



TEXAS A&M UNIVERSITY
College of Agriculture
& Life Sciences

TEXAS A&M
AGRILIFE
RESEARCH

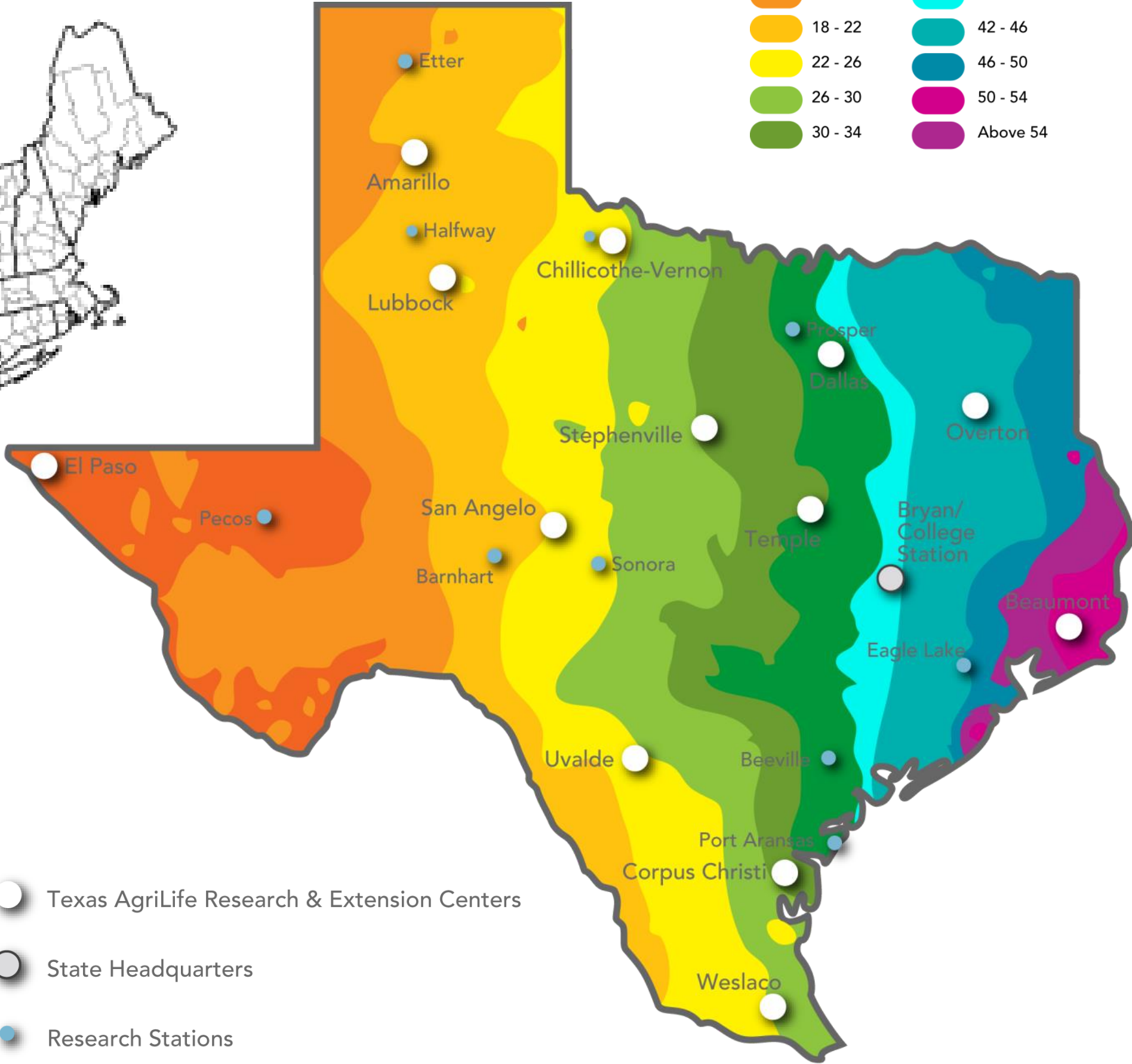
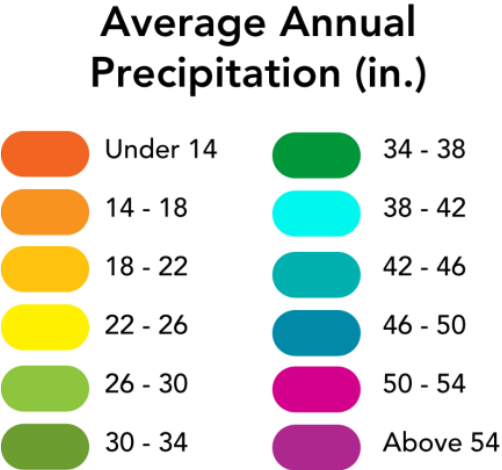
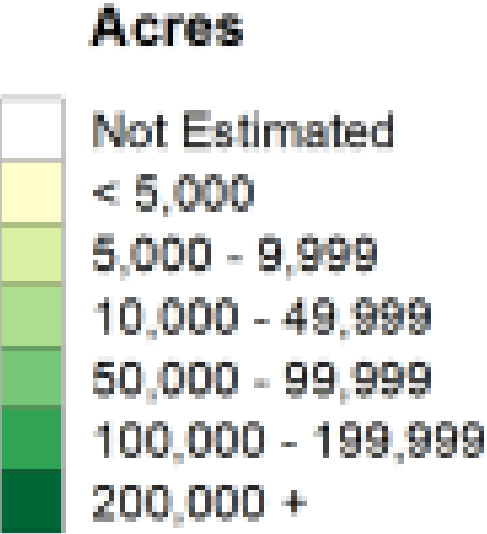
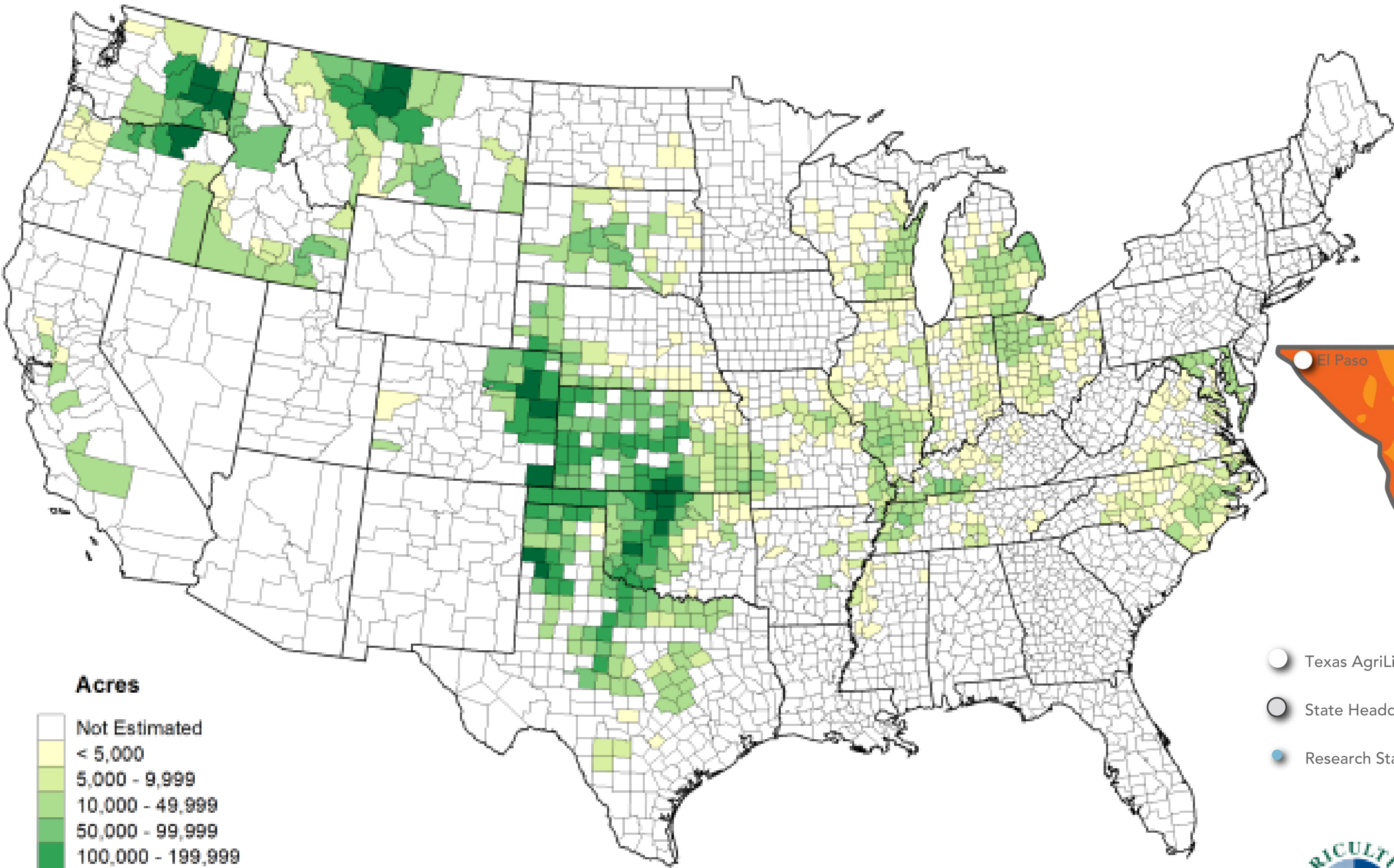
TEXAS A&M AGRILIFE

