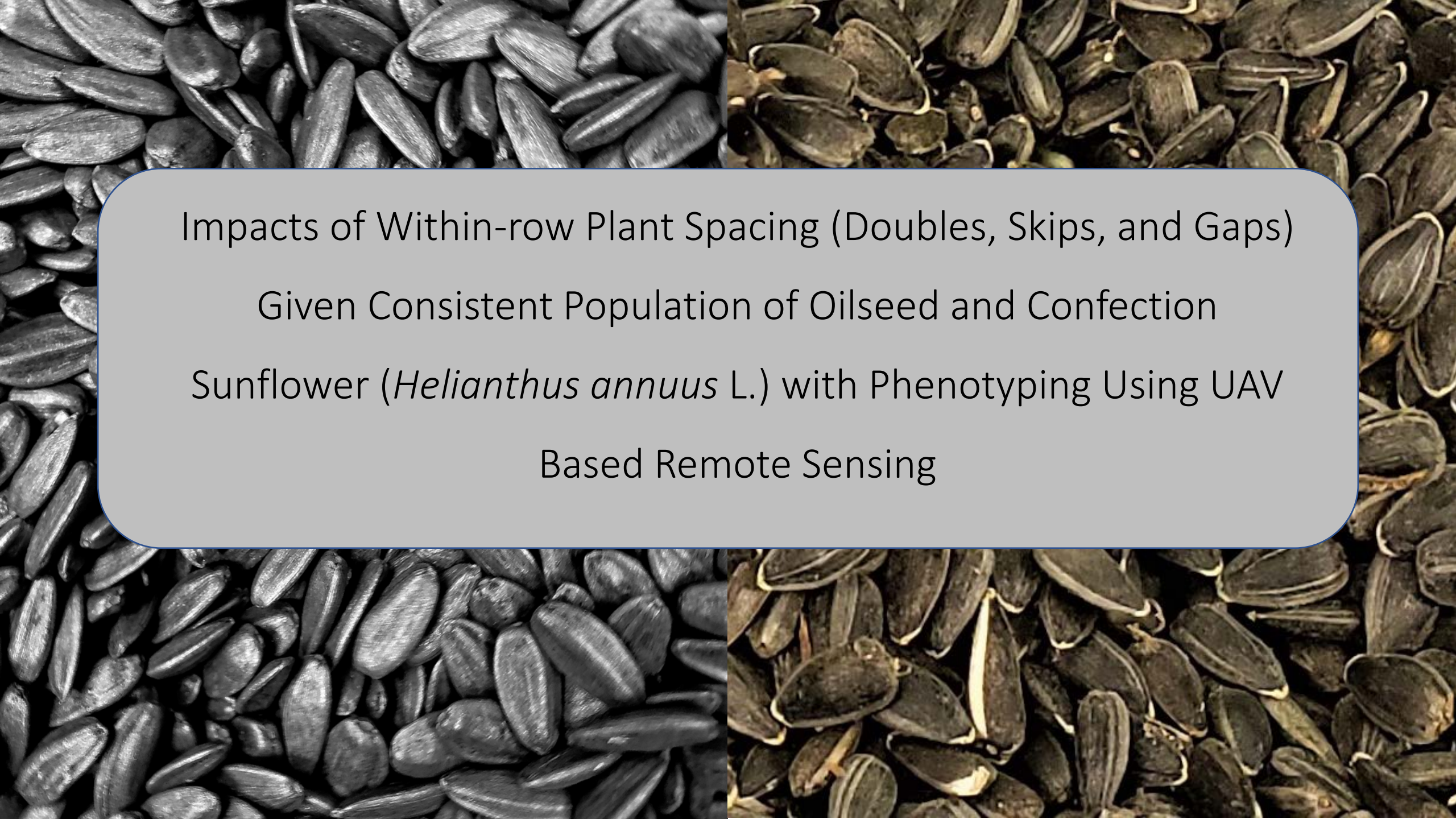


Impacts of Within-row Plant Spacing (Doubles, Skips, and Gaps) Given Consistent Population of Oilseed and Confection Sunflower (*Helianthus annuus* L.) with Phenotyping Using UAV Based Remote Sensing

Introduction

- Neil Olson
- NDSU Plant Science M.S. Program
- Detroit Lakes, MN

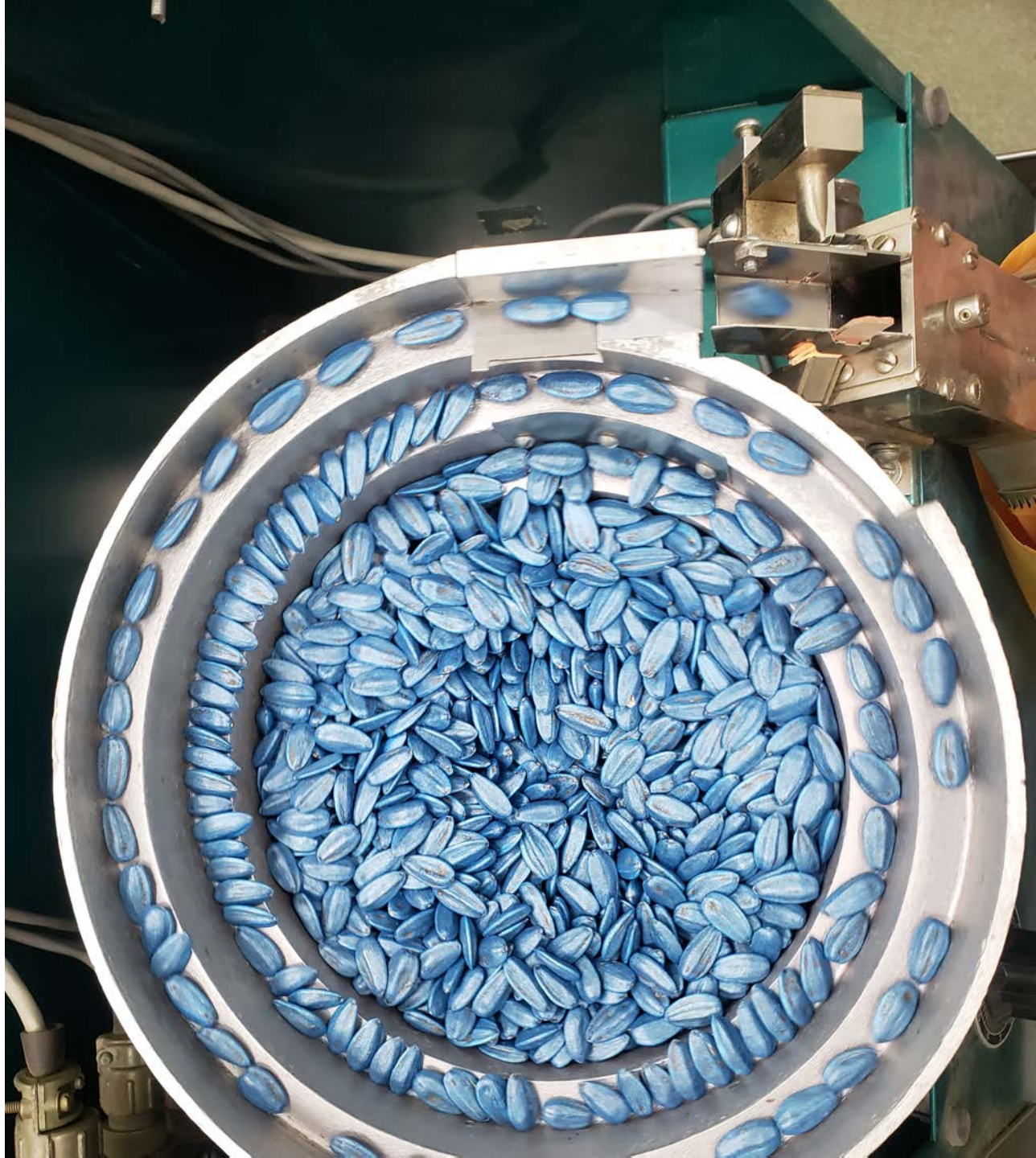
Three Objectives

Spacing	Gaps	Phenotype
• Skips • Doubles	• Middle • 1,2, & 3 m	• Remote Sensing • Emergence

