

Soil-water dynamics in semi-arid production systems

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19 December 2023

OSU Winter Crops School
Stillwater, OK

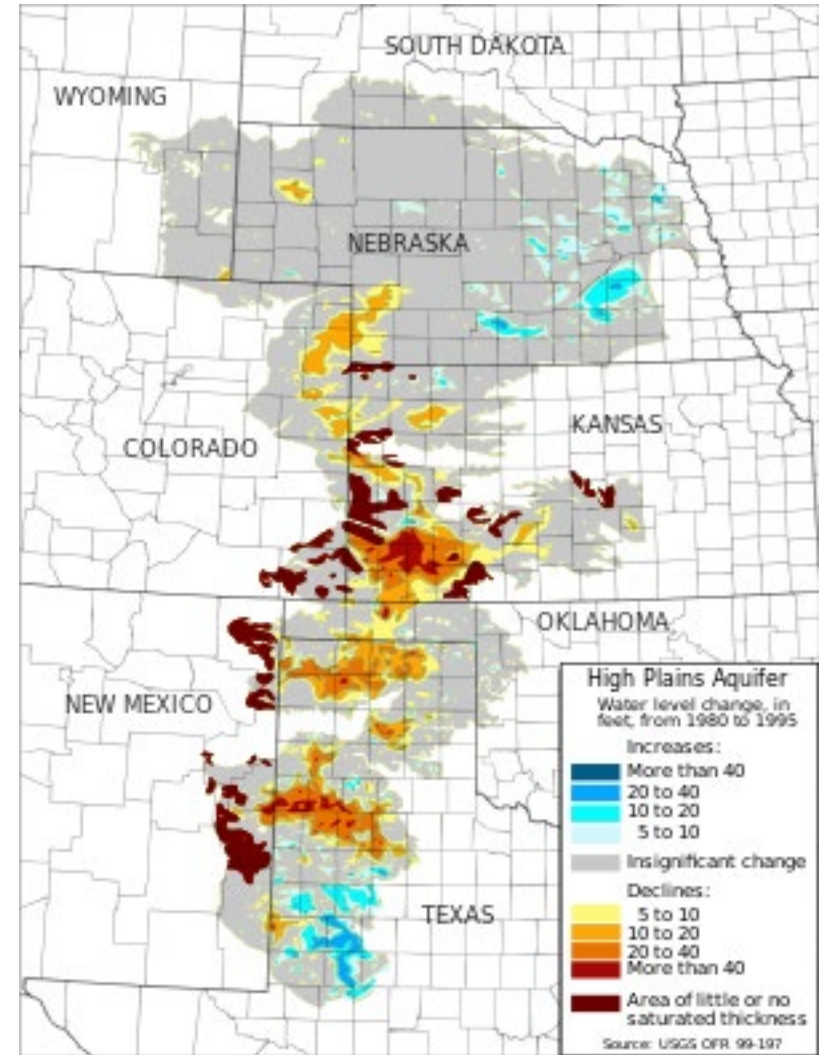
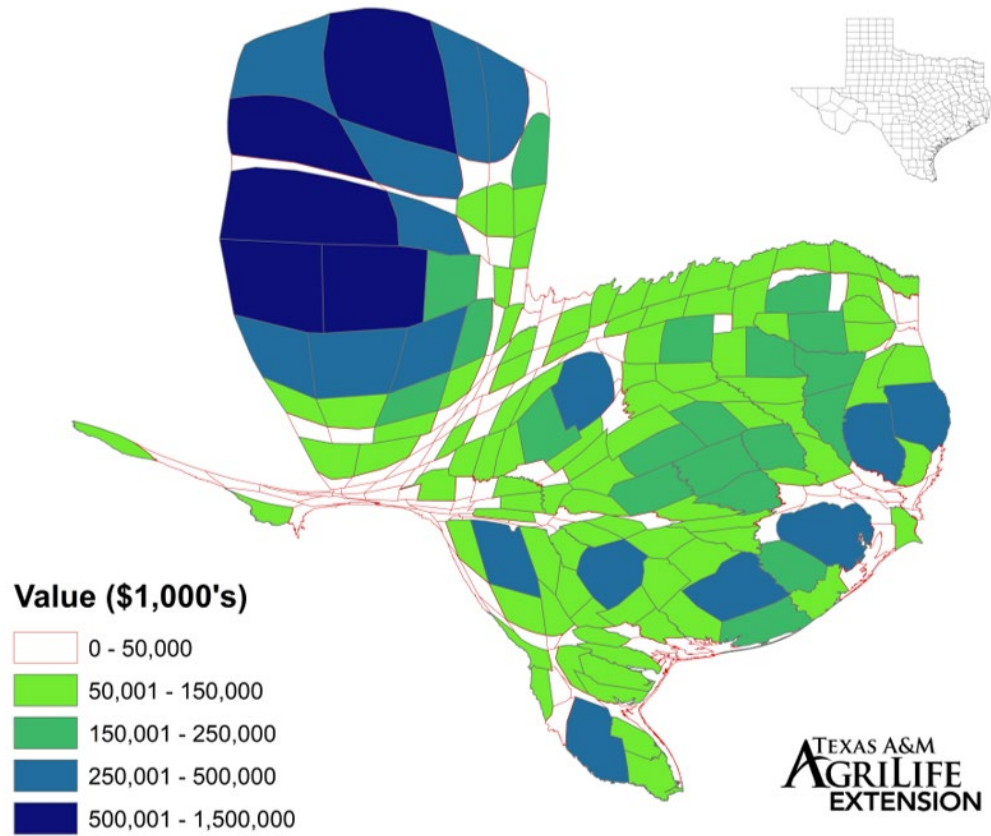
Regenerative agriculture on the High Plains

The continued capacity of agricultural systems to function in a changing climate that supports soil health, communities, economic output, environmental sustainability, and resilience to the outside threats of these outcomes.





Texas Agriculture


Value of Texas Agricultural Production, 2014




The Southern High Plains climate

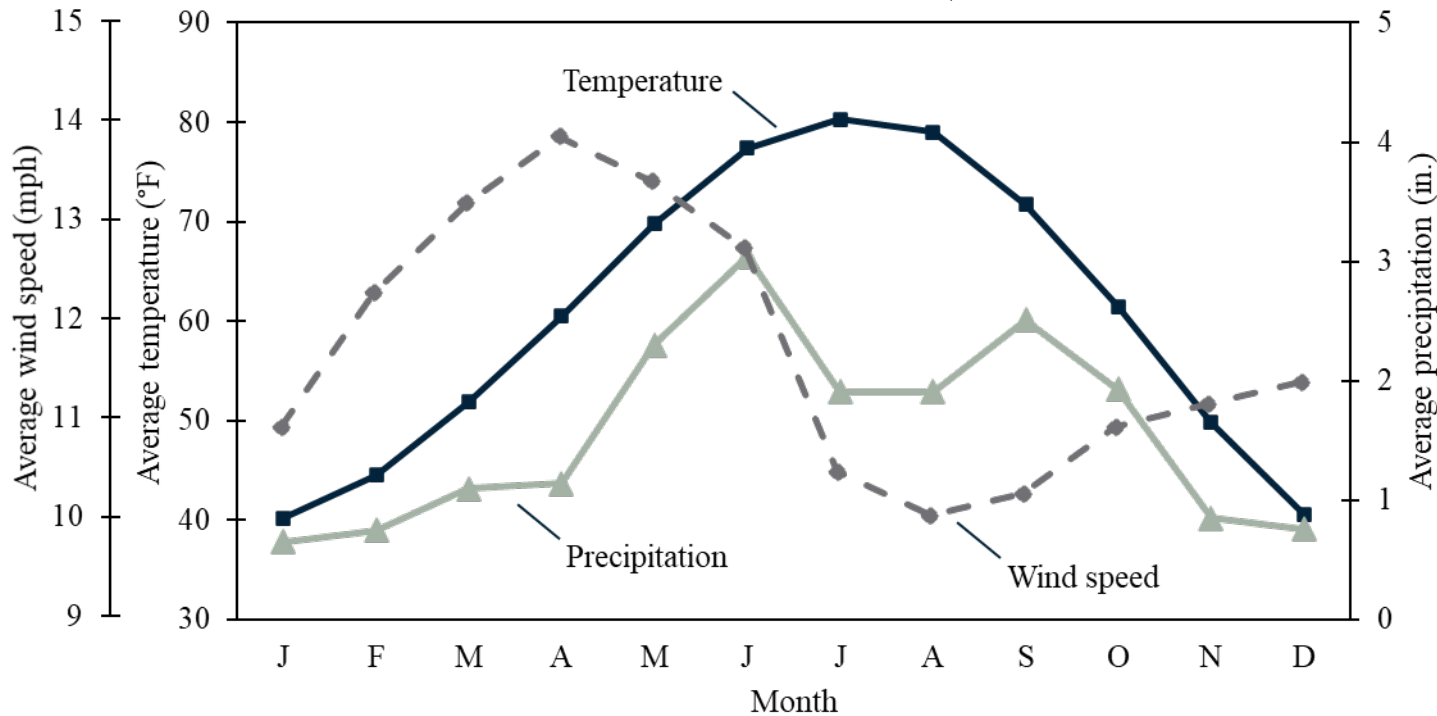
 55 – 63°F

 12.3 mph

 16 – 22 inches

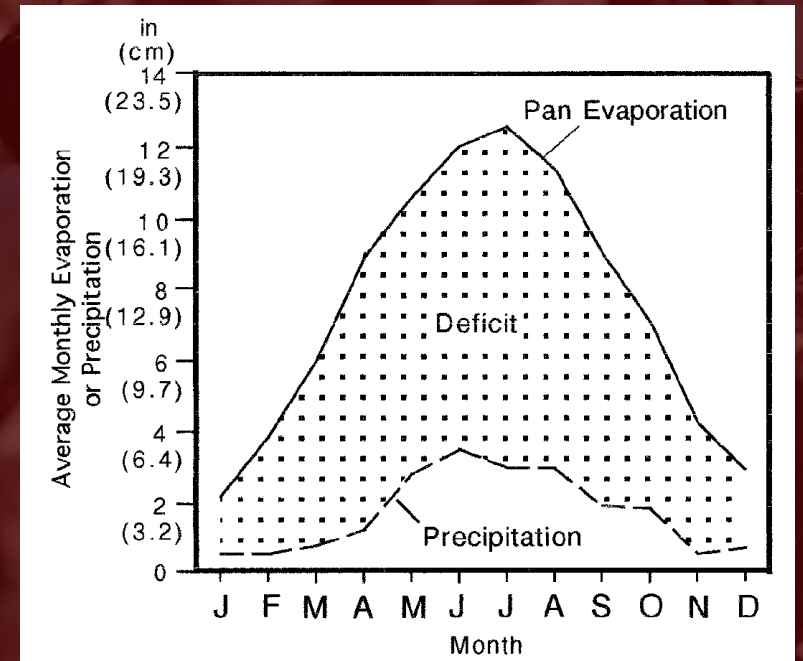
 195 – 255 days y⁻¹

Climate in Lamesa, TX



Potential evapotranspiration (PET)

- Average annual PET exceeds precipitation by 2-3 times



Gustovson and Holliday, 1999.
J. Sediment. Res. 69: 622-634.