Six Years of Wheat UAS Phenotyping

→ Shannon Baker, Jackie Rudd, Jinha Jung,
Amir Ibrahim, Brent Auvermann, Shuyu
Liu, Juan Landivar, Mahendra Bhandari,
Jose Landivar Scott, Russ Garretson,
Kylie Diaz



Winter Wheat 2021
Planted Acres by County
for Selected States

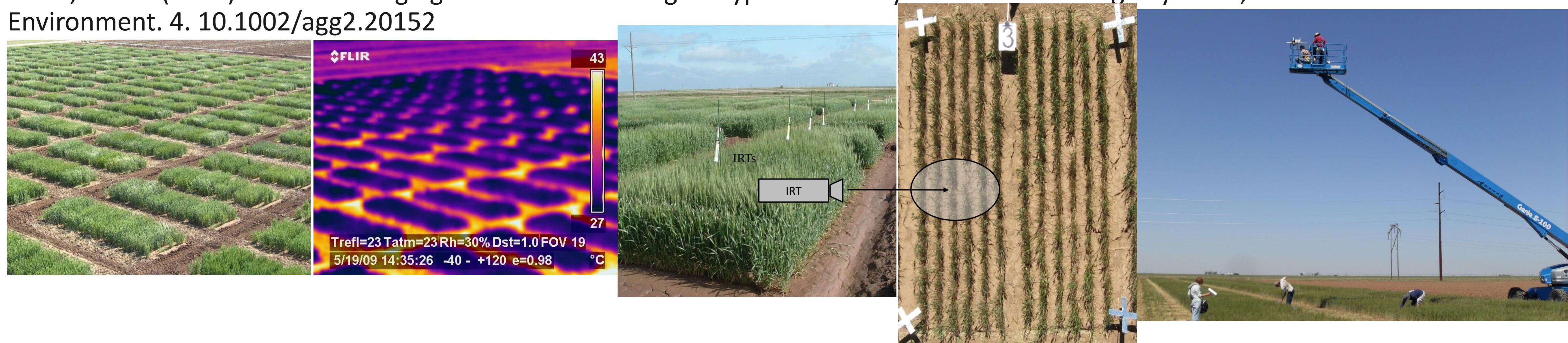


- Texas AgriLife Research & Extension Centers
- State Headquarters
- Research Stations