Design

- 3 Sites
- 2 Hybrids
- 8 Treatments
- 4 Reps
- 4 rows
- 30 foot plots
- 360 seeds per row

9	Confection							
8								
7								
6								
5	Oilseed							
4								
3								
2								
	2	3	4	5	6	7	8	9

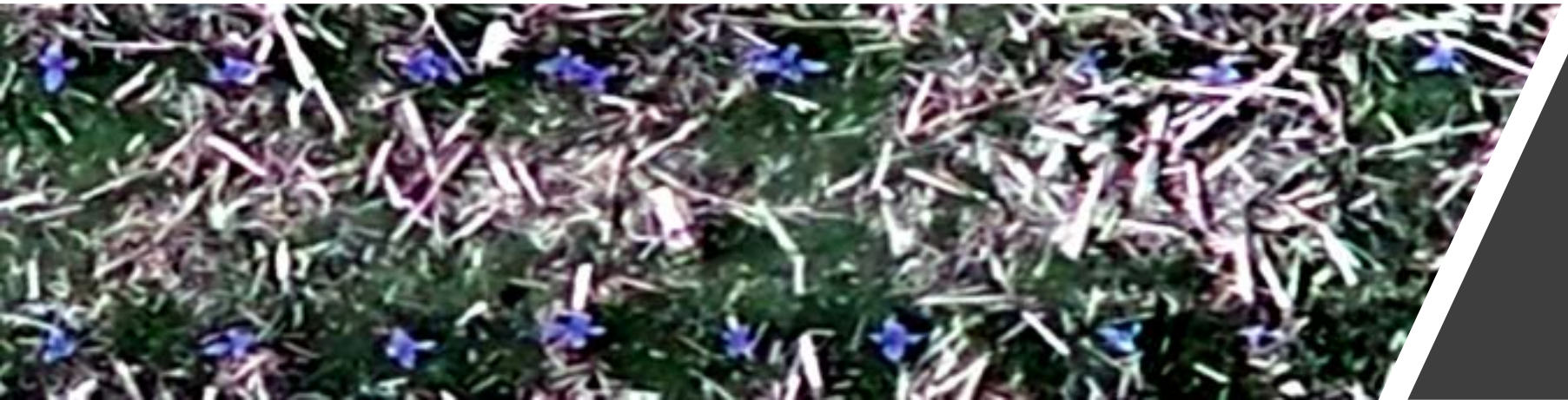


Plants in red

Applying Treatments

Plots are thinned to treatment levels

Skips/Doubles	Gaps
• 6.25% • 12.5% • 25% • 37.5%	• 1 meter • 2 meter • 3 meter • Control