Cotton agronomy timeline

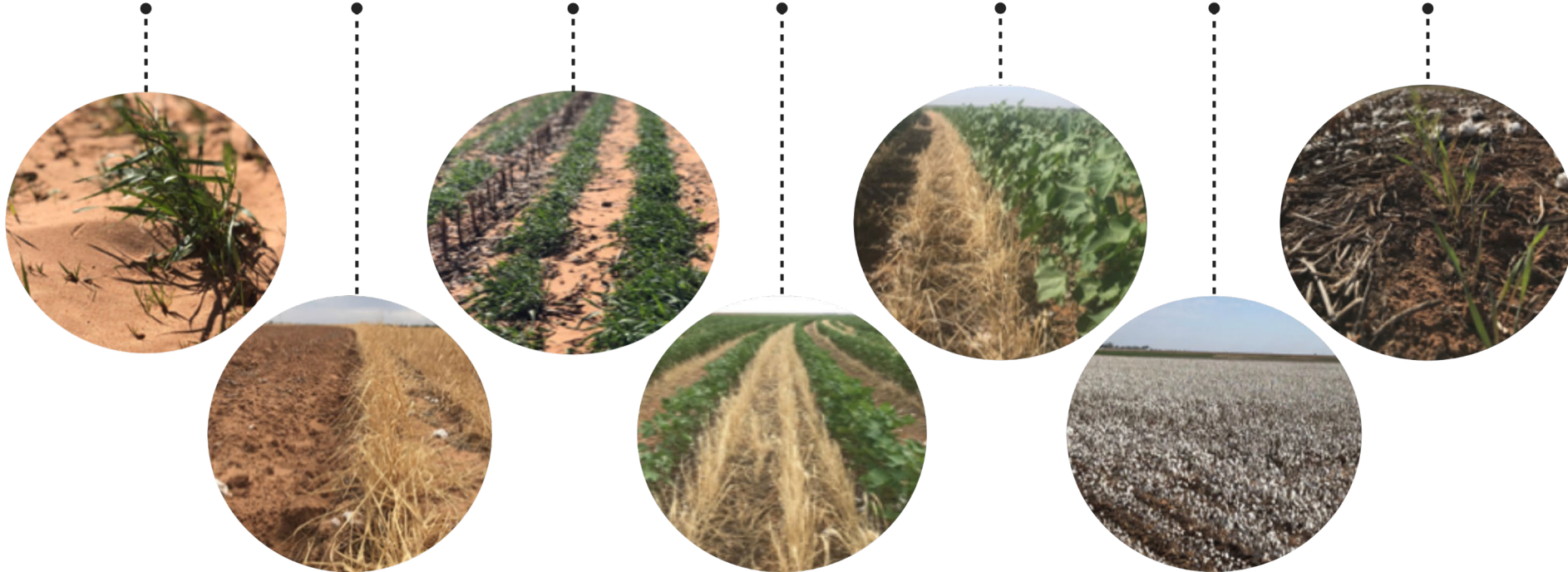
Months of the Year

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Traditional cotton agronomy timeline:



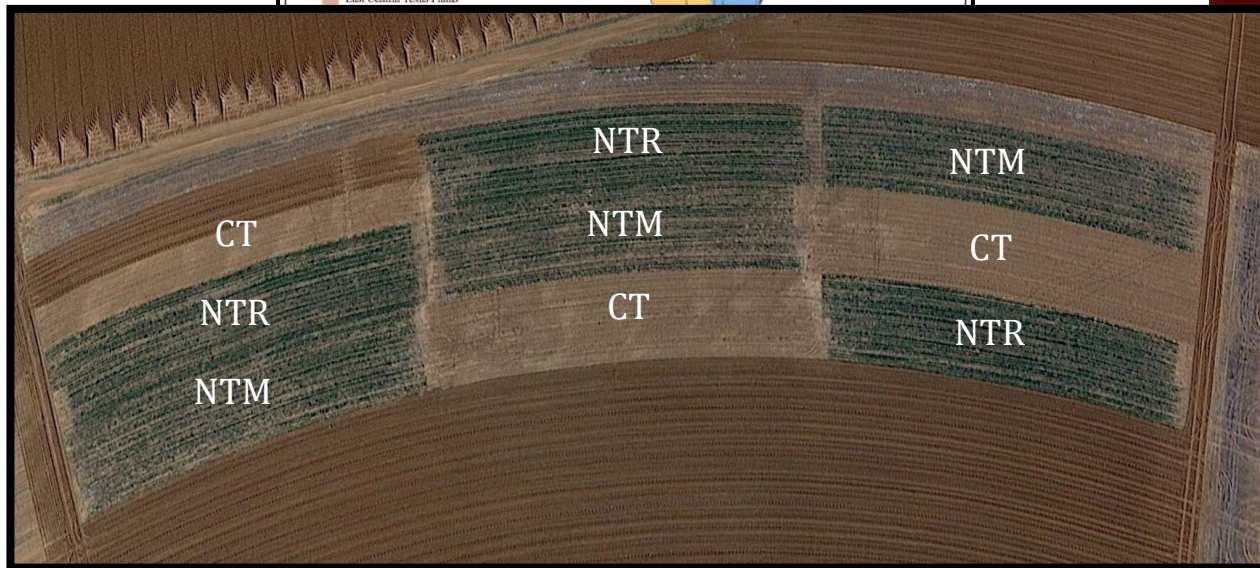
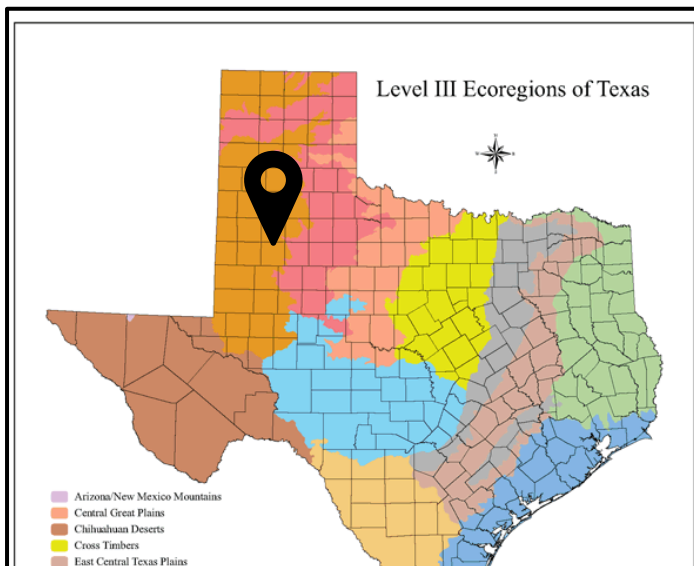
Conservation cotton agronomy timeline:



Strategies to capture and store moisture

- Practices that are perceived to reduce the capability of soils to capture rainfall or use stored soil moisture will hinder adoption
- Retain precipitation
 - Increase infiltration, water holding capacity, residue management
- Reduce evaporation
 - Keep soil covered
- Water-use efficient crops
- Fallow periods
- Cover crops?

Our long-term system



Evaluated systems

Continuous cotton systems – (est. 1998)

- Conventional tillage, winter fallow (CT)
- No-tillage, Rye cover (R-NT), 40 lb ac⁻¹
- No-tillage, Mixed cover (M-NT), 40 lb ac⁻¹
 - Rye (50%)
 - Austrian Winter Pea (33%)
 - Hairy Vetch (10%)
 - Radish (7%)
 - by weight
- Established in November 2014
- NRCS recommended mixture

Native Systems (NAT)

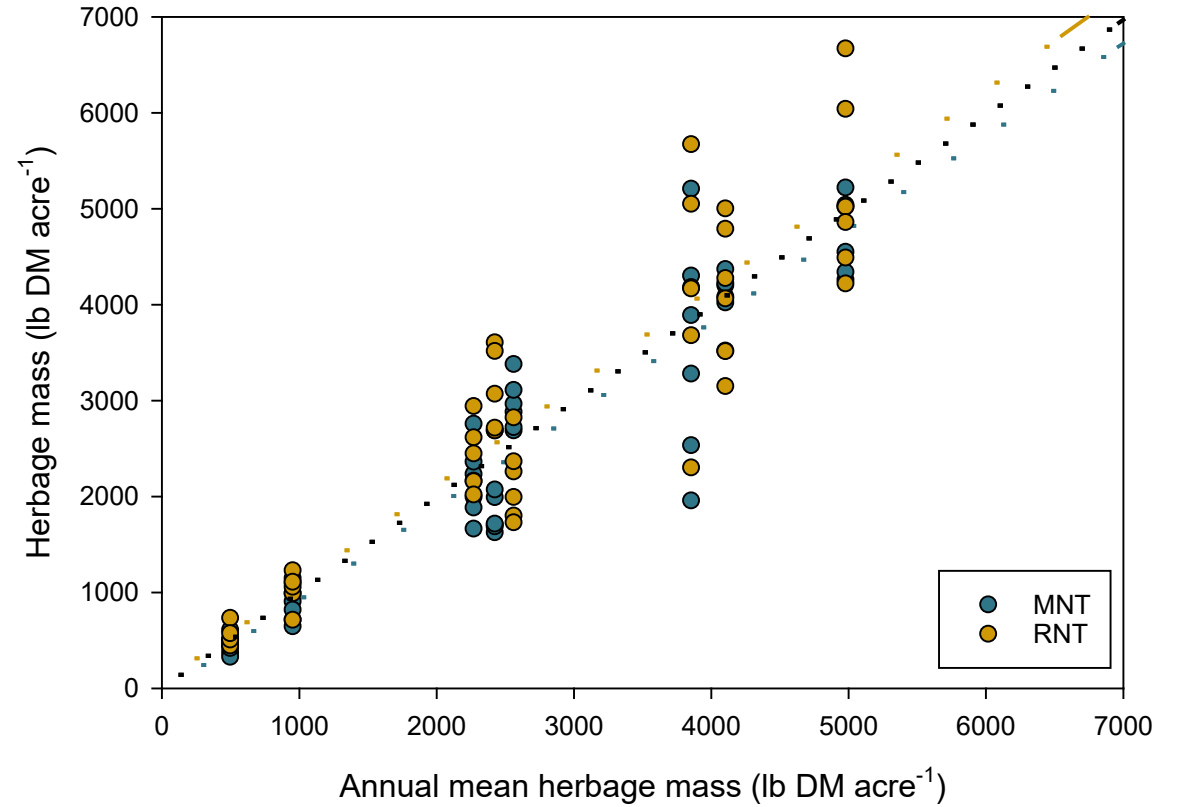
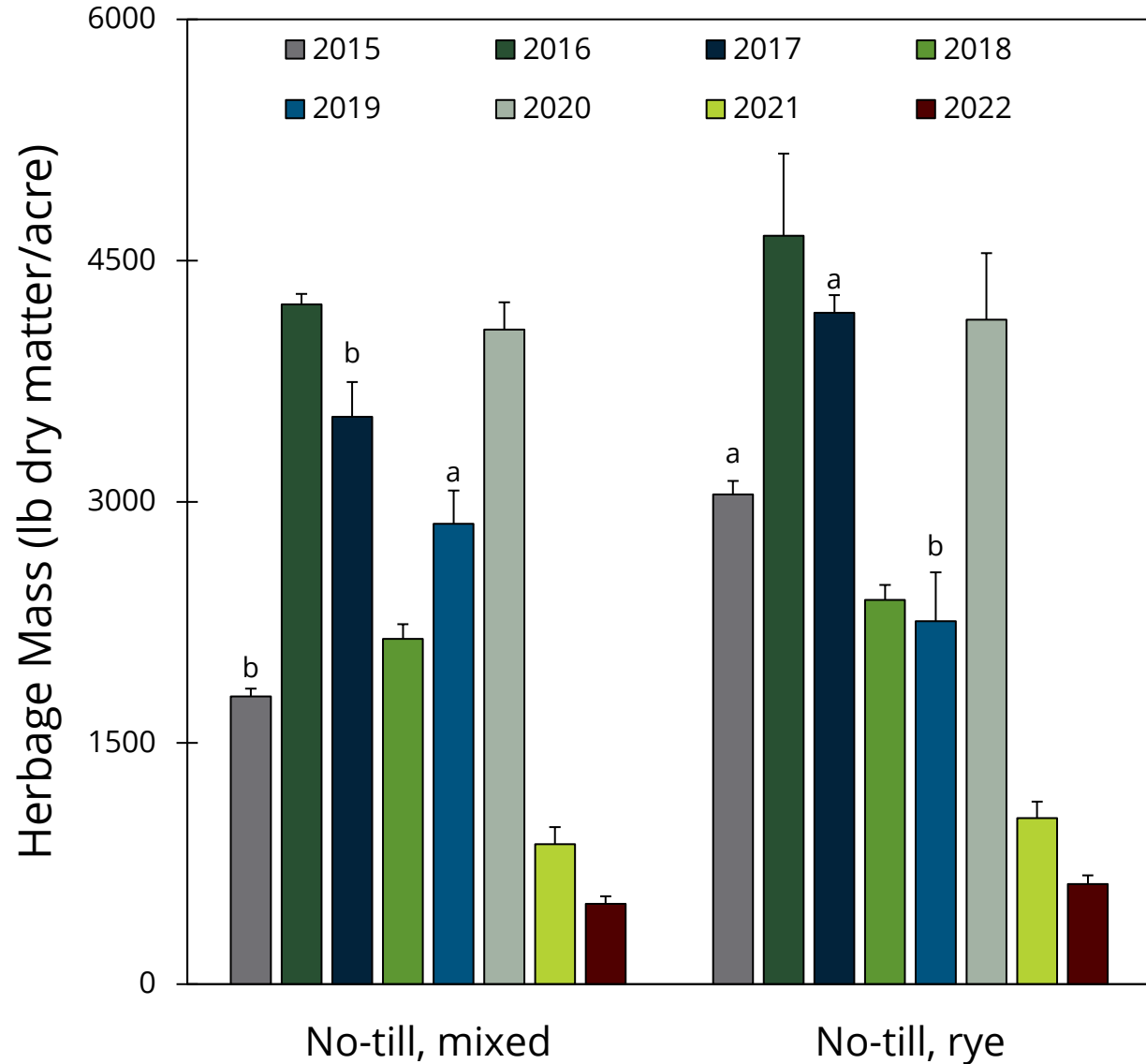
- Rangeland - historical record indicates it unplowed at least 80 years