Evolution of our Field Phenotyping

Bhandari, Mahendra & Xue, Qingwu & Liu, Shuyu & Stewart, B. & Rudd, Jackie & Pokhrel, Pramod & Blaser, Brock & Jessup, Kirk & Baker, Jason. (2021). Thermal imaging to evaluate wheat genotypes under dryland conditions. *Agrosystems, Geosciences & Environment*. 4. 10.1002/agg2.20152



Sushil Thapa, Jackie C. Rudd, Qingwu Xue, Mahendra Bhandari, Srirama K. Reddy, Kirk E. Jessup, Shuyu Liu, Ravindra N. Devkota, Jason Baker & Shannon Baker (2019): Use of NDVI for characterizing winter wheat response to water stress in a semi-arid environment, *Journal of Crop Improvement*, 10.1080/15427528.2019.1648348

Olanrewaju, Sarah & Rajan, Nithya & Ibrahim, Amir & Rudd, Jackie & Liu, Shuyu & Sui, Ruixiu & Jessup, Kirk & Xue, Qingwu. (2019). Using aerial imagery and digital photography to monitor growth and yield in winter wheat. *International Journal of Remote Sensing*. 40. 1-25. 10.1080/01431161.2019.1597303



Evolution Continues

DJI M100

Multispectral – SlantRange 3P



DJI Matrice 300 RTK

RGB: ZenmuseP1 (35 mm)