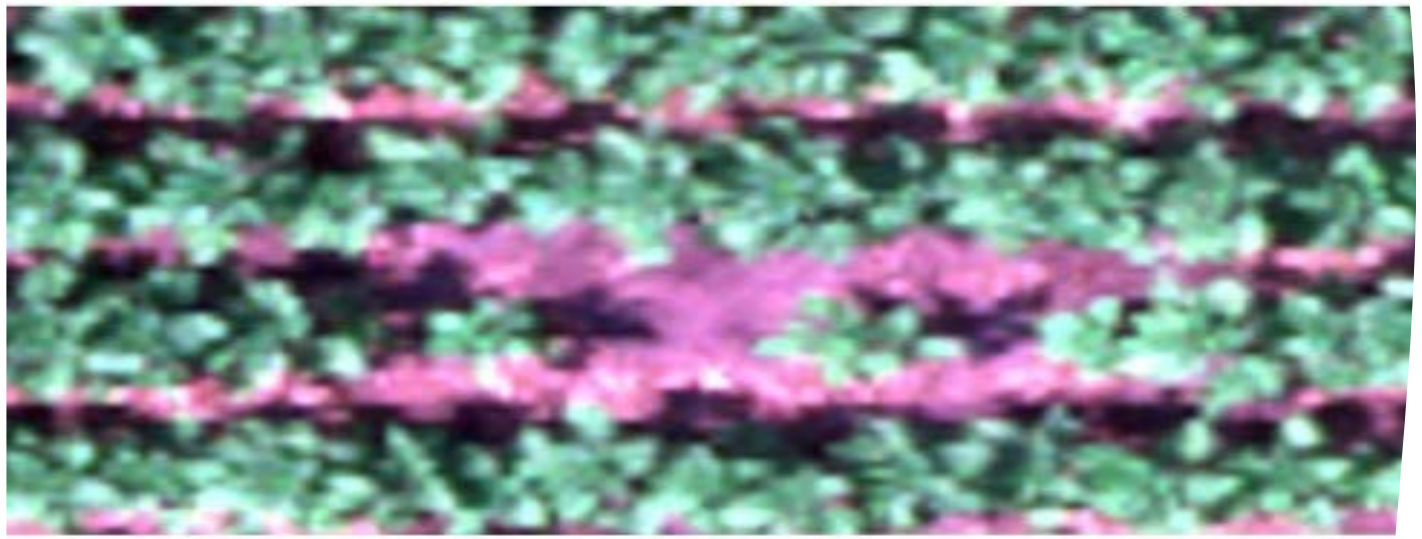


Plants in blue

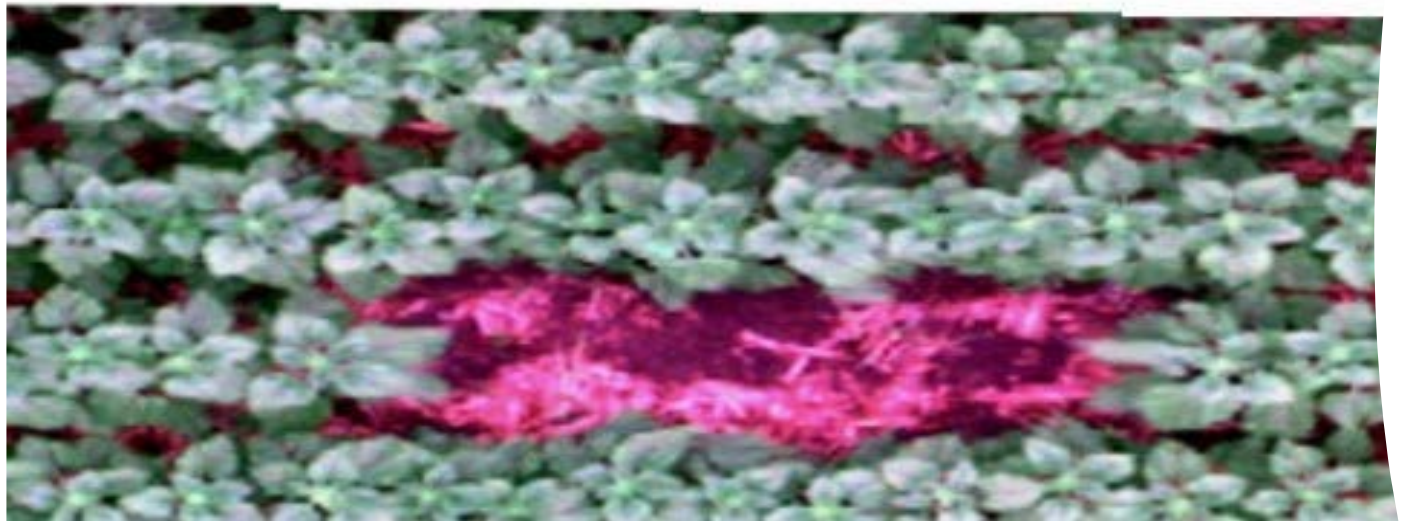
Maintaining Treatments

- Thin late emerging plants
- Gap treatments are useful for a guide

07/13/2019



07/18/2019

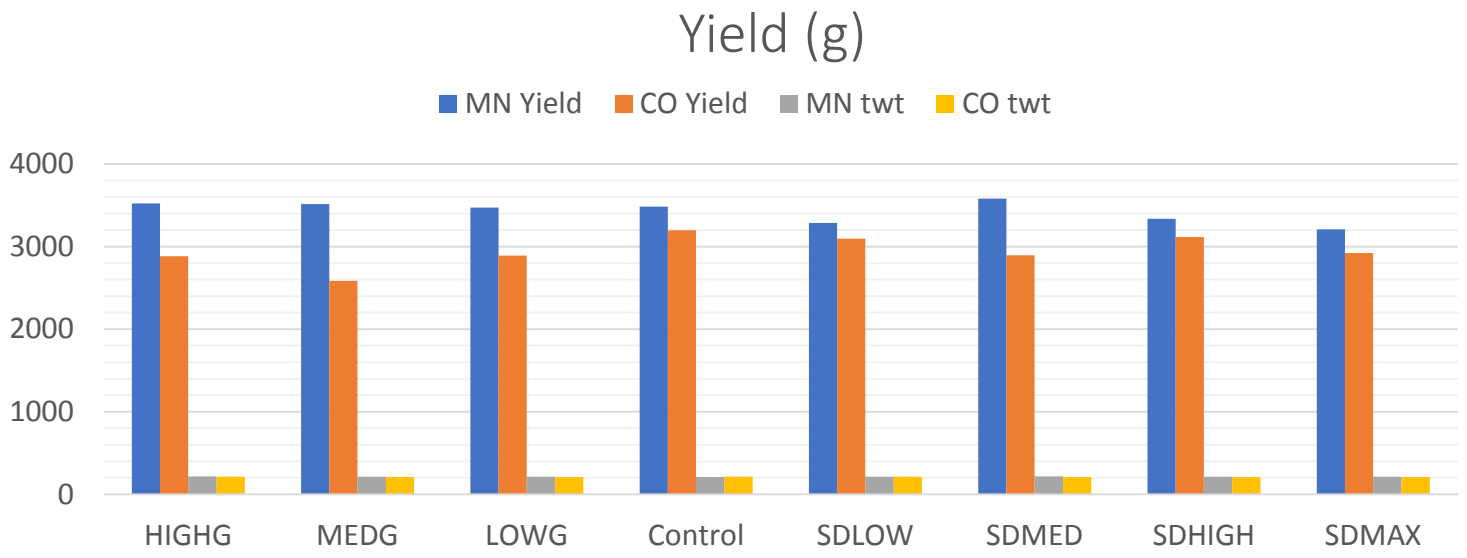


Harvested on Oct. 29th – 30th

Around 150 days in the field

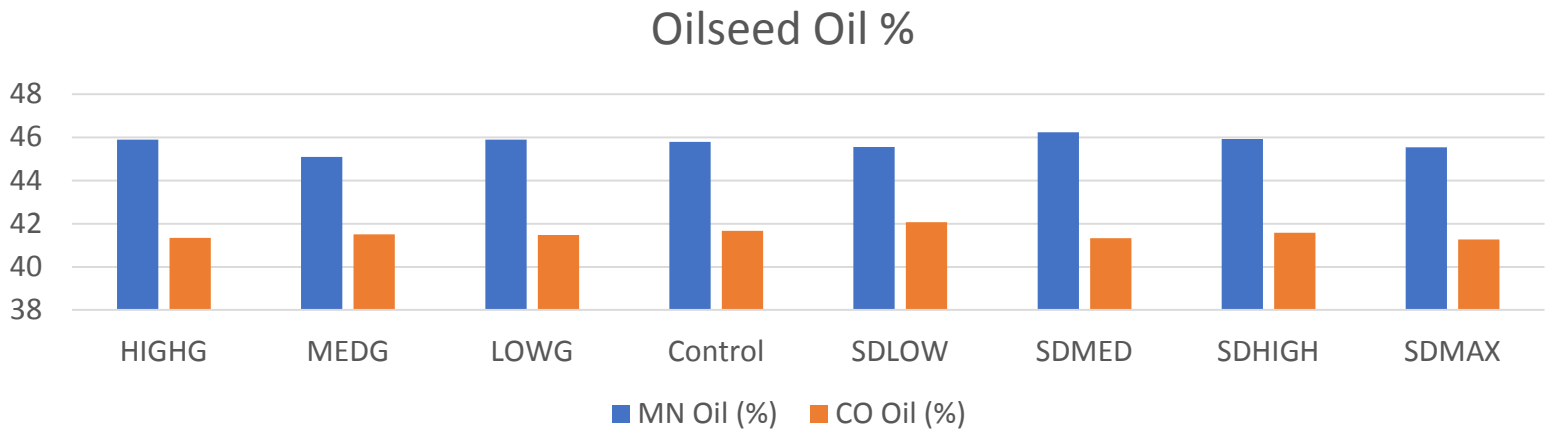
Very wet field conditions Units in inches	Month	Rainfall	Normal	Departure
	July	4.774	2.79	+1.984
	Aug.	3.531	2.56	+0.971
	Sept.	4.205	2.57	+1.635
	Oct.	3.456	2.15	+1.306
	Total	15.966	10.07	+5.896