RCBD with three replications

Plot Size (AG-CARES) – 16 rows by 200' long

Research plot design at Ag-CARES in Lamesa, TX

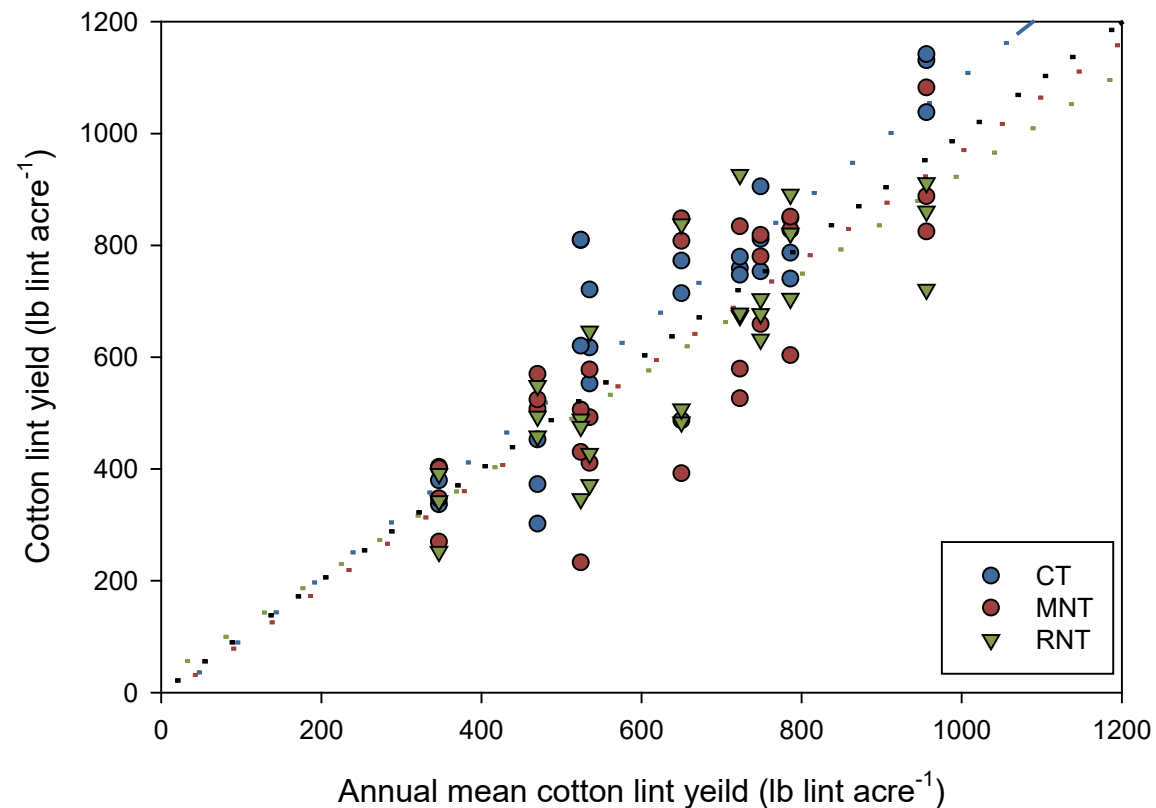
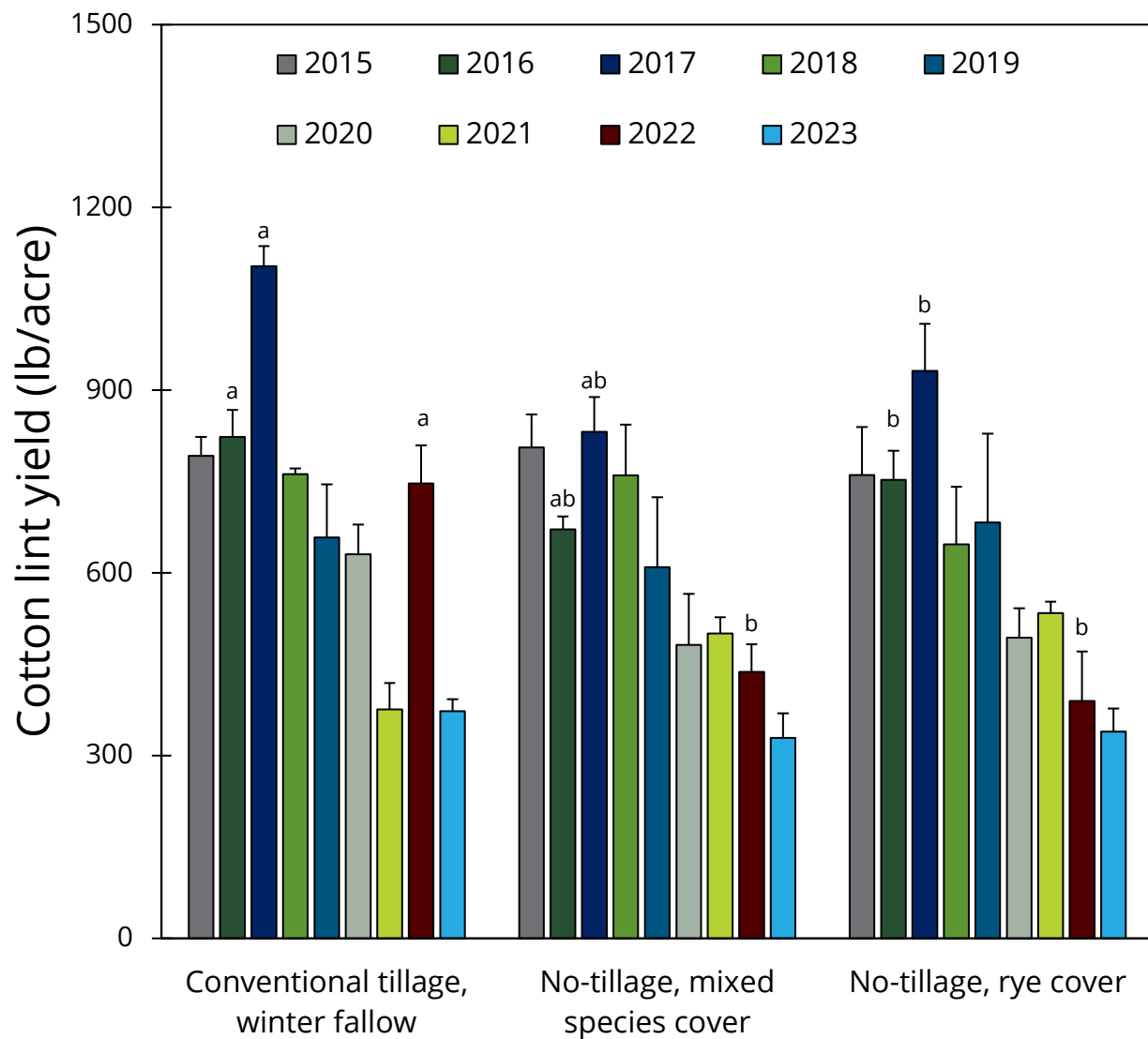
Herbage mass and stability