Multispectral

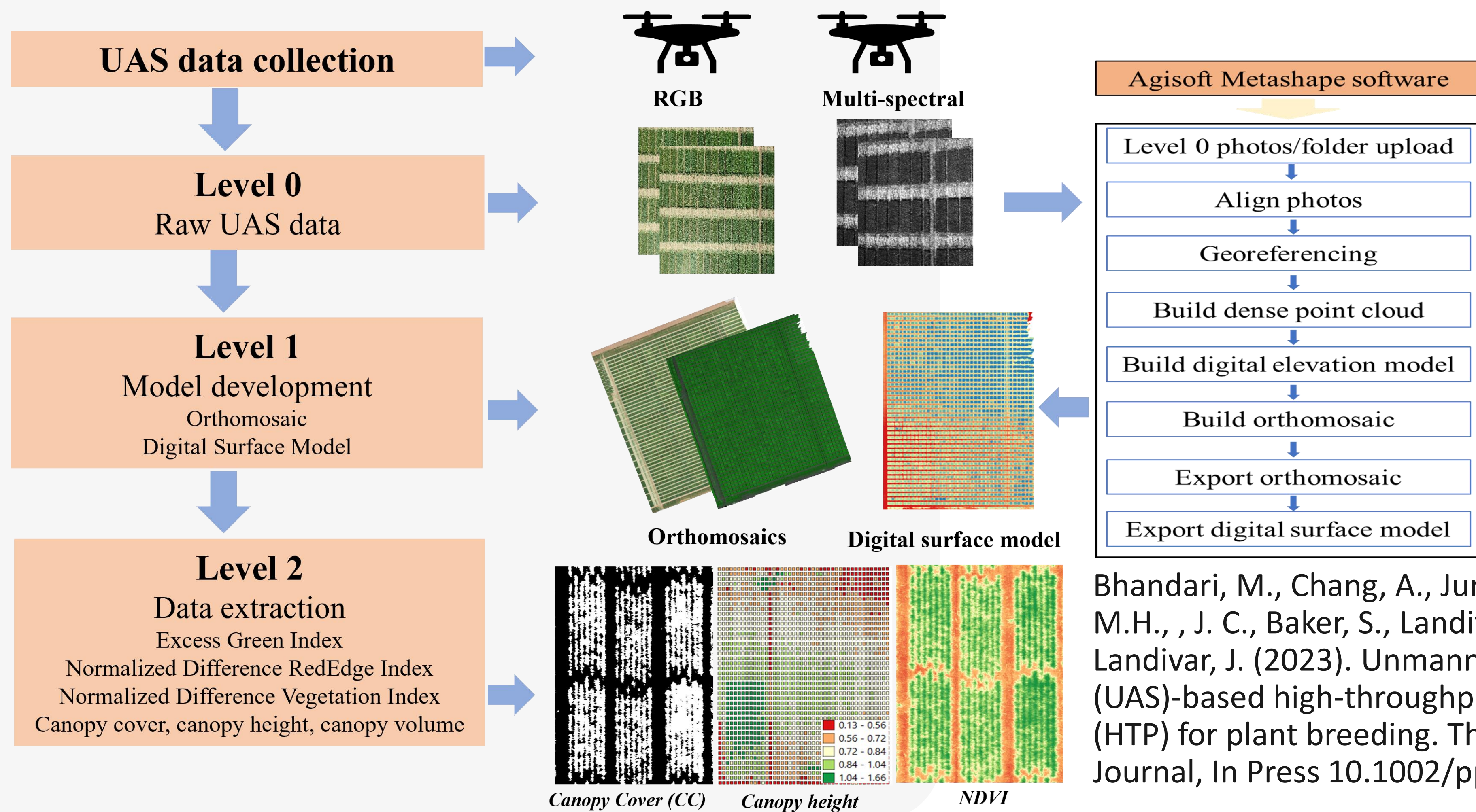
MicaSense AltumPT



TEXAS A&M UNIVERSITY
College of Agriculture
& Life Sciences

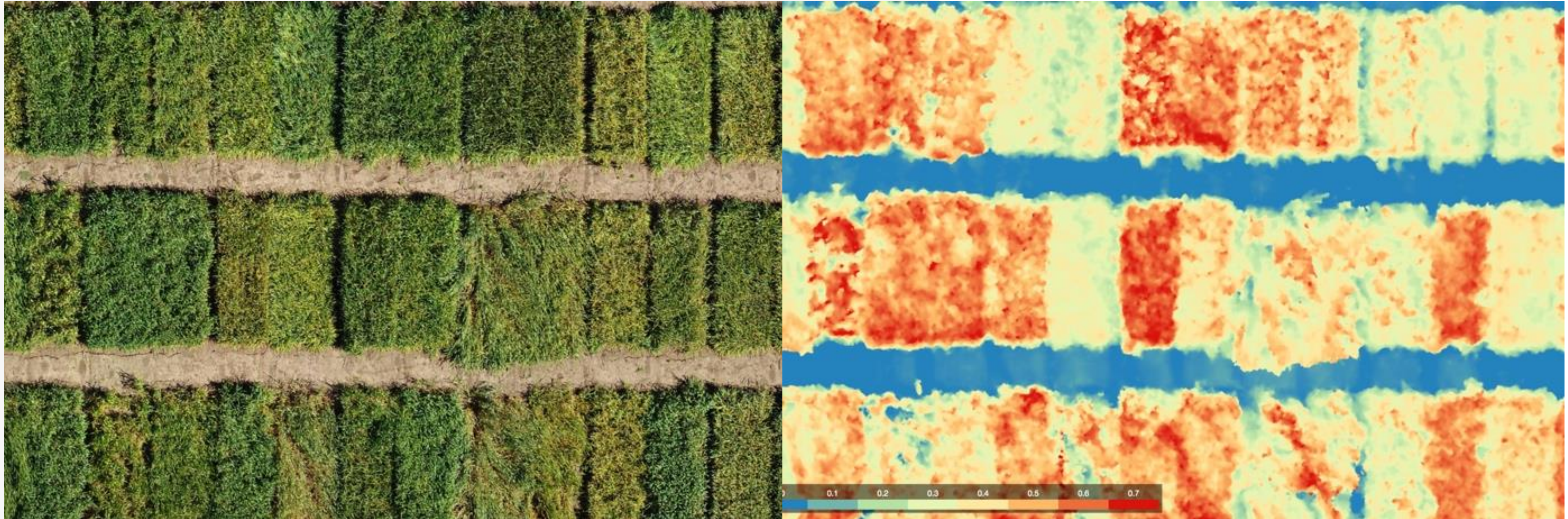
TEXAS A&M
AGRI LIFE
RESEARCH

UAS Processing Pipeline

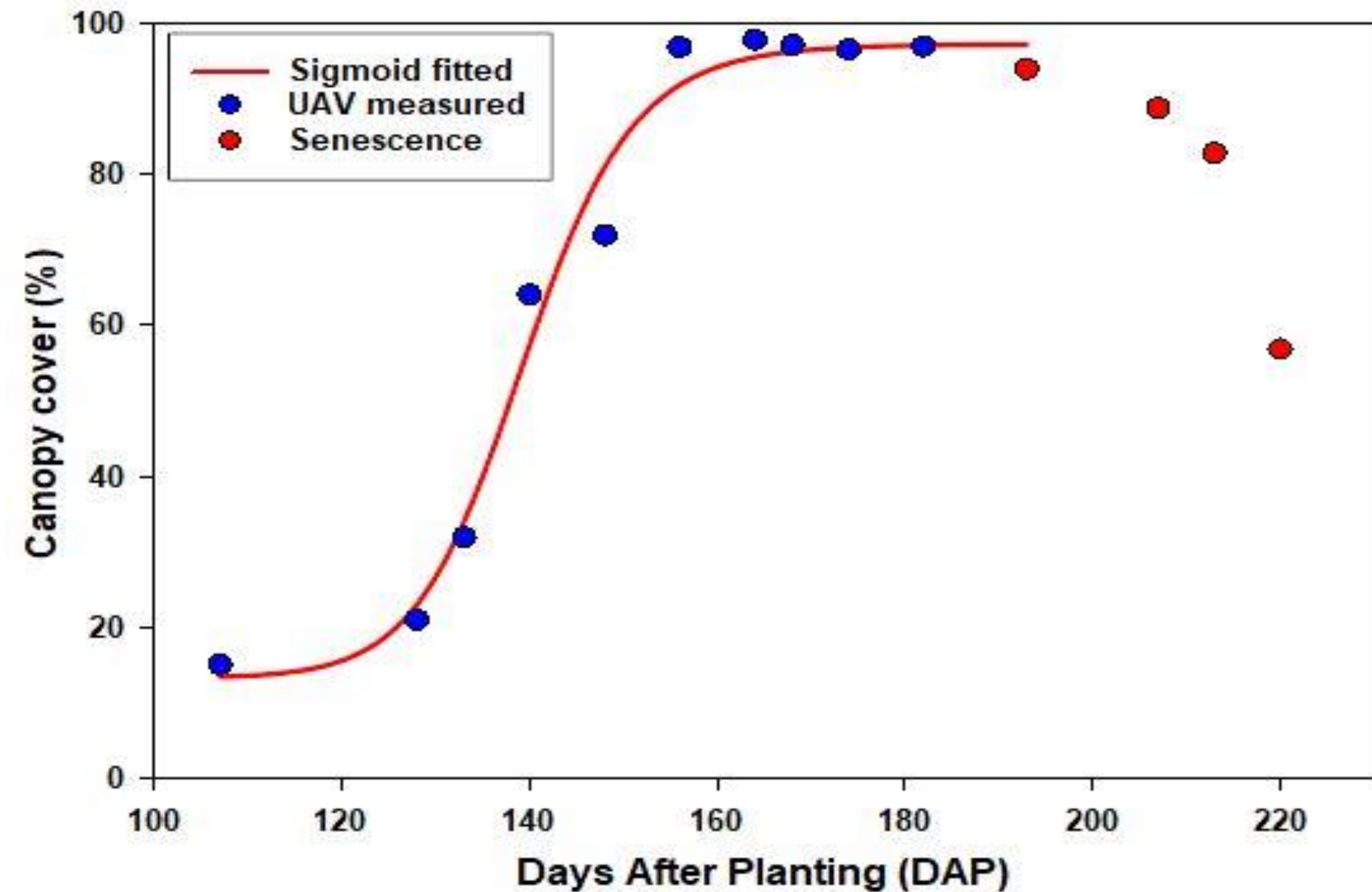