Results



Yield CV (%) For Confection	
Combined	9.5
CO yield	13.6
MN yield	7.3

Yield CV (%) For Oilseed	
Combined	9.7
Colorado	12.9
CO yield	6.3



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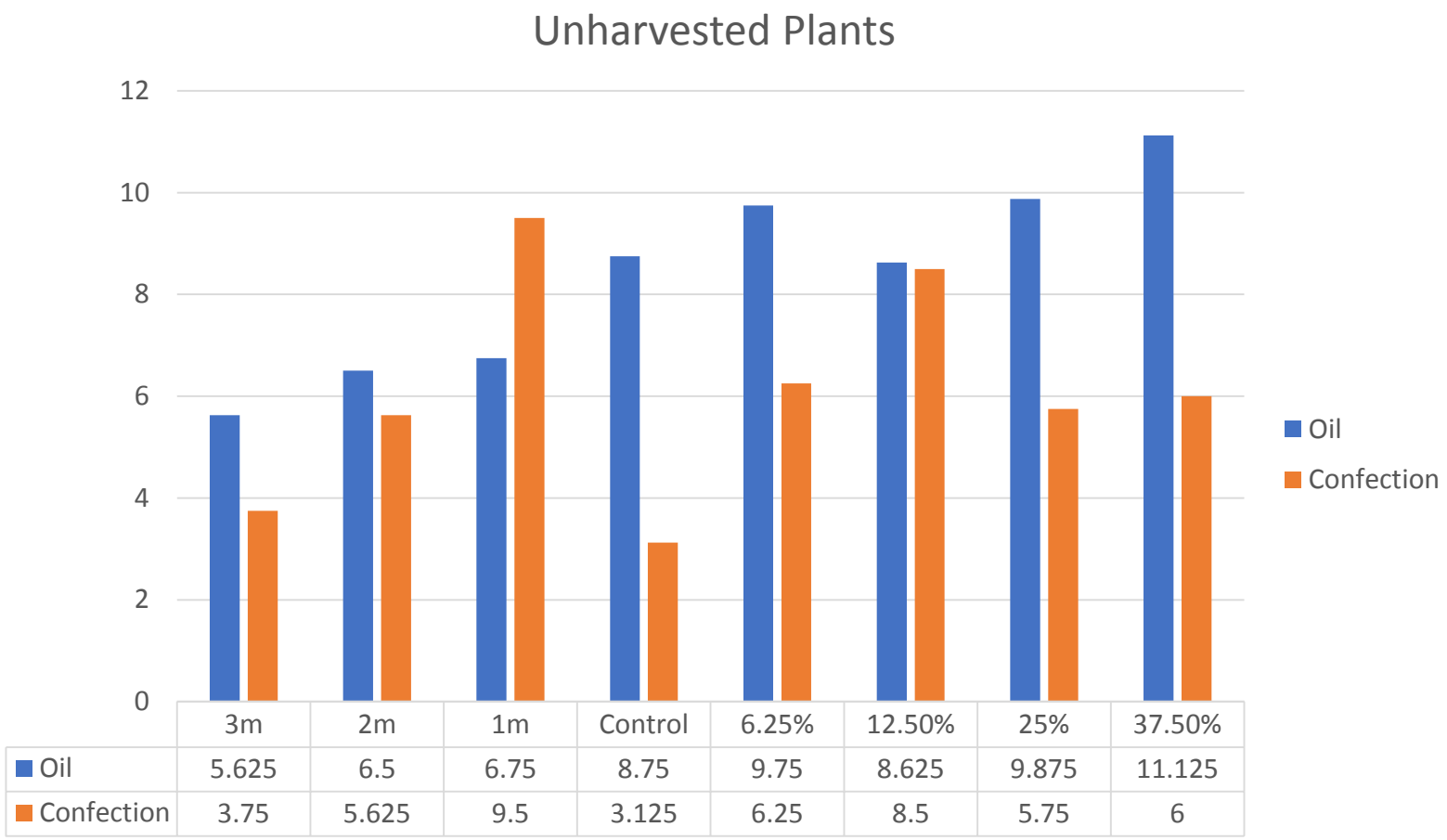


	3m	2m	1m	Control	6.25%	12.50%	25%	37.50%
Oil	5.625	6.5	6.75	8.75	9.75	8.625	9.875	11.125
Confection	3.75	5.625	9.5	3.125	6.25	8.5	5.75	6

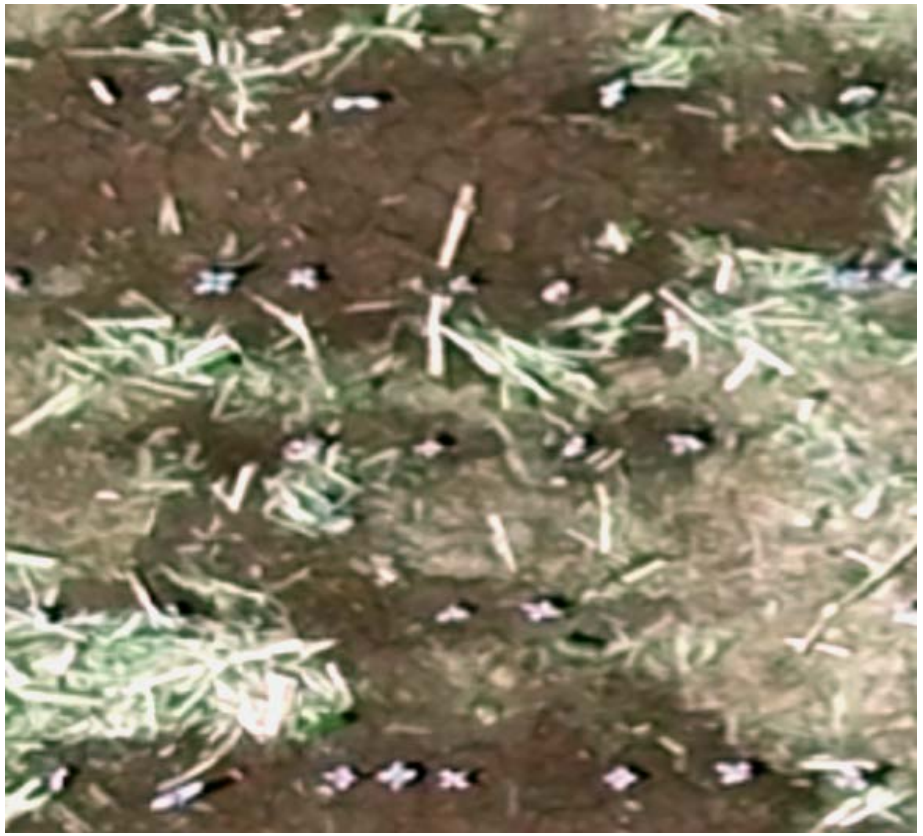
Confection Unharvested Plants	
R^2	0.714
Coeff Var	40.55
RSME	2.26974
Mean	5.59615
Treatment	0.0492
LSD	2.7074

Oilseed Unharvested Plants	
R^2	0.909
Coeff Var	32.22
RSME	2.69921
Mean	8.375
Treatment	0.0019
LSD	2.7236