Treatment	$\hat{\beta}_1$	R ²
MNT	0.968	0.551
RNT	1.031	0.655

> 1, more stable; = 1, stable; < 1, less stable

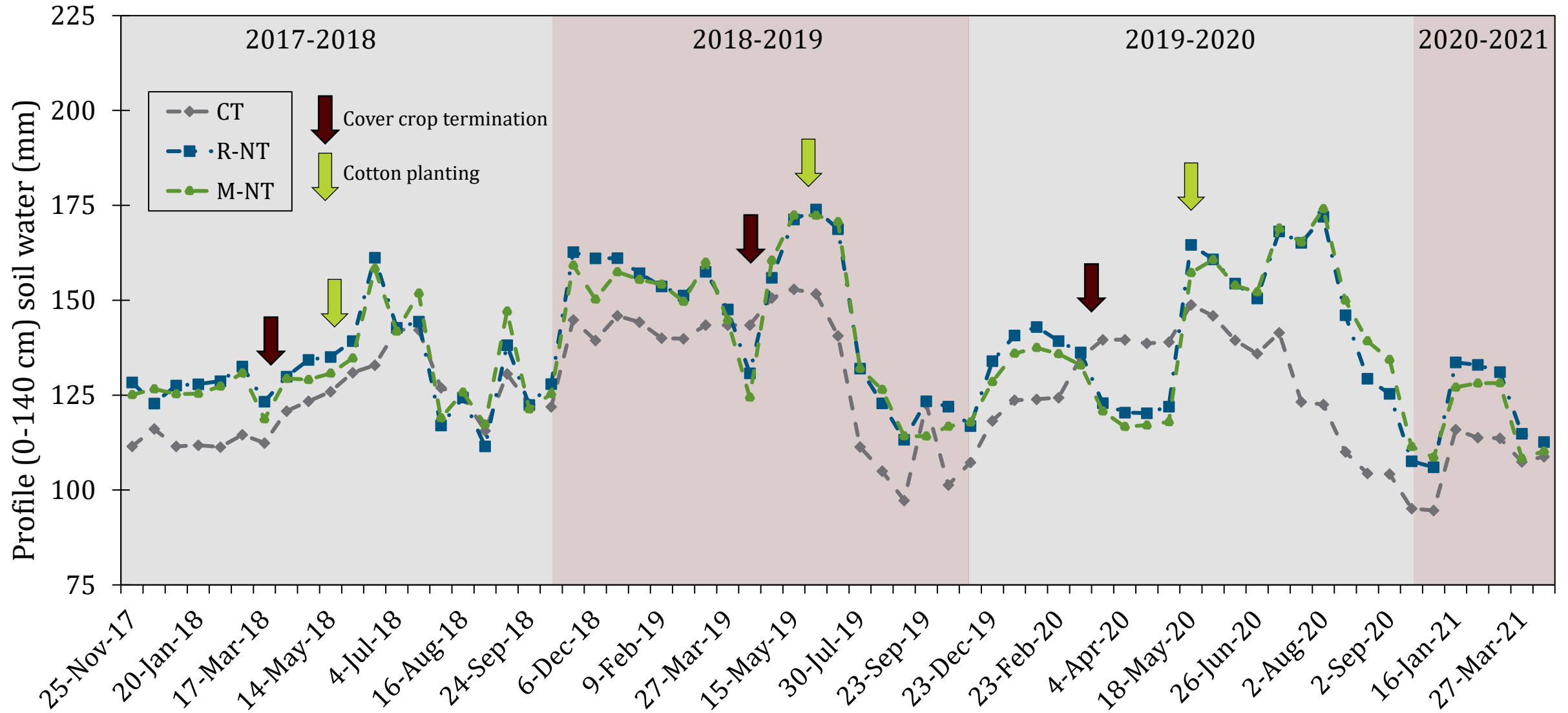
Yield and stability



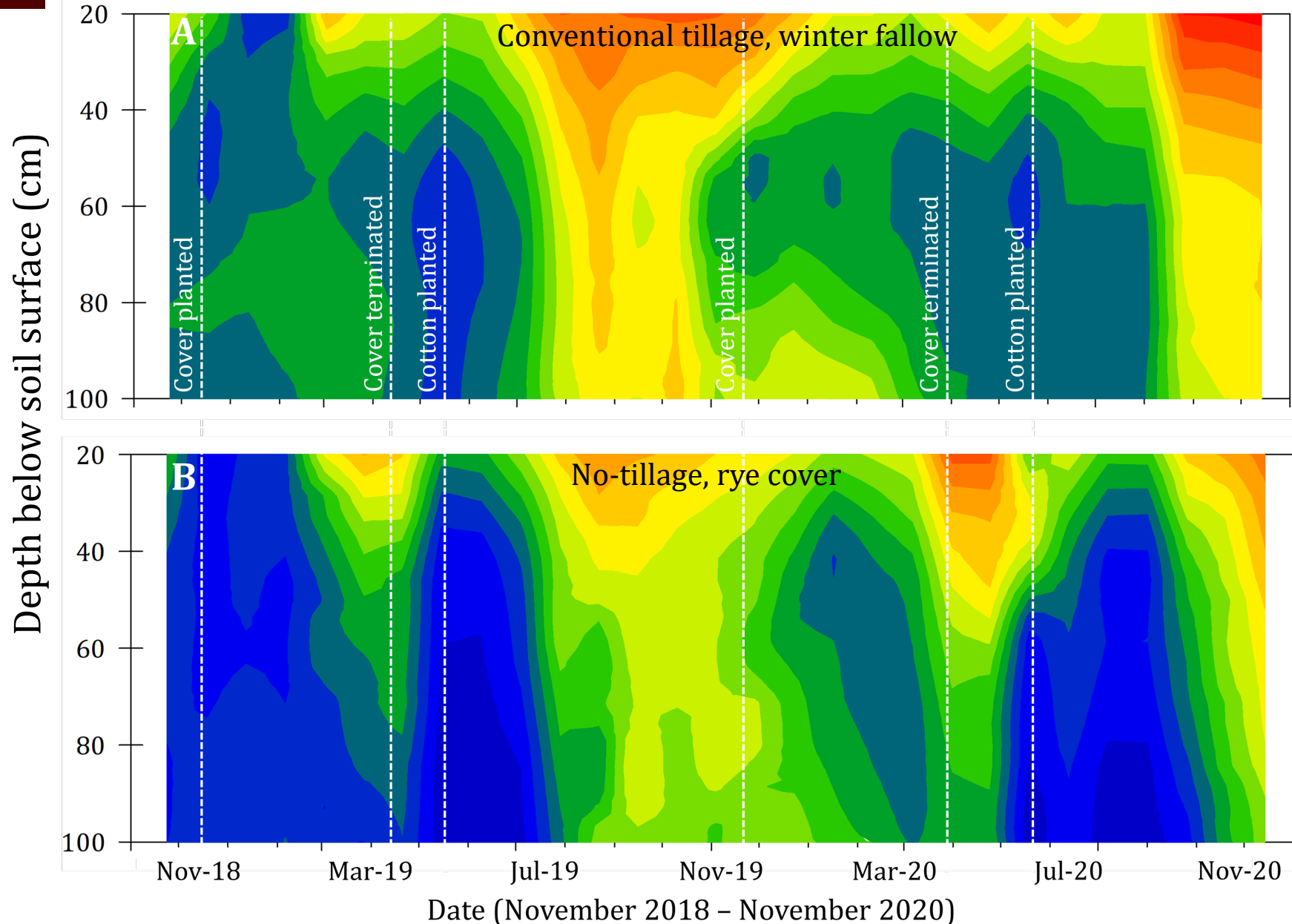
Treatment	$\hat{\beta}_1$	R ²
CT	1.120	0.771
MNT	0.978	0.659
RNT	0.903	0.696

> 1, more stable; = 1, stable; < 1, less stable

Soil water over time



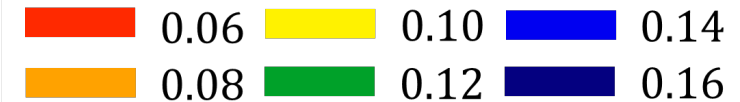
Soil water at depth

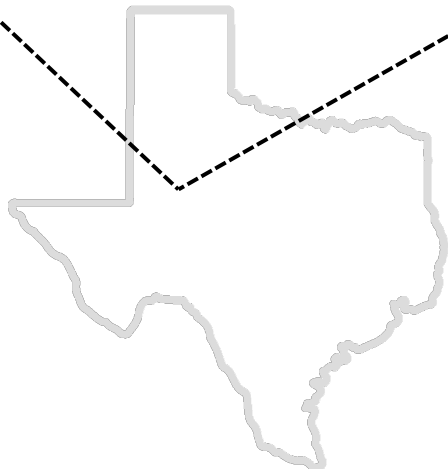
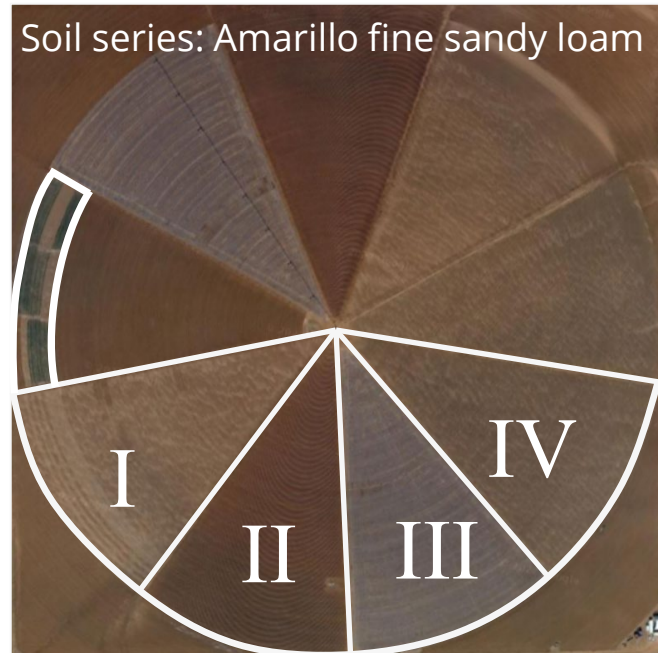


Stages of soil water

- 1 Period of decreased soil water prior to planting cotton from soil evaporation or cover crop water use
- 2 Period of increased soil water near planting from precipitation and/or deficit irrigation
- 3 Period of decreased soil water during growing season as cotton develops vegetatively
- 4 Period of increased soil water as cotton vegetative growth and water demand decreases

Volumetric water content (θ)





Cropping System

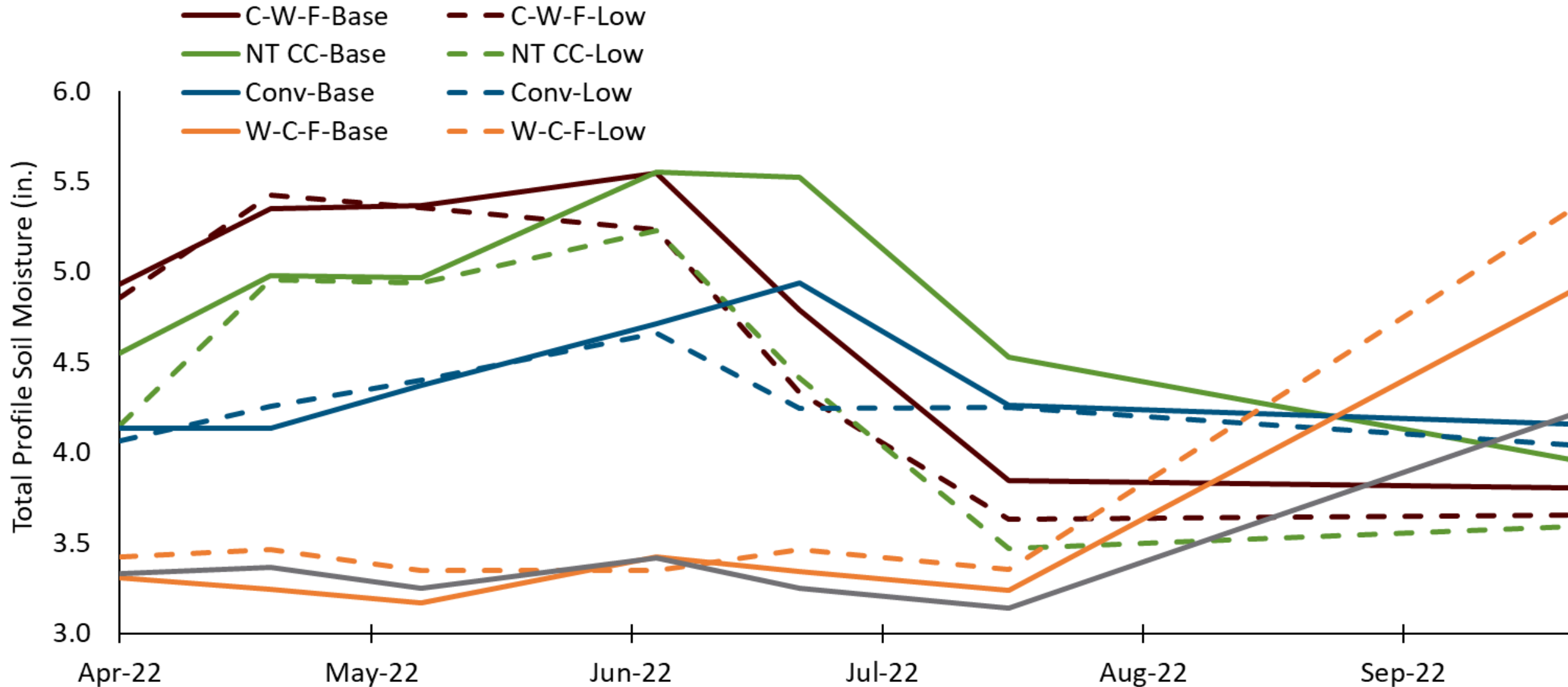
- I** Continuous cotton; winter fallow; conventional tillage
- II** Continuous cotton; rye cover crop; no-tillage
- III** Cotton ('22)-wheat-fallow; no-tillage
- IV** Wheat- fallow-cotton ('23); no-tillage
Wheat-summer cover-cotton ('23); no-tillage

Irrigation

- 60% estimated ET replacement
- Irrigation to achieve adequate stands with ≤ 3 in. of early season irrigation, otherwise dryland cropping system

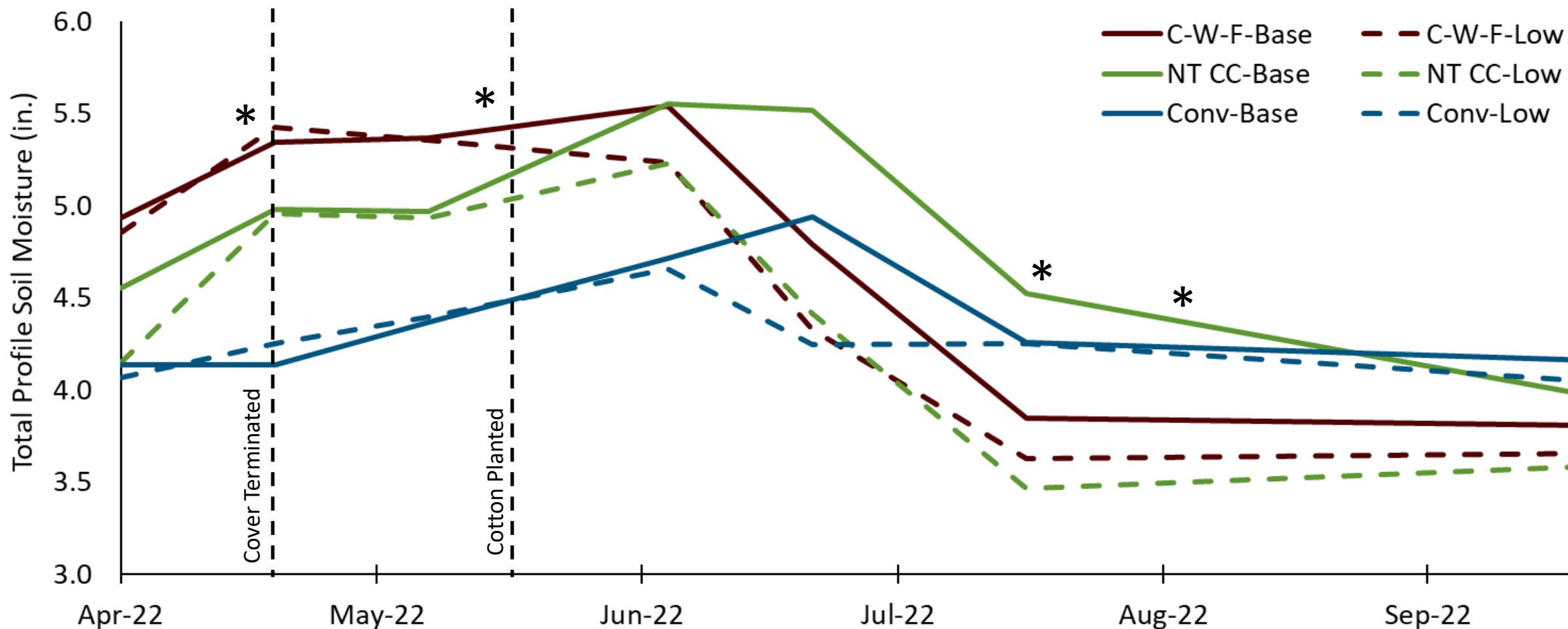
Soil water and cropping systems

Cobos et al.