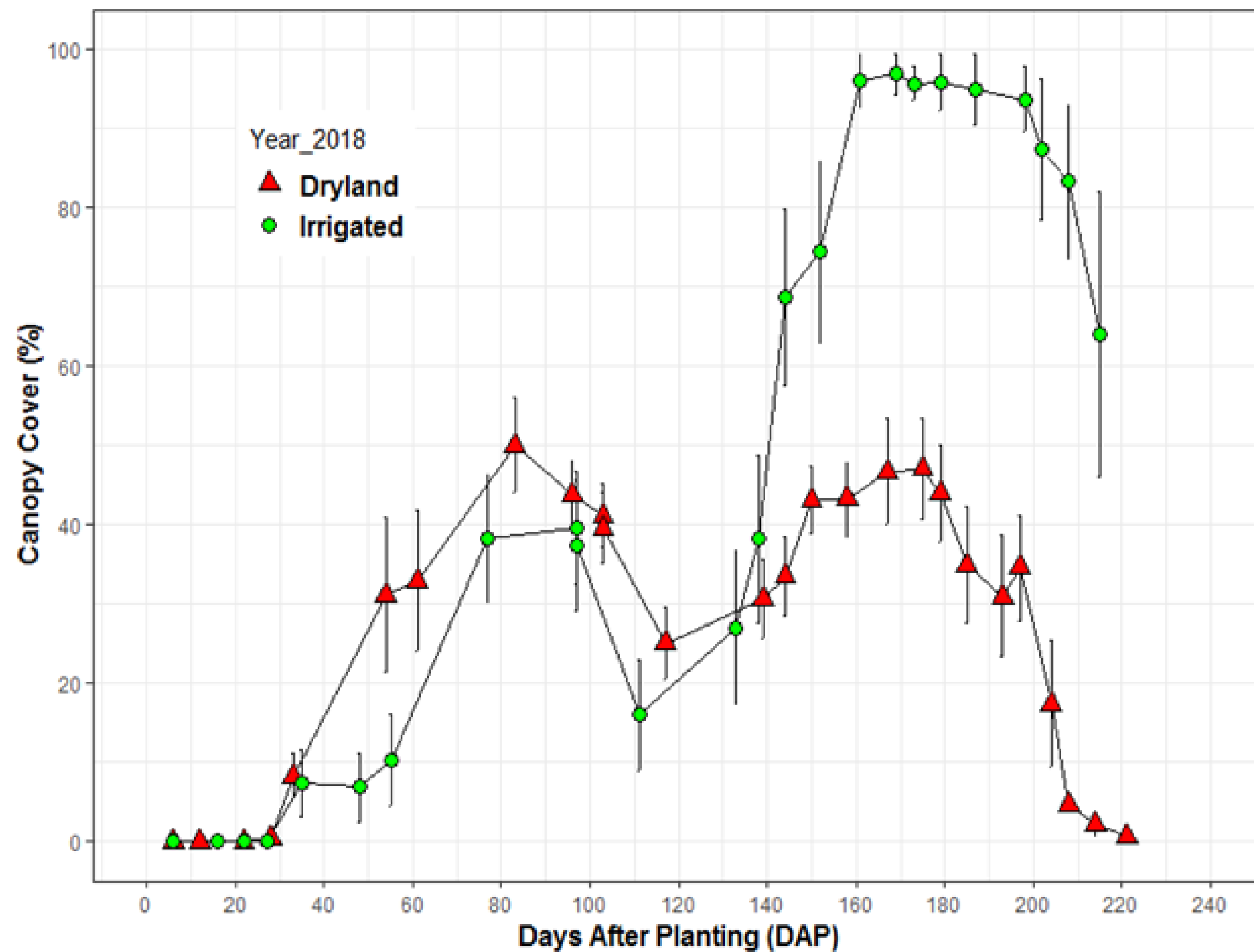


Bhandari, M., Chang, A., Jung, J., Ibrahim, A. M.H., , J. C., Baker, S., Landivar, J., Liu, S., & Landivar, J. (2023). Unmanned aerial system (UAS)-based high-throughput phenotyping (HTP) for plant breeding. The Plant Phenome Journal, In Press 10.1002/ppj2.20058