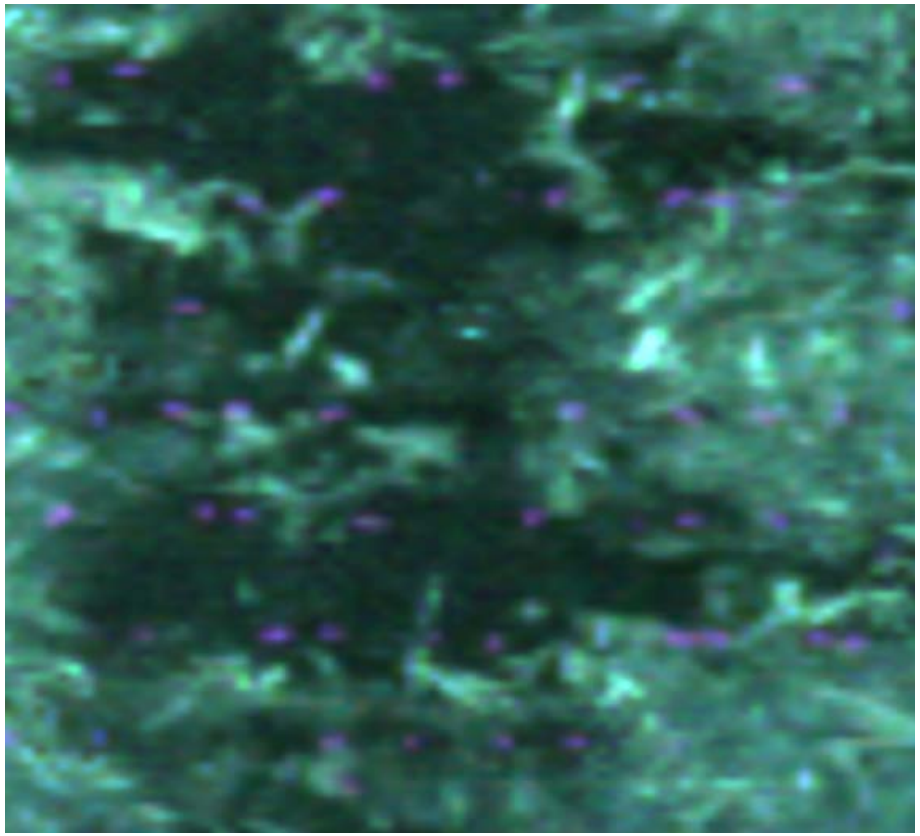
Remote Sensing

- Emergence
- Stand Count
- Canopy closure
- Bloom date
- Plant Height

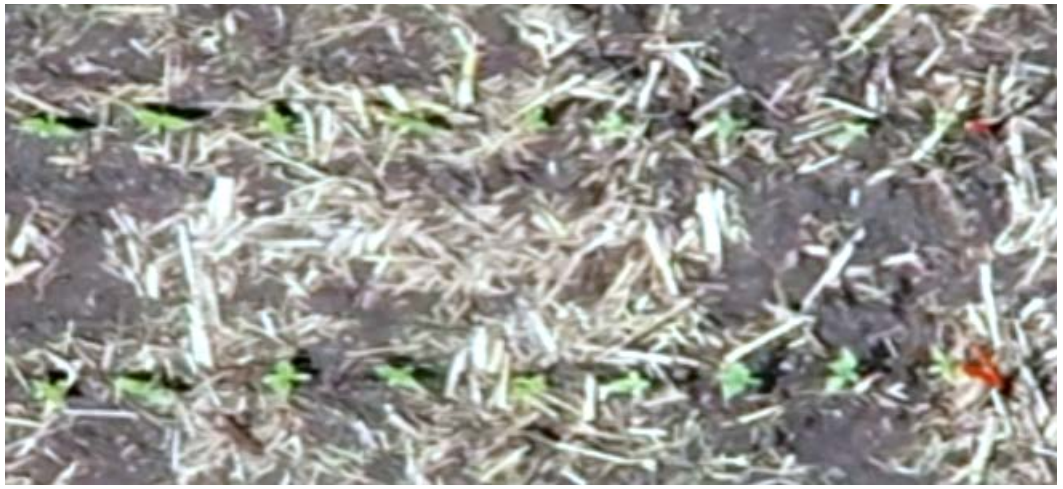
Emergence



- VE is difficult
- V4 is easy
- Corn residue can be an issue
- Multispectral sensors help block out noise

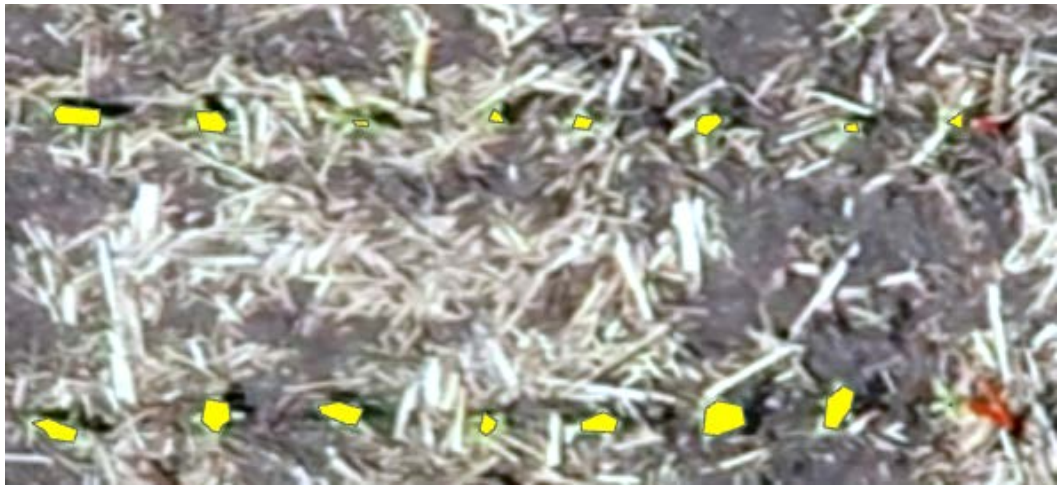


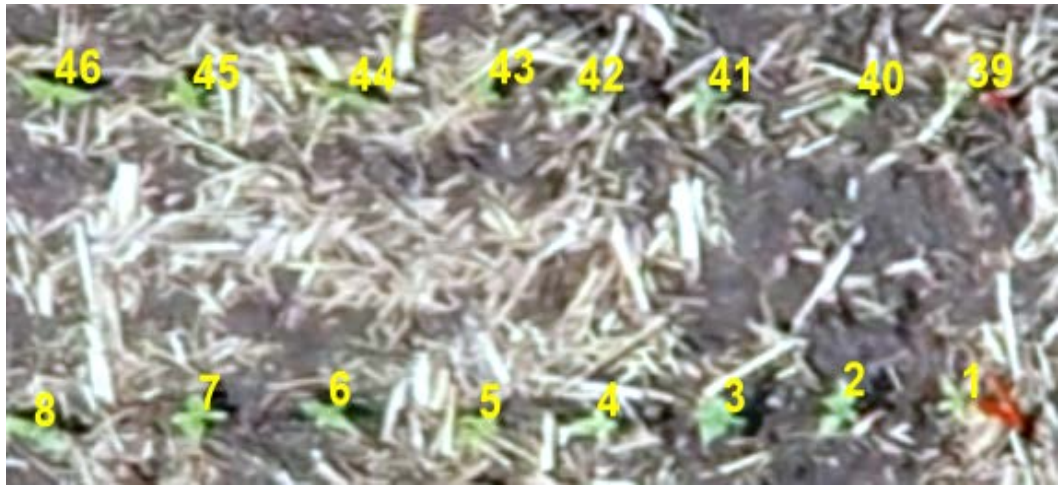
Stand Counts



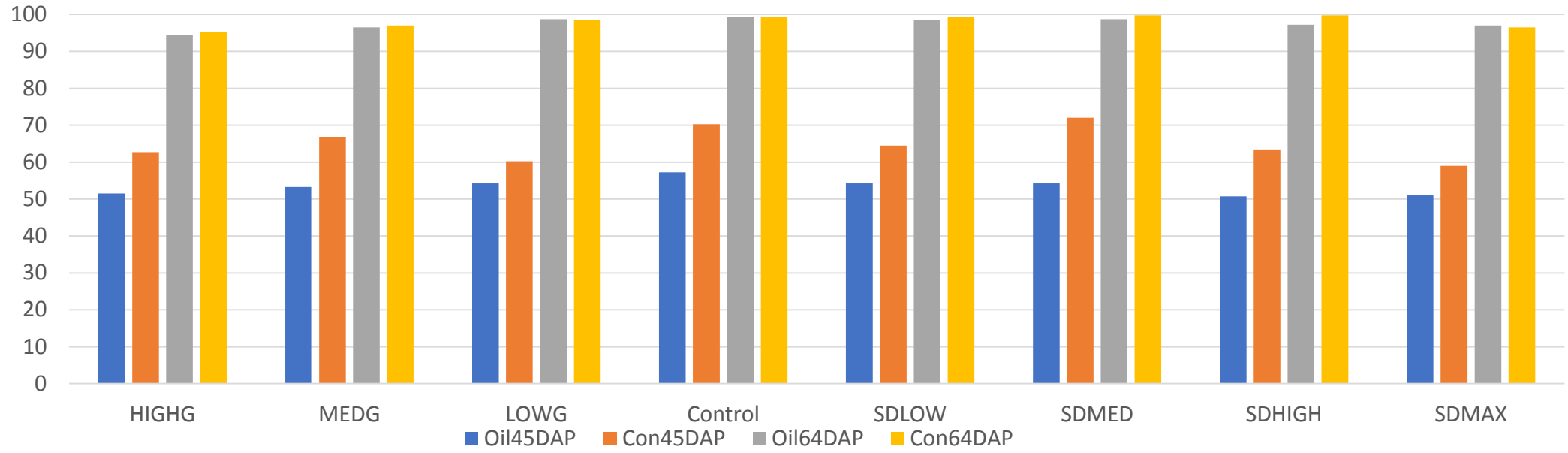
Control plot

Pitfalls:
Doubles are often counted as one
Should be done before within row closure