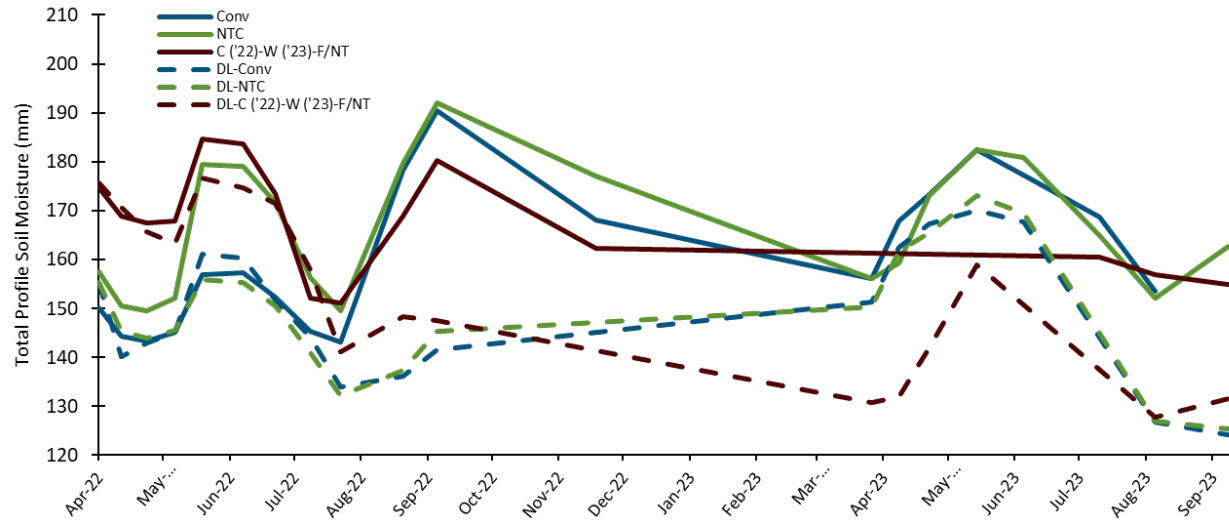
Soil water and cropping systems

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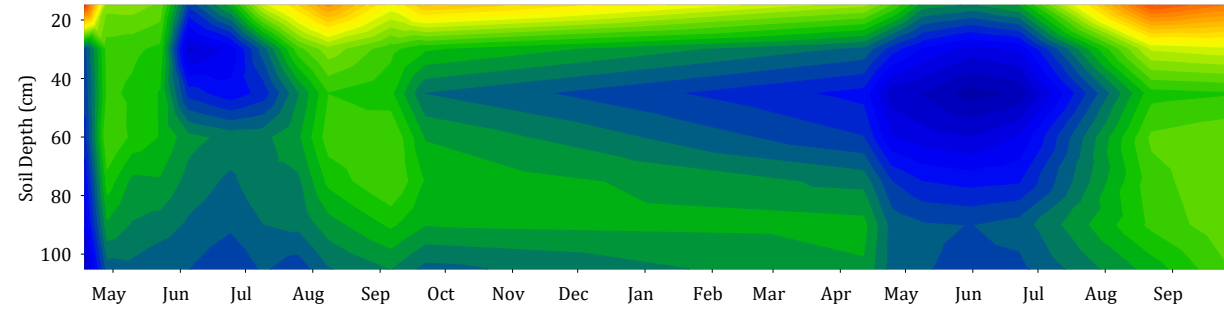
* = significant differences

Soil water by system

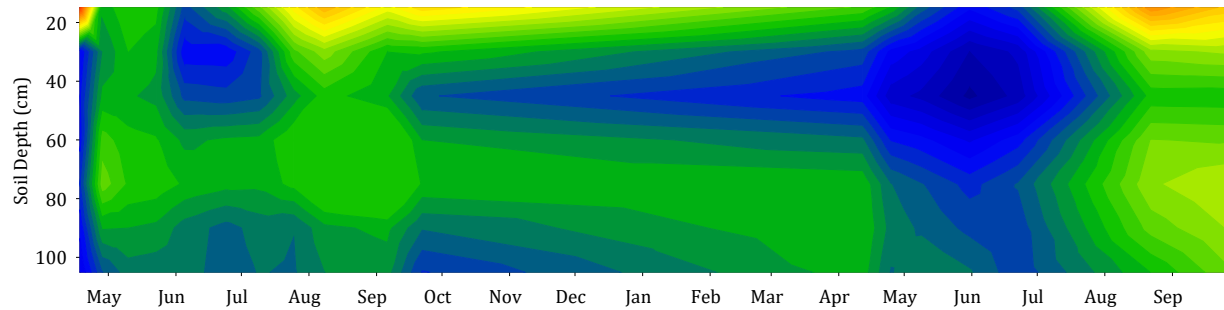
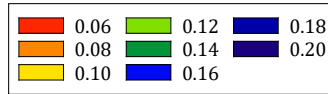


Cotton-Wheat-Fallow rotation shows increased soil moisture in dryland agroecosystems during a drought year

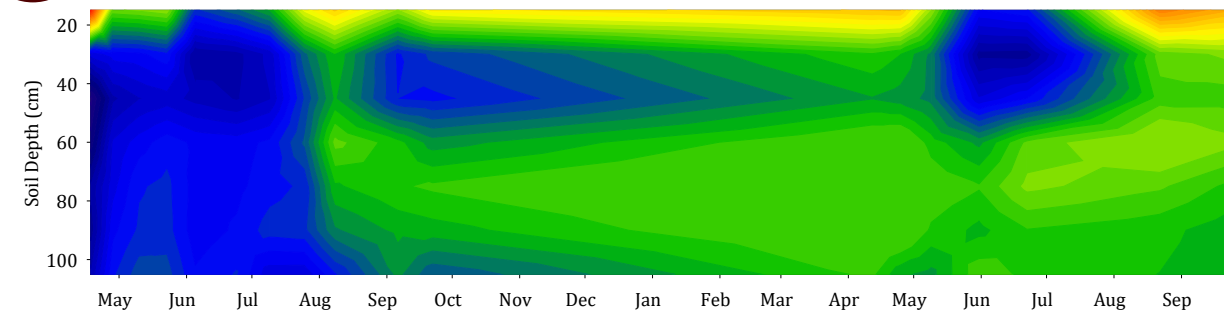
I Conventional tillage, winter fallow (Dryland)



II No-tillage, rye cover crop (Dryland)

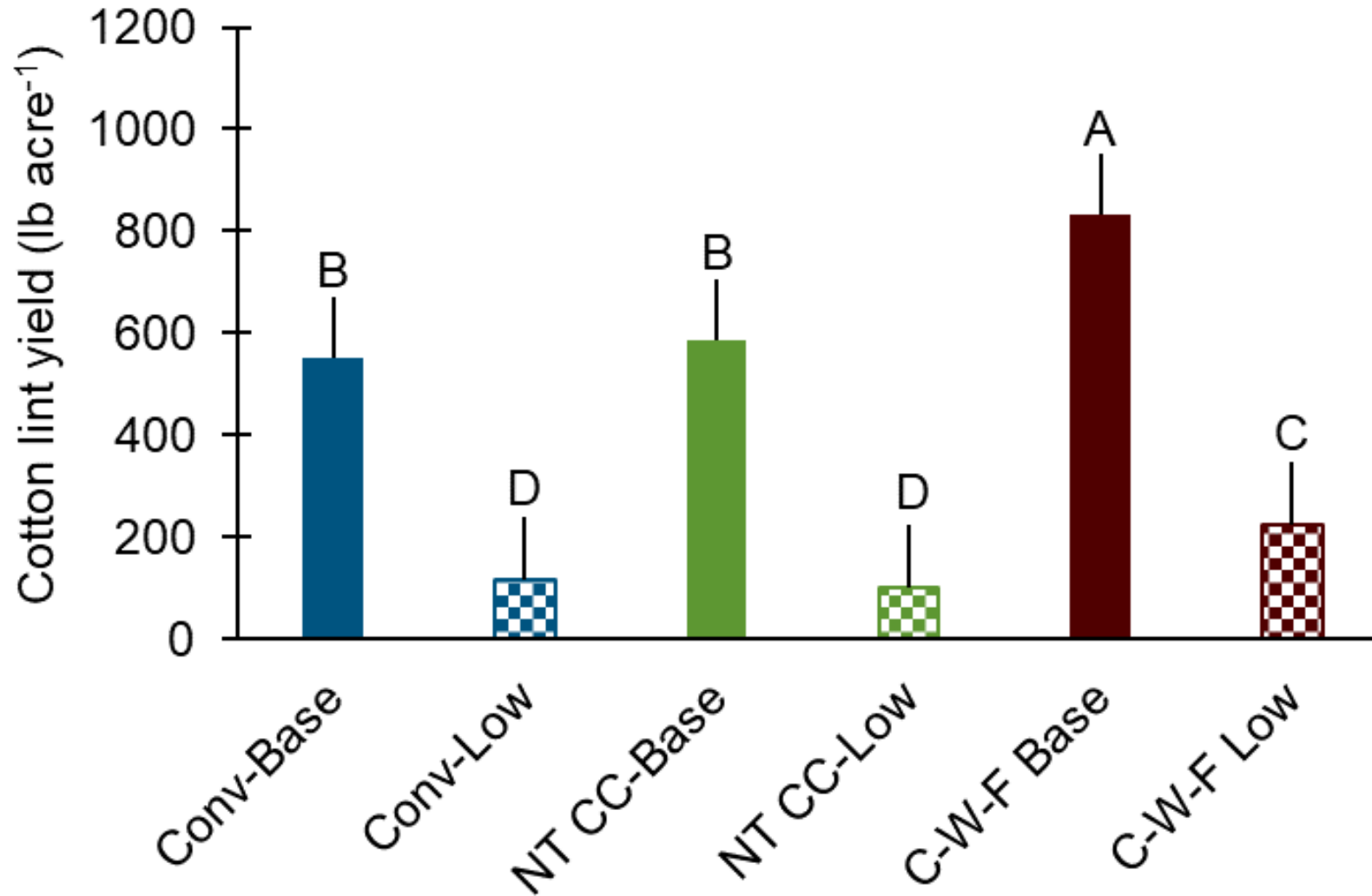


III Cotton ('22)-Wheat ('23)-Fallow (Dryland)



Soil water by cropping system and lint yield

Cobos et al.



Cover crop termination timing

Cobos et al.



Cover crop termination timing

Cobos et al.

Objective:

Determine optimal cover crop termination timing in semi-arid cotton conservation systems