RGB: Estimating Canopy Height

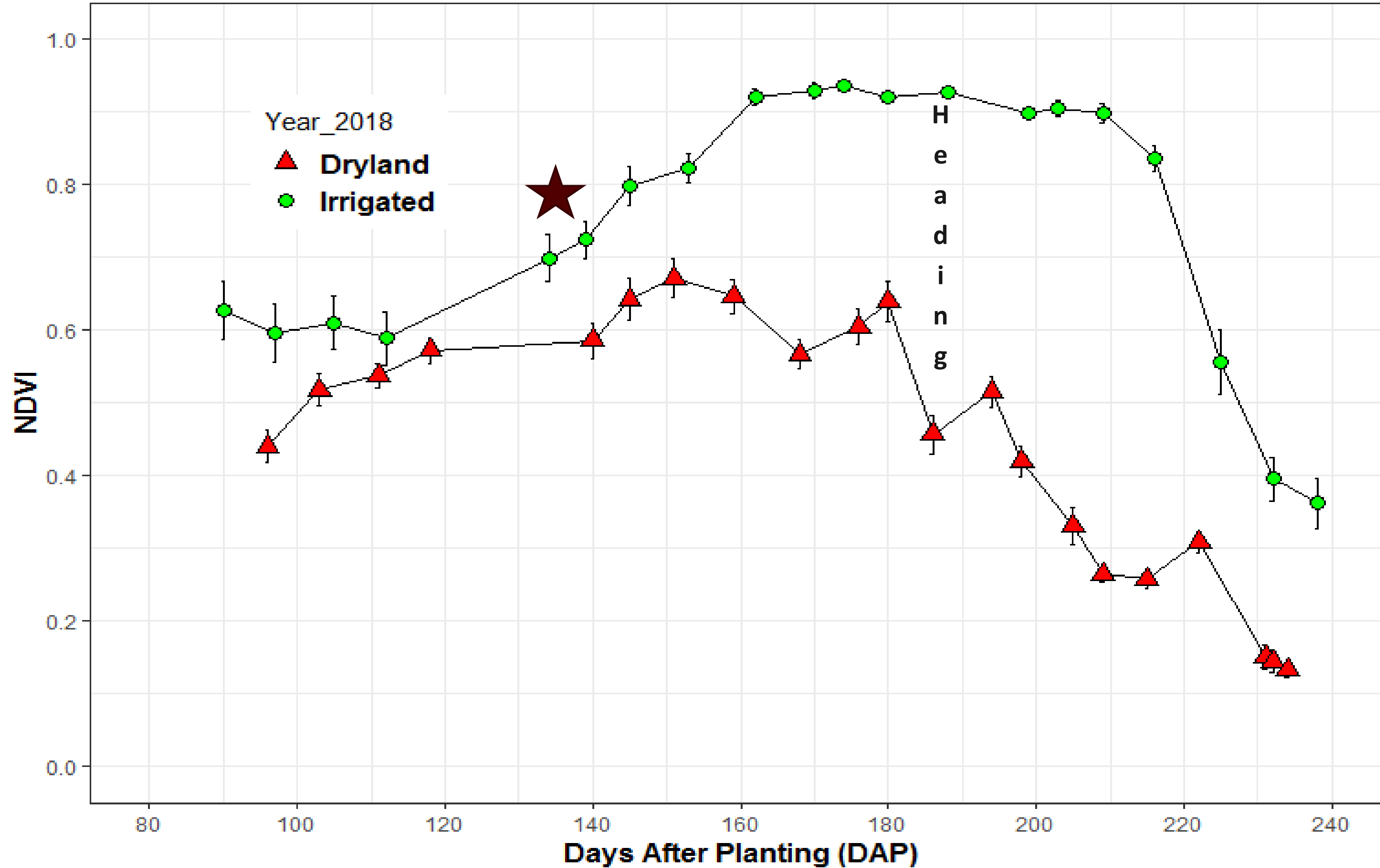


RGB: Canopy Cover Growth Curves



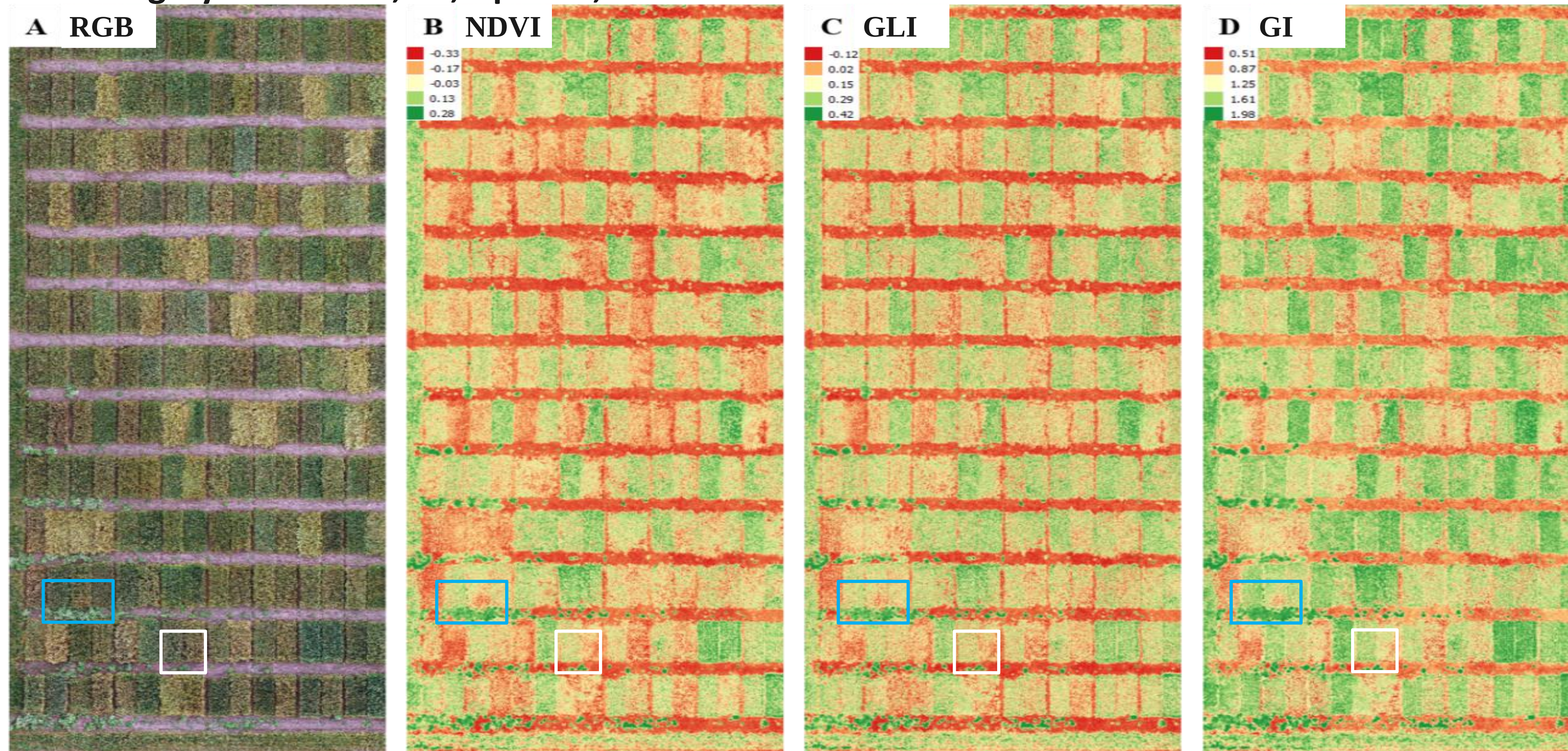
Bhandari, M.; Baker, S.; Rudd, J.C.; Ibrahim, A.M.H.; Chang, A.; Xue, Q.; Jung, J.; Landivar, J.; Auvermann, B. Assessing the Effect of Drought on Winter Wheat Growth Using Unmanned Aerial System (UAS)-Based Phenotyping. Remote Sens. 2021,13, 1144. 10.3390/rs13061144.