Canopy %


100
90
80
70
60
50
40
30
20
10
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HIGHG
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LOWG
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SDLOW
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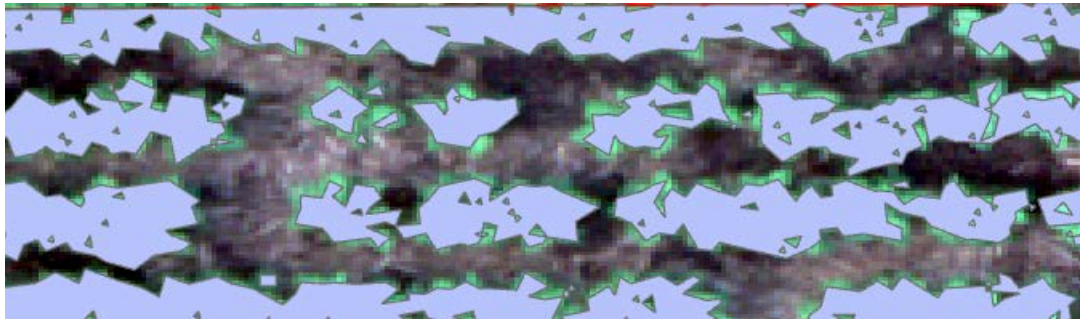
Oil45DAP
Con45DAP
Oil64DAP
Con64DAP

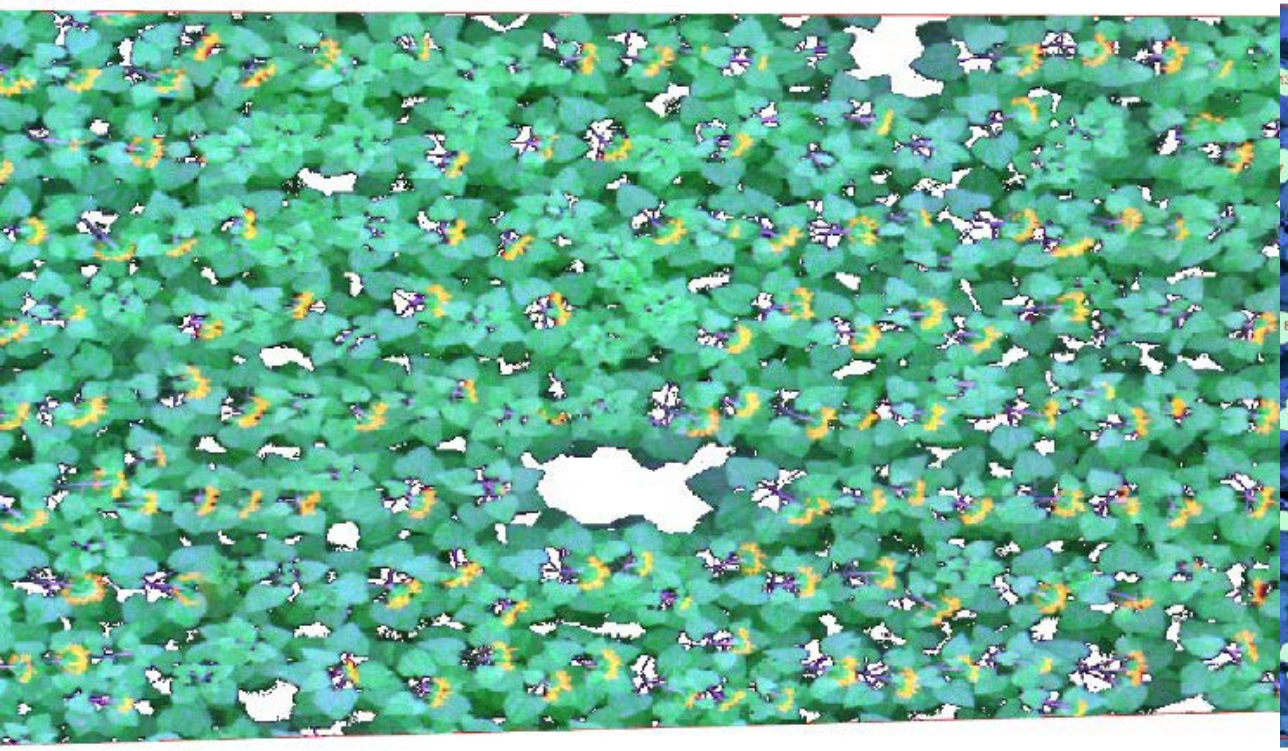


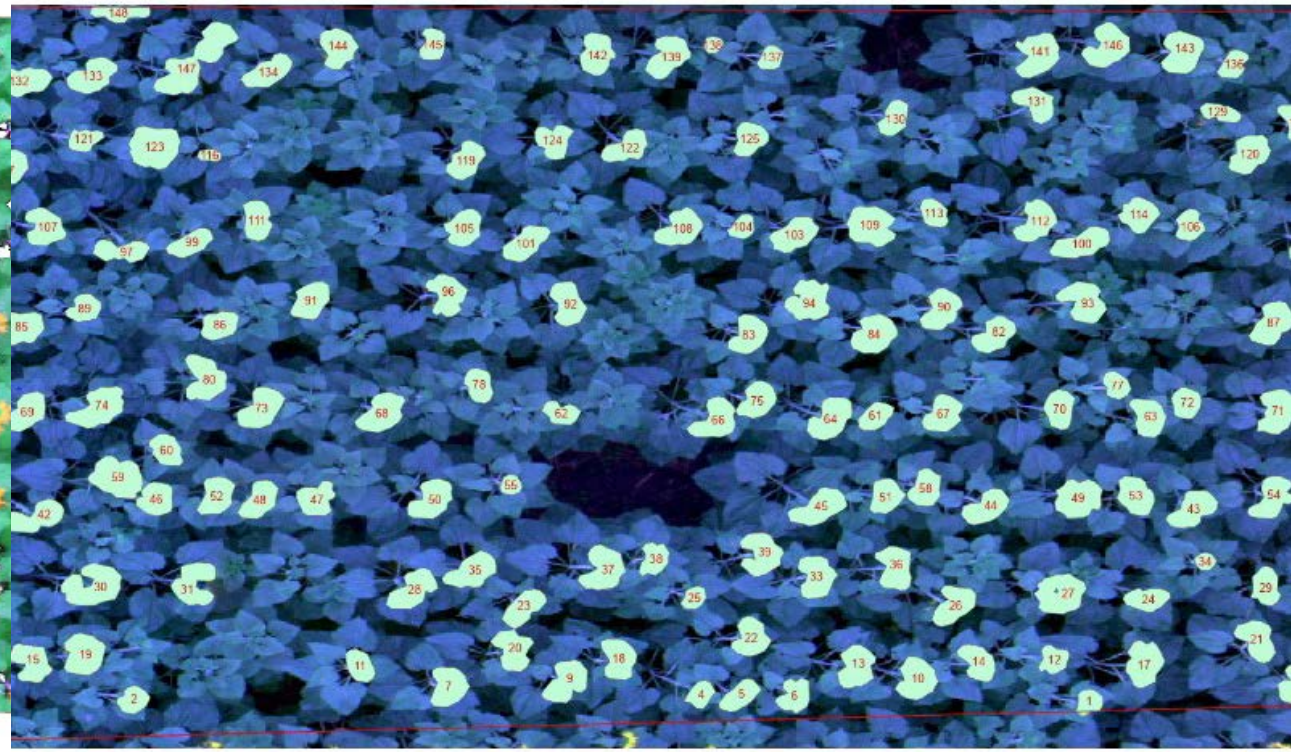
Bloom Notes

	TP	FP	FN	TN
	148	0	3	30
Sensitivity	0.98013245		Observed	178
Specificity	1		Expected	128.939226
Precision	1		Kappa	0.94237503
Accuracy	0.98342541			
Miss Rate	0.01986754			
Fall Out	0			

TP = True positive. FP = False positive.
FN = False negative. TN = True negative.