Cover crop termination date



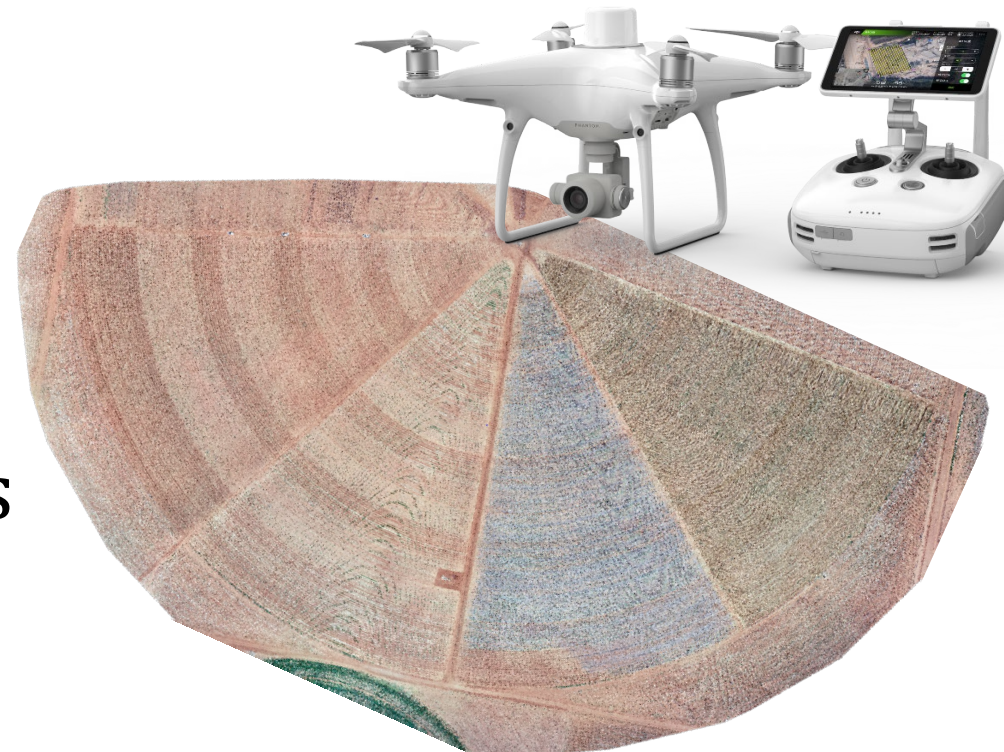
Multi-spectral sUAS



Soil moisture and nutrient analysis

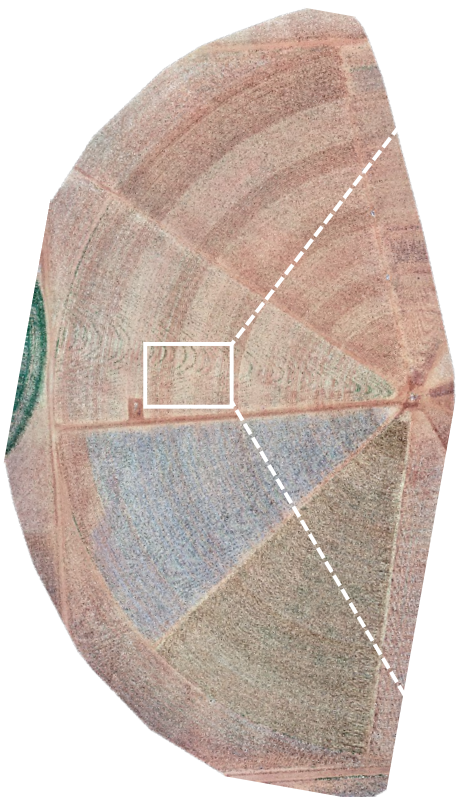


Plant growth characteristics



Base Irrigation

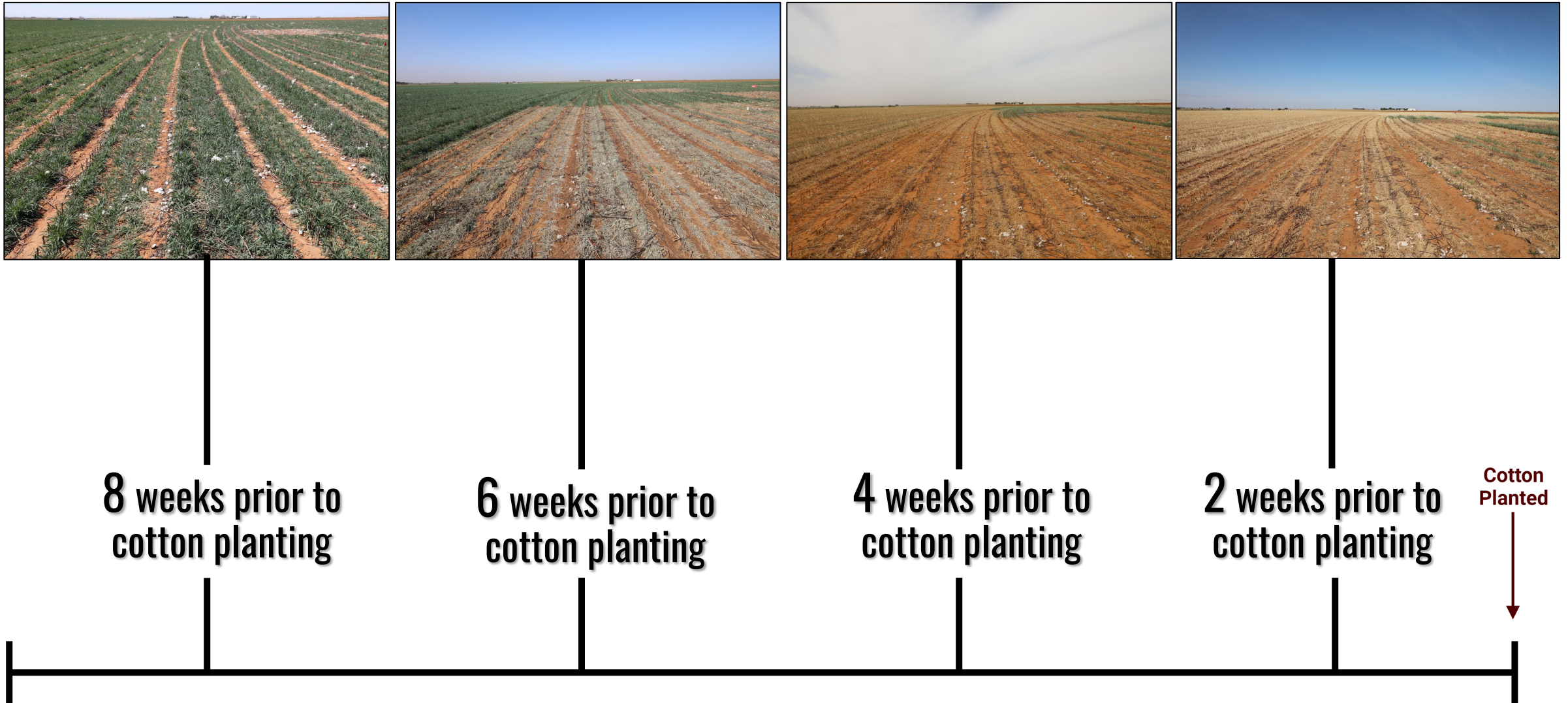
Low Irrigation

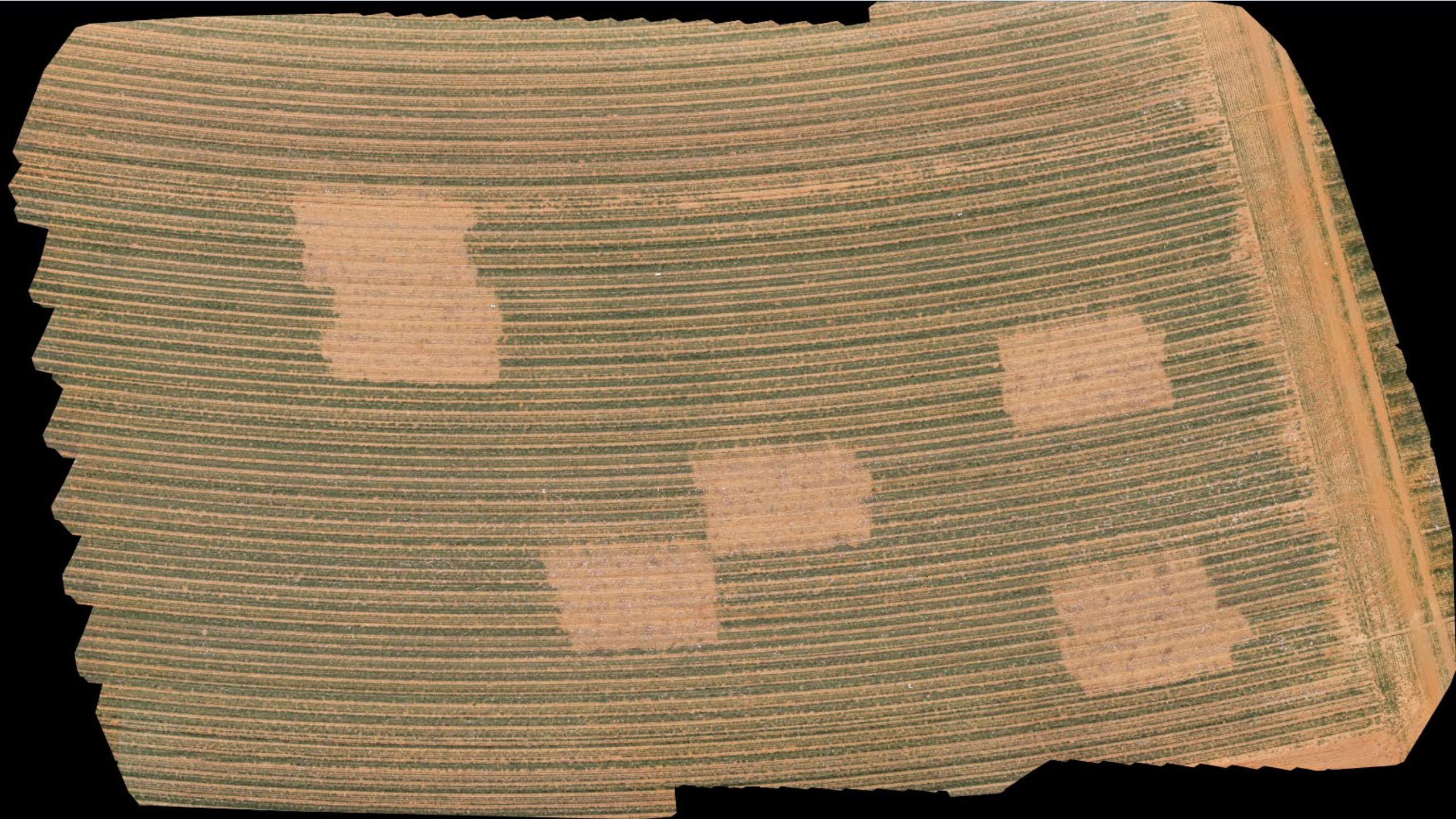


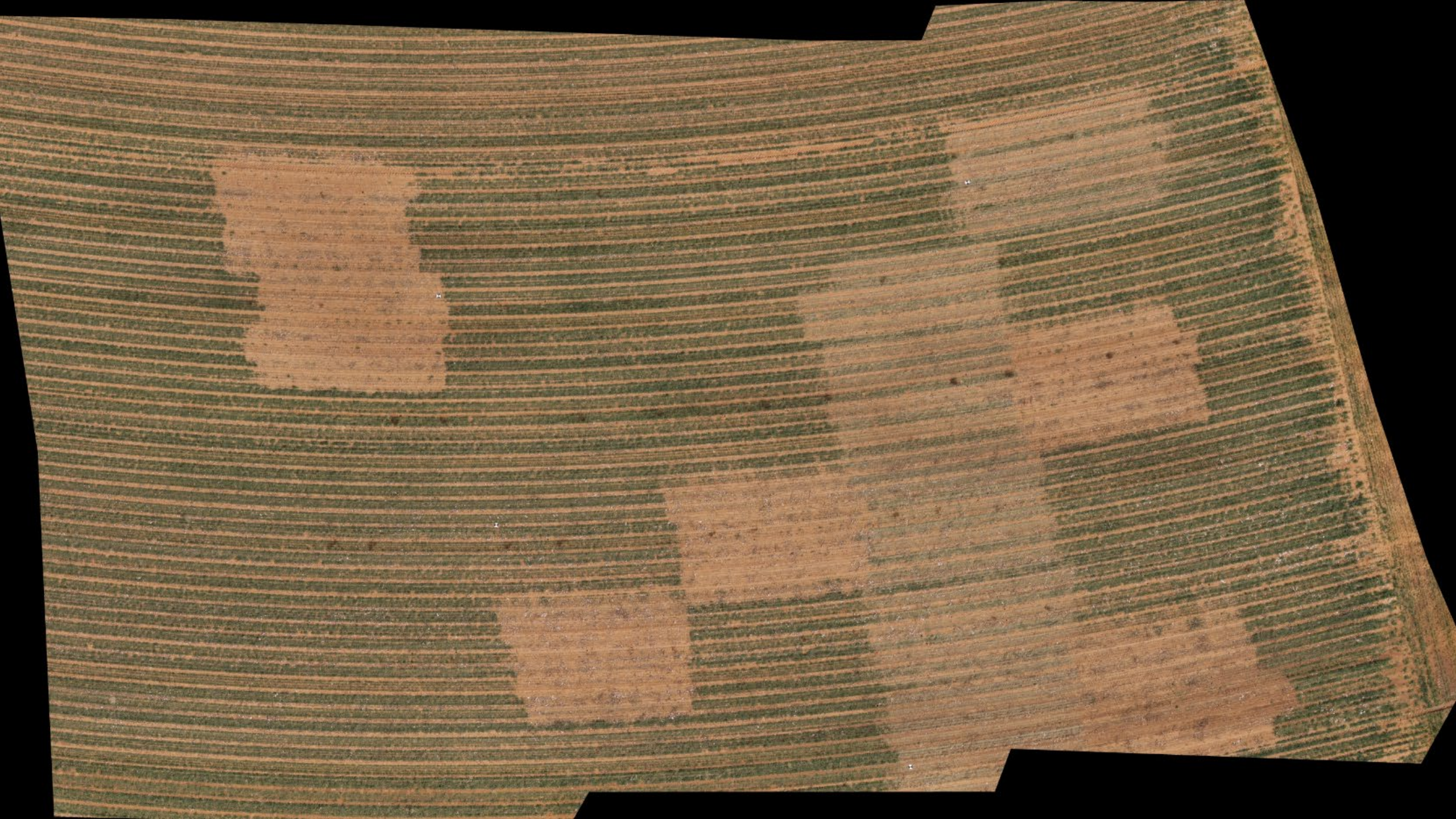
2 wks	2 wks	4 wks	2 wks	Control	Control
4 wks	Control	6 wks	4 wks	2 wks	2 wks
6 wks	6 wks	Control	6 wks	4 wks	6 wks
8 wks	8 wks	8 wks	8 wks	8 wks	4 wks
Control	4 wks	2 wks	Control	6 wks	8 wks
8 Rows	8 Rows	8 Rows	8 Rows	8 Rows	8 Rows