Multispectral: Vegetative Indices



Multispectral: Vegetative Indices

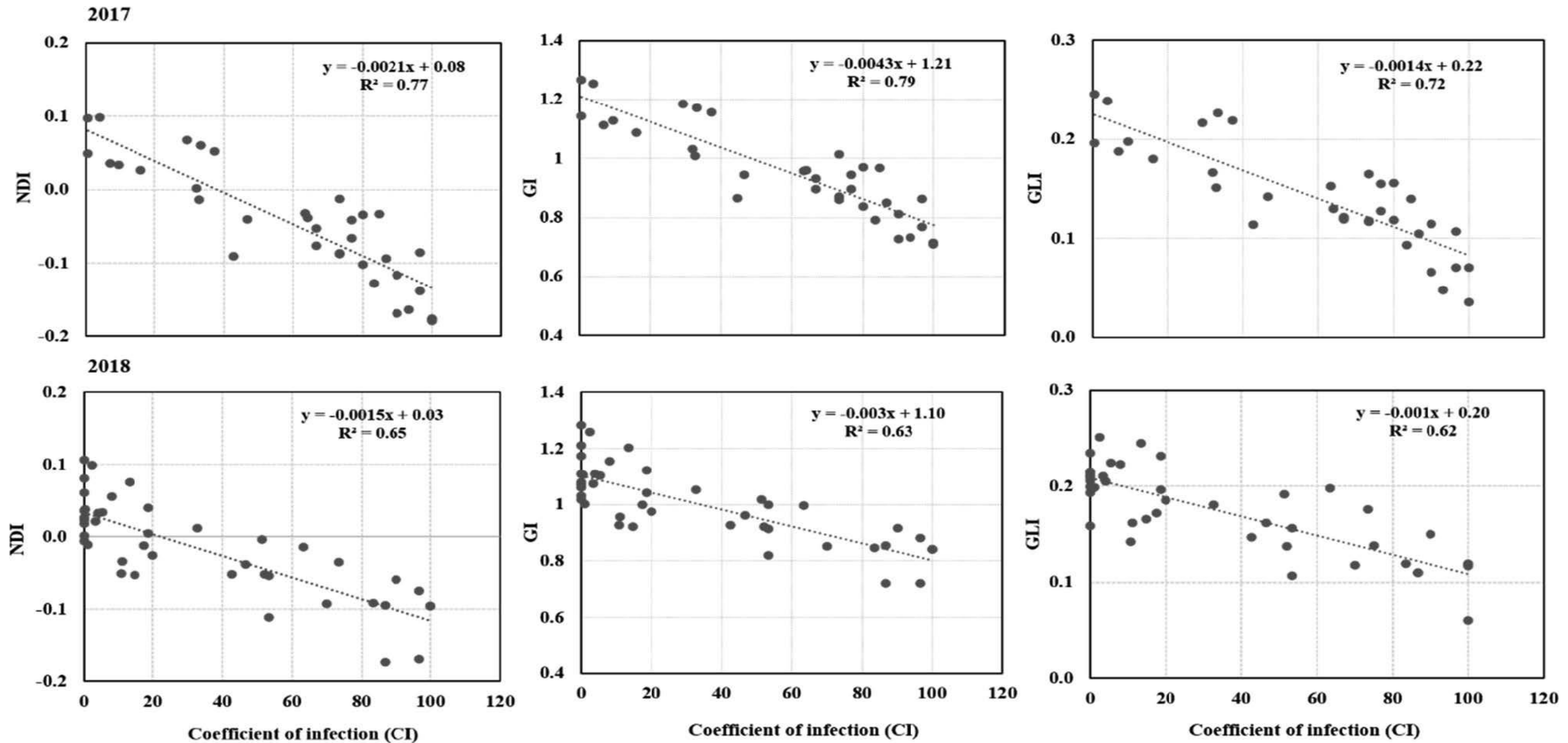
UAS Imagery Castroville, TX, April 14, 2017



Mahendra Bhandari, Amir M.H. Ibrahim, Qingwu Xue, Jinha Jung, Anjin Chang, Jackie C. Rudd, Murilo Maeda, Nithya Rajan, Haly Neely, Juan Landivar (2020): Assessing winter wheat foliage disease severity using aerial imagery acquired from small Unmanned Aerial Vehicle (UAV), Computers and Electronics in Agriculture, DOI: 10.1016/j.compag.2020.105665