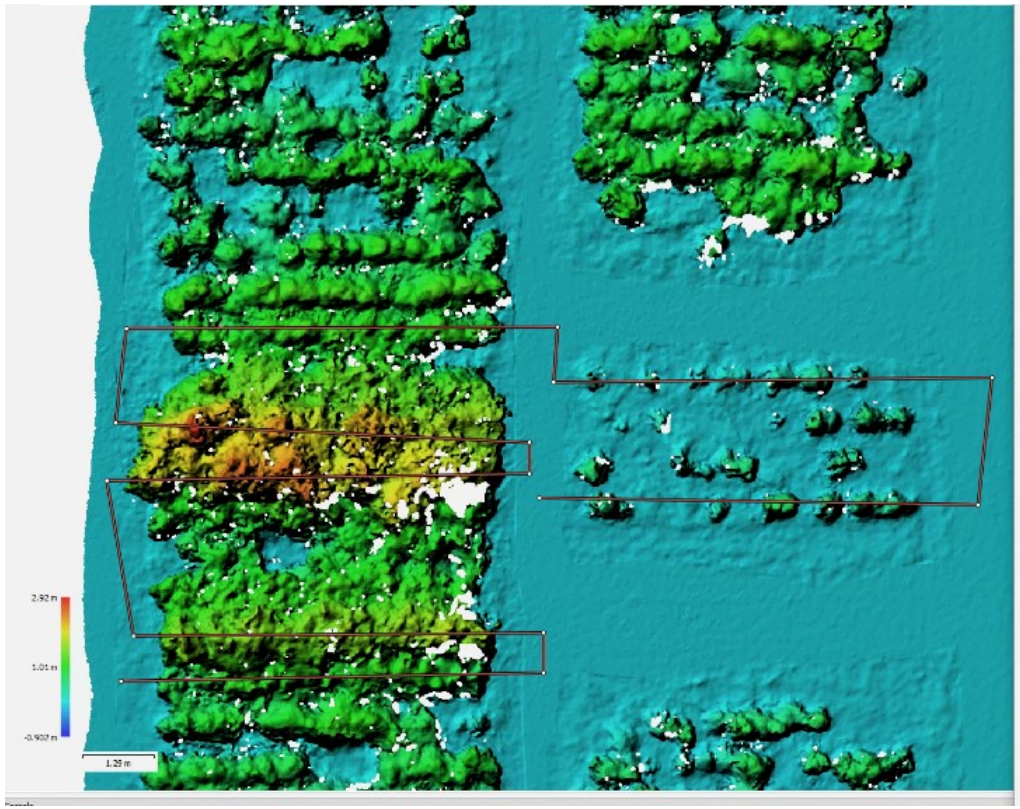
Units in Square cm	Average	Median	Range	% of Plant	Low	High	Total Flower	Total Plant
Flower Head	556.3765	579.485	1118.27	14.6	122.97	1241.24	82343.72	563954.0473