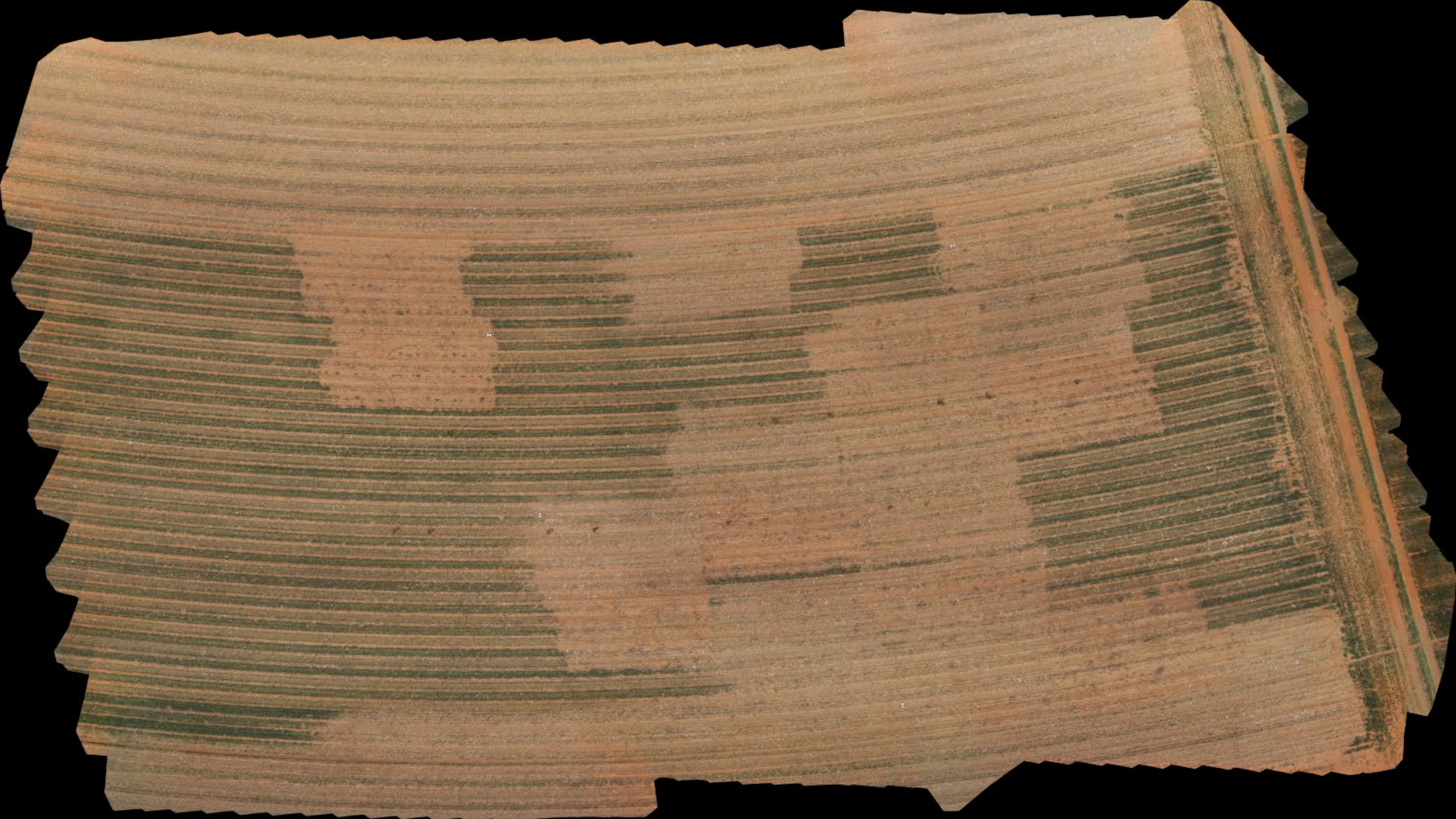
Cover crop termination timing

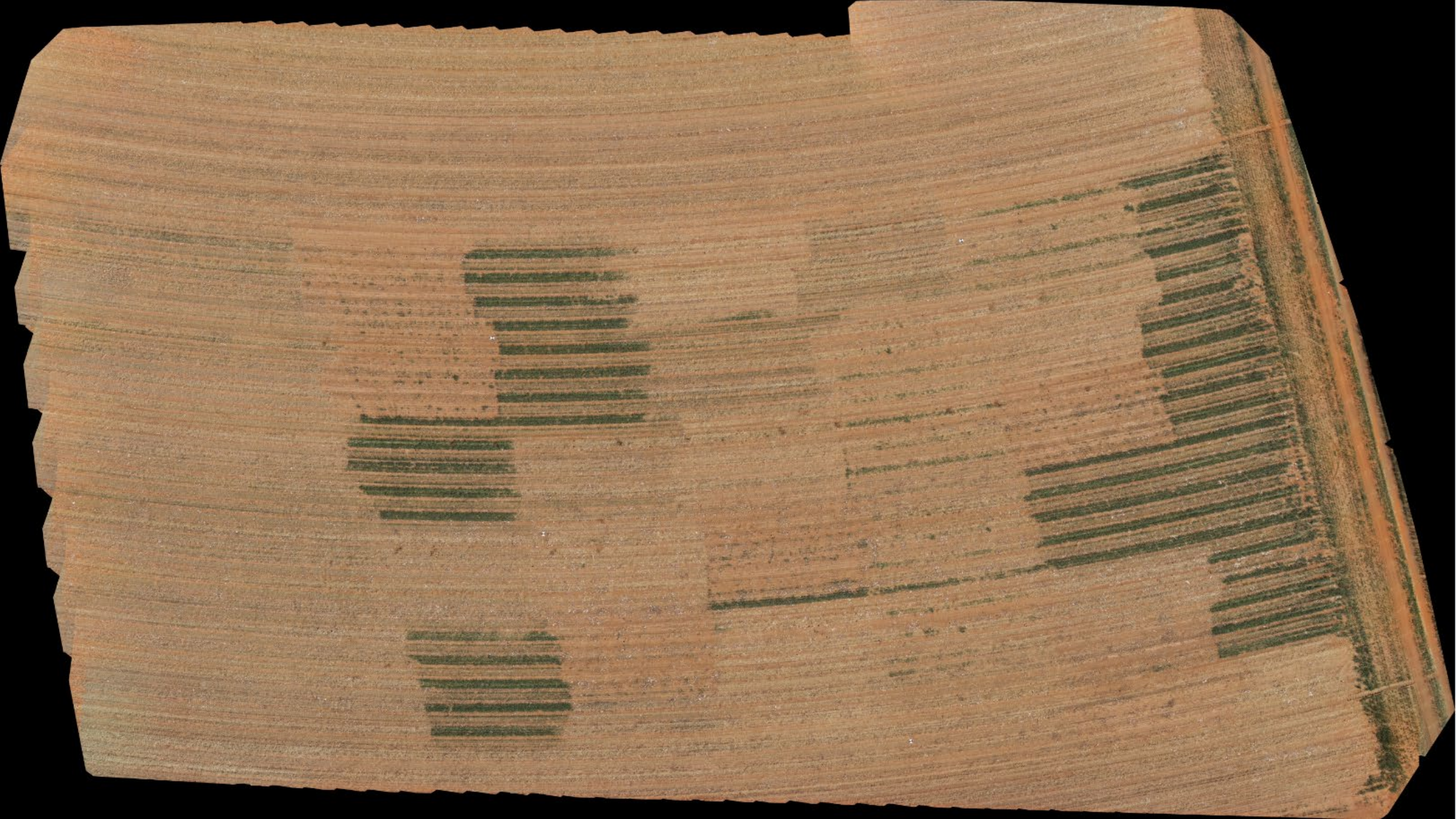
Cobos et al.

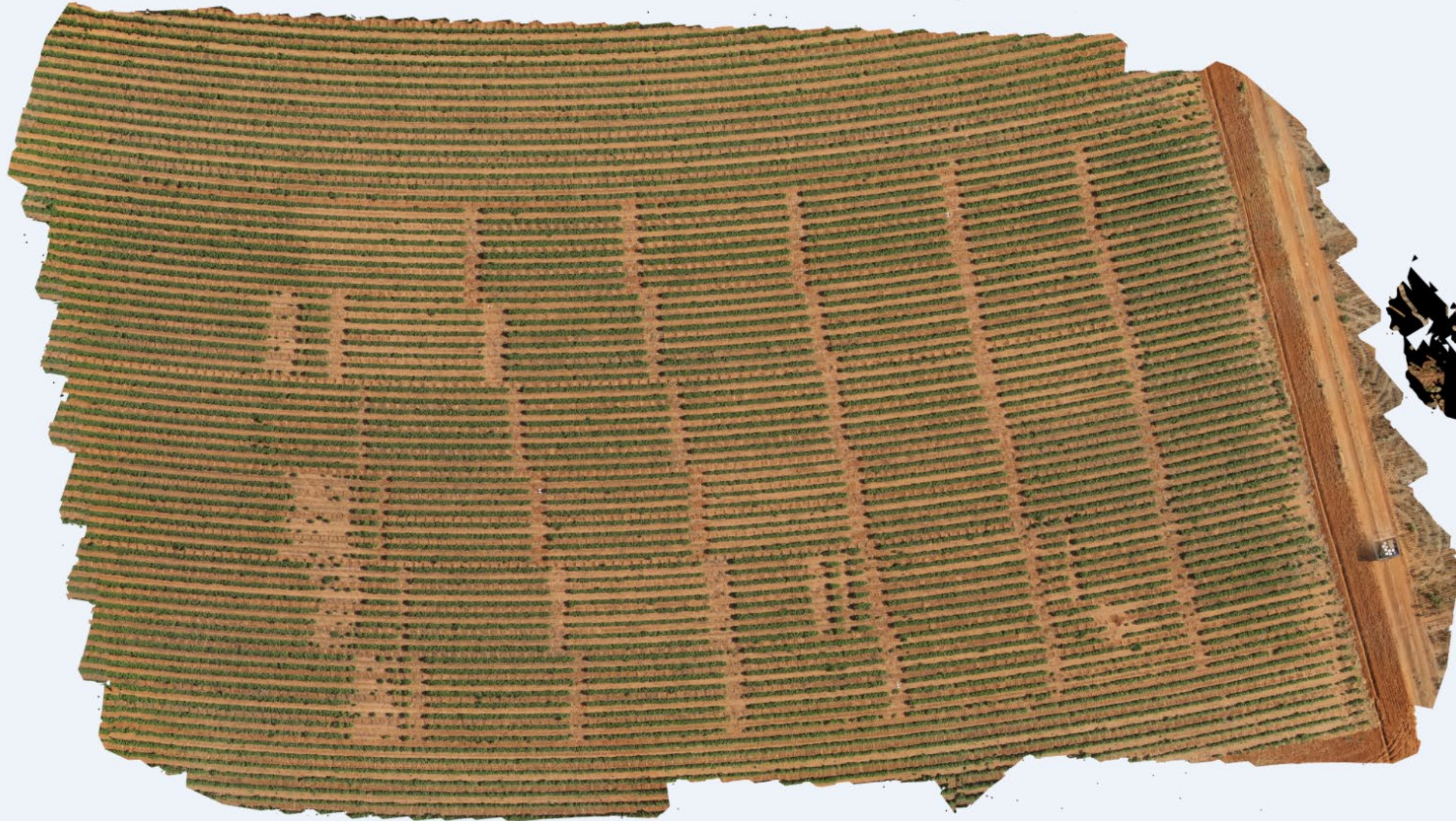












Cover crop termination timing

Cobos et al.