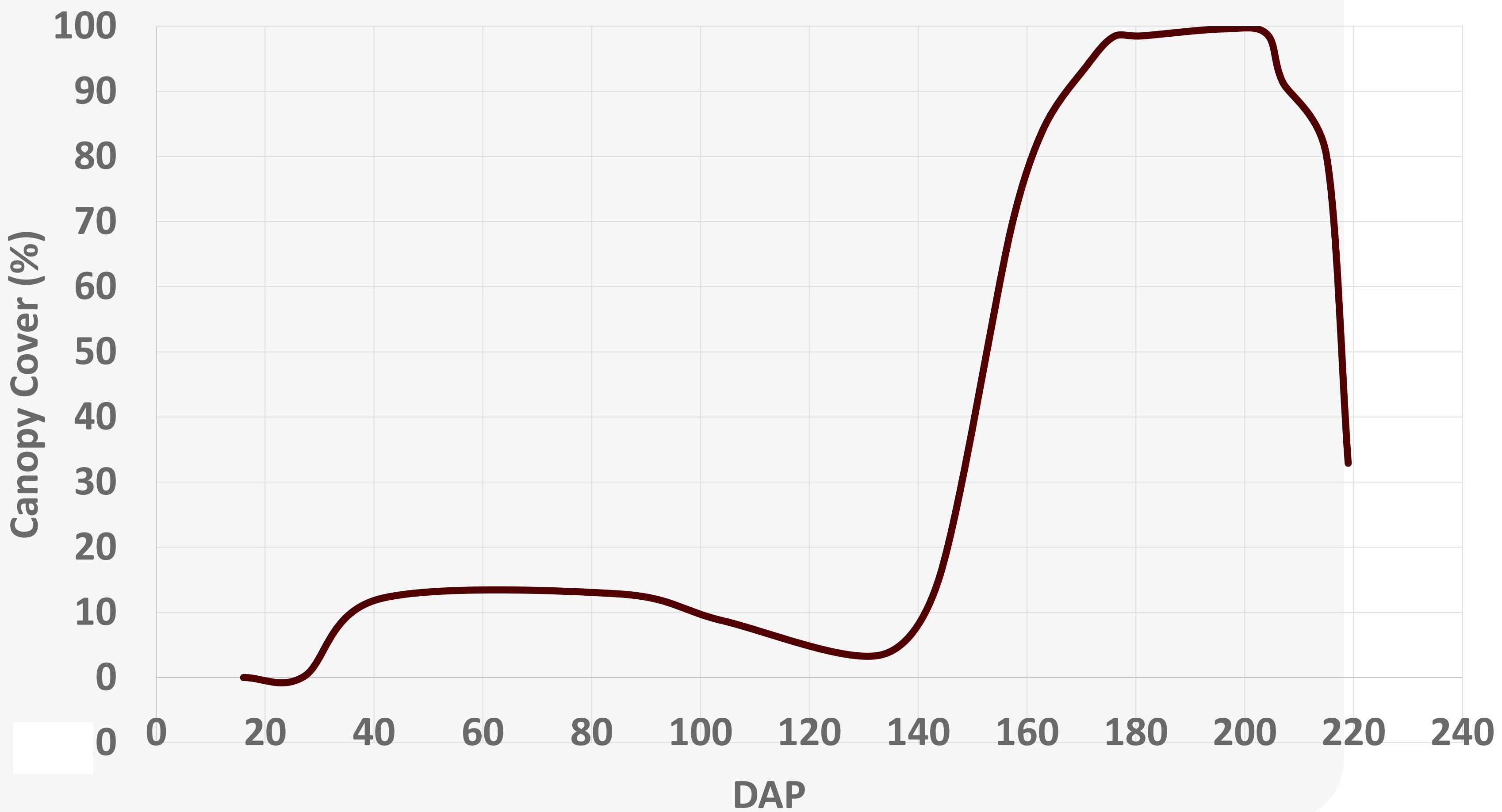
Multispectral: Vegetative Indices

Correlations between vegetation indices and coefficient of infection (CI)



Normalized Difference Index (NDI), Green Leaf Index (GLI), and Green Index (GI)

2022 Canopy Cover



Flow diagram of TAM Wheat Breeding

Year	Where / trial name	Generation	Entries	Reps	Locations
Year 1	Greenhouse Crossing Block		2000		
Year 2	Greenhouse rows	F ₁	2000		
Year 3	Field plots	F ₂	2000		
Year 4	Field plots	F ₃	1600	1	2
Year 5	Field plots	F ₄	1200	1	2
Year 6	Head-rows	F _{4:5}	90,000	1	2
Year 7	Preliminary yield trials	F _{4:6}	3000	1	2
Year 8	Year 1: Advanced yield trials	Advanced	700	2	5
Year 9	Year 2: Advanced yield trials	Advanced	200	2	7
Year 10	TXE		15	3	18
Year 11	SRPN, TXE, and increase		6	3	42
Year 12	SRPN, TXE, UVT, increase, and WQC		2	3	65
Year 13	Release		1		

What Have We Learned?

Successes

Canopy Height

NDVI

Visual Traits

Disease/insect damage

Challenges

Updated Equipment

Regulatory

Big data

Planting arrangement





What's Valuable?

- Stand establishment/early season vigor
- Winter survival or winterkill
- Spring greenup
- Biomass at anthesis
 - NDVI or CC% or ExG
 - Rate of senescence – growth curve
- Not making in-season decisions – yet
- Digital twin in event of severe weather/biotic stress
- Data processing is good, we are working on integrating it into the program



Contact Us

————→ **Shannon Baker**
shannon.baker@ag.tamu.edu

————→ **Mahendra Bhandari**
mahendra.bhandari@ag.tamu.edu

————→ **Amir Ibrahim**
aibrahim@tamu.edu

————→ **Jackie Rudd**
jcrudd@ag.tamu.edu