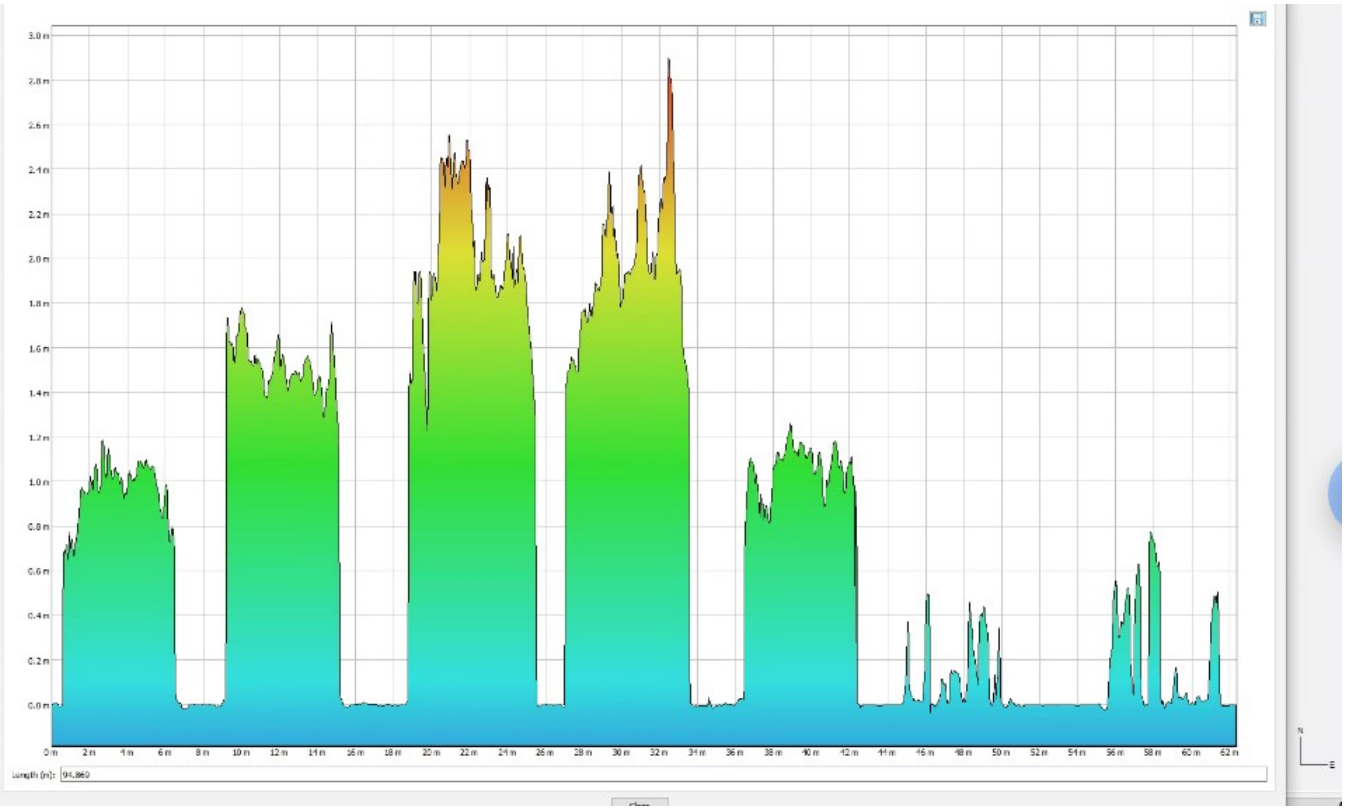




Plant Height

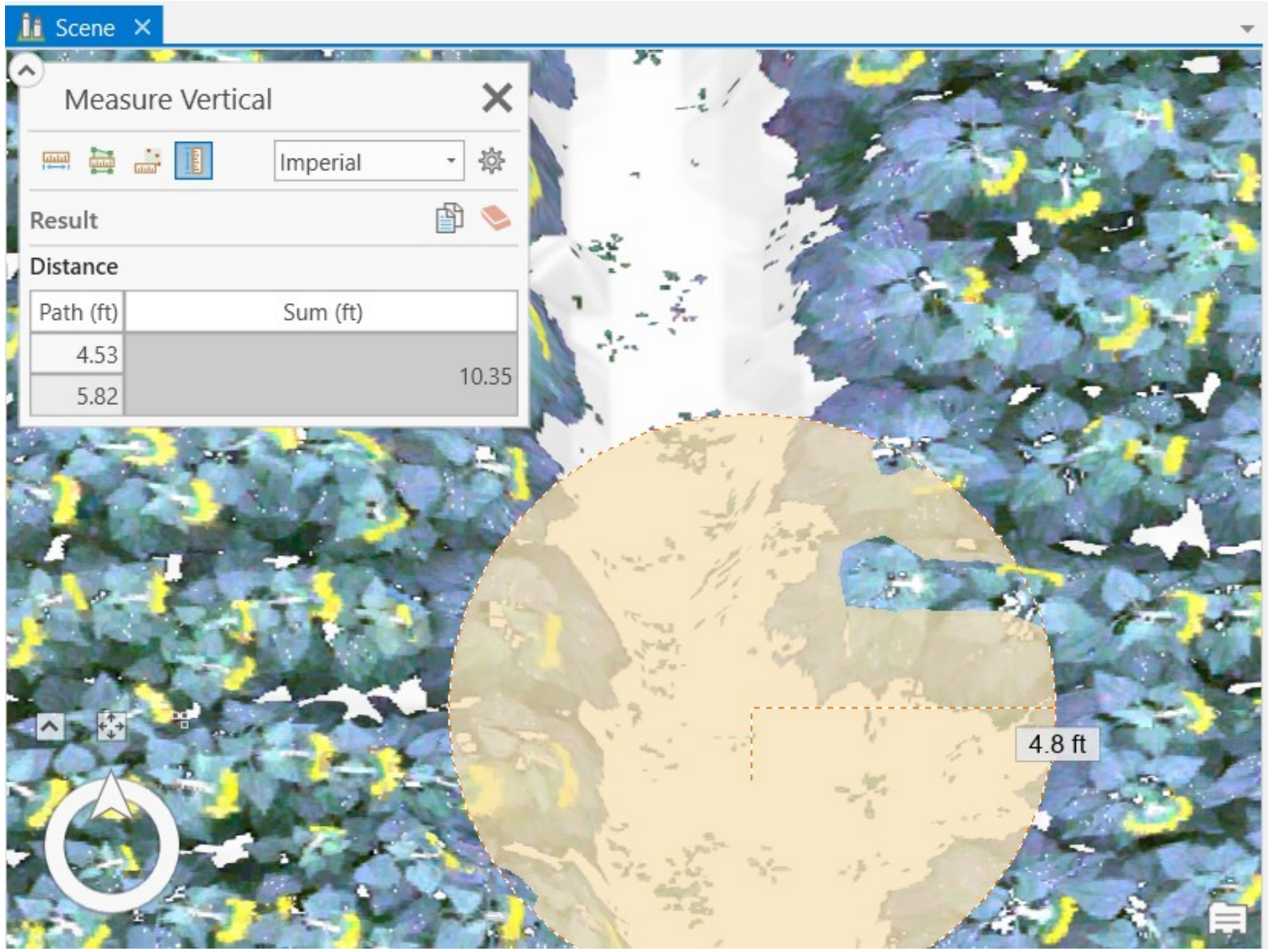
- Agisoft’s Metashape

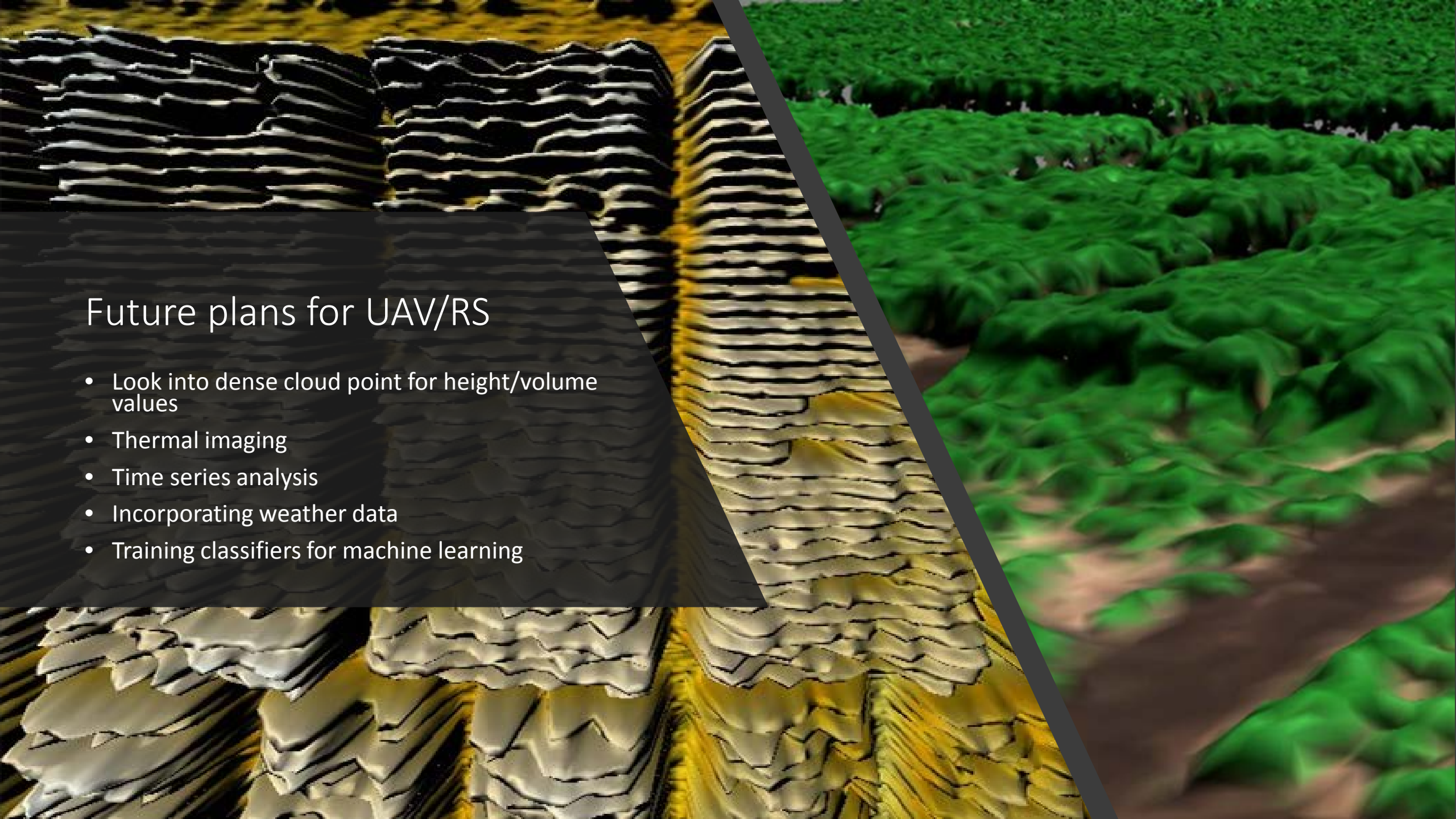




Cont.

- ESRI’s ArcGIS Pro/scene





Future plans for UAV/RS

- Look into dense cloud point for height/volume values
- Thermal imaging
- Time series analysis
- Incorporating weather data
- Training classifiers for machine learning

Thanks to the Hulke lab's crew and to the National Sunflower Association

Brent Hulke

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Brady Koehler

Mike Grove

Brian Smart

Mike DeGreef

Cameron Poyd

Jaime Paterson

Adam Wronski