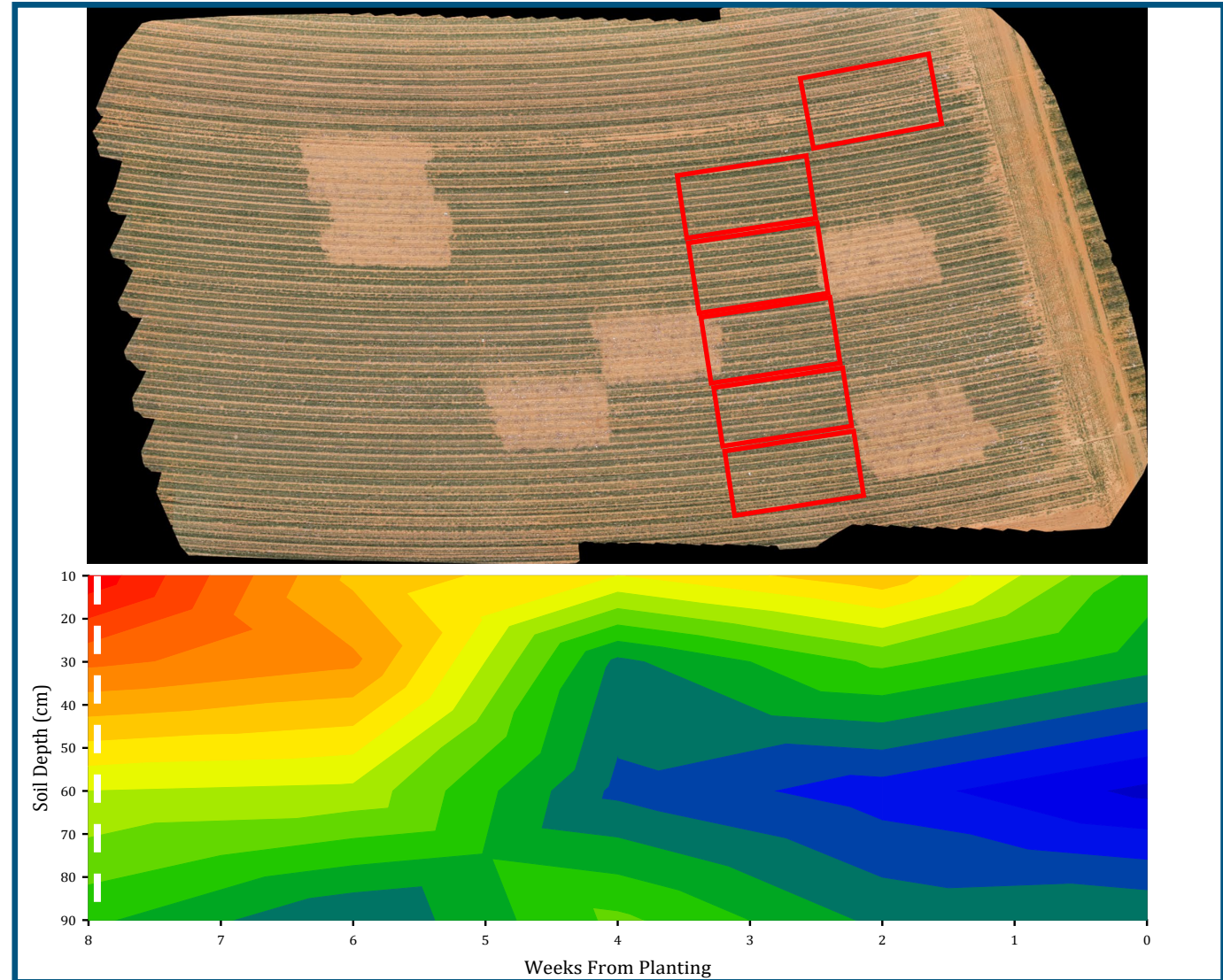
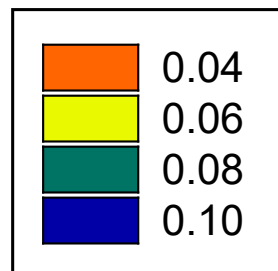


8 weeks prior to
cotton planting



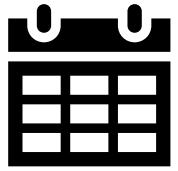
Pre-boot

*Volumetric
Water Content
(cm^3/cm^3)*

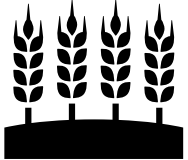


Cover crop termination timing

Cobos et al.

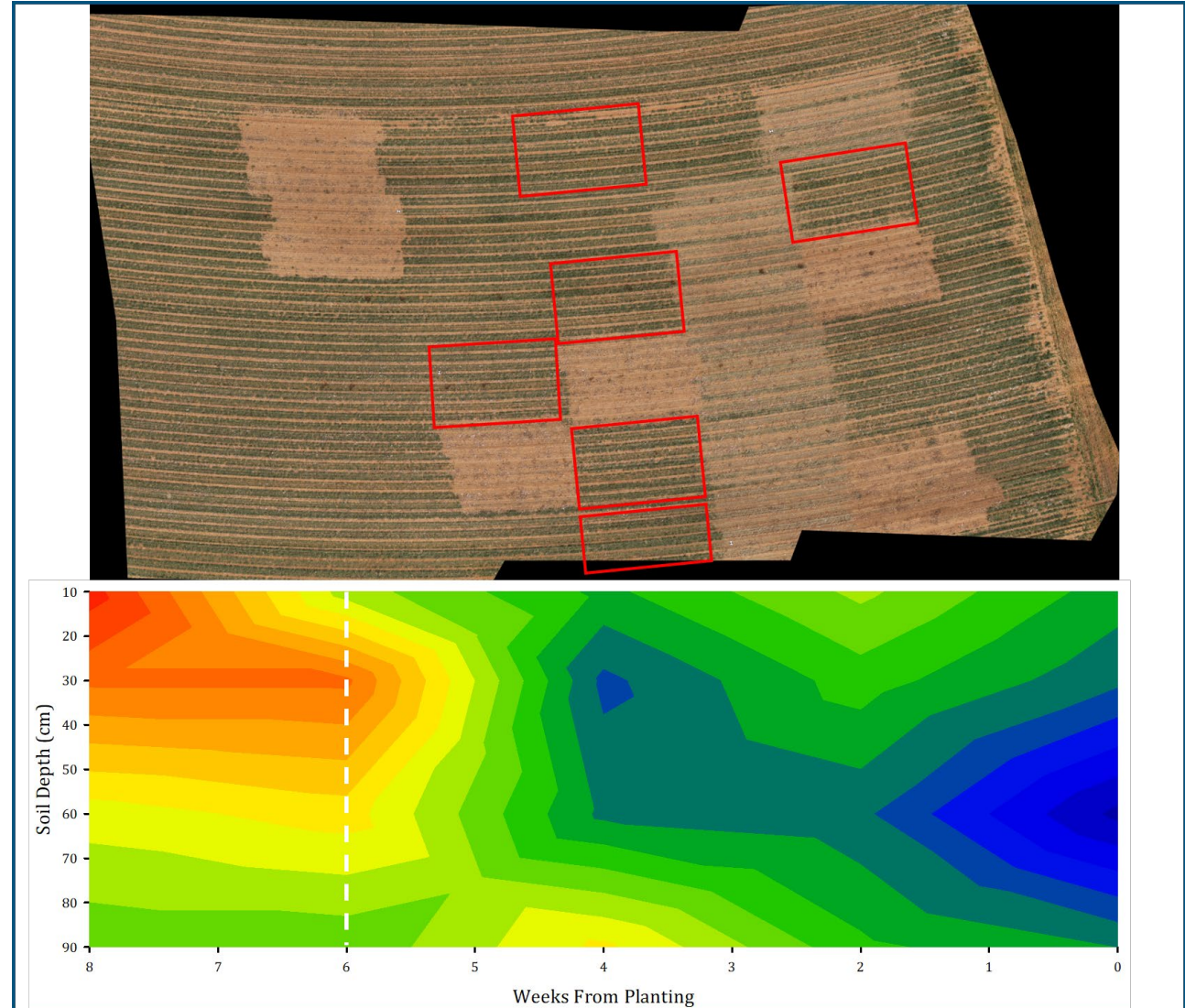
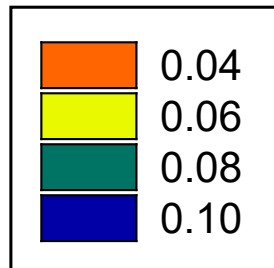


6 weeks prior to
cotton planting



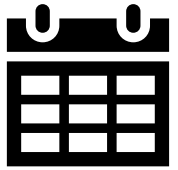
Head emergence

*Volumetric
Water Content
(cm³/cm³)*



Cover crop termination timing

Cobos et al.

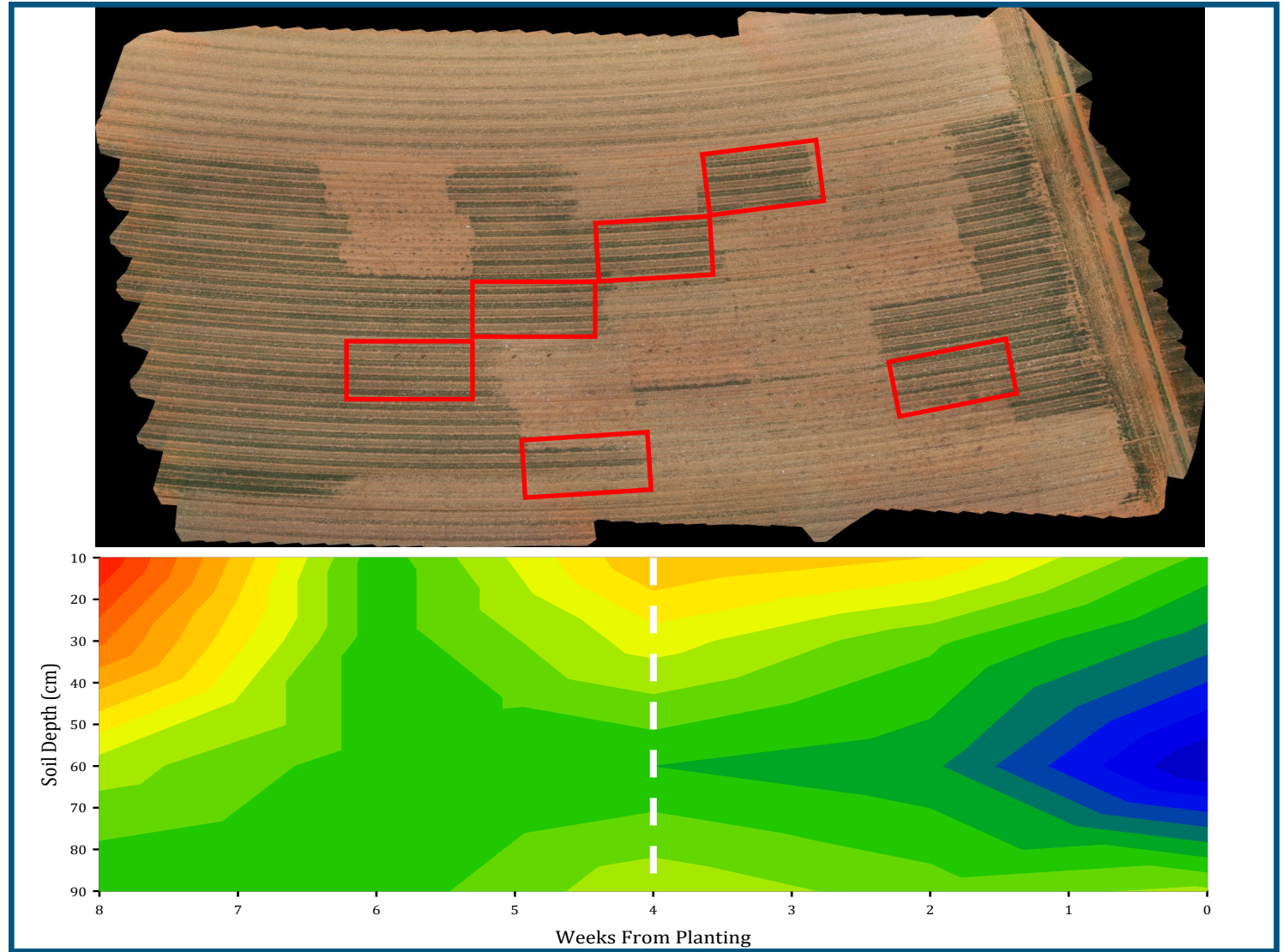
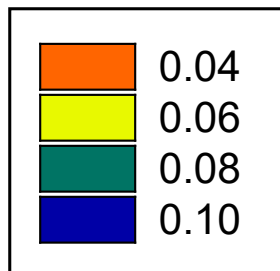


4 weeks prior to
cotton planting



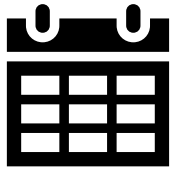
Anthesis

*Volumetric
Water Content
(cm³/cm³)*



Cover crop termination timing

Cobos et al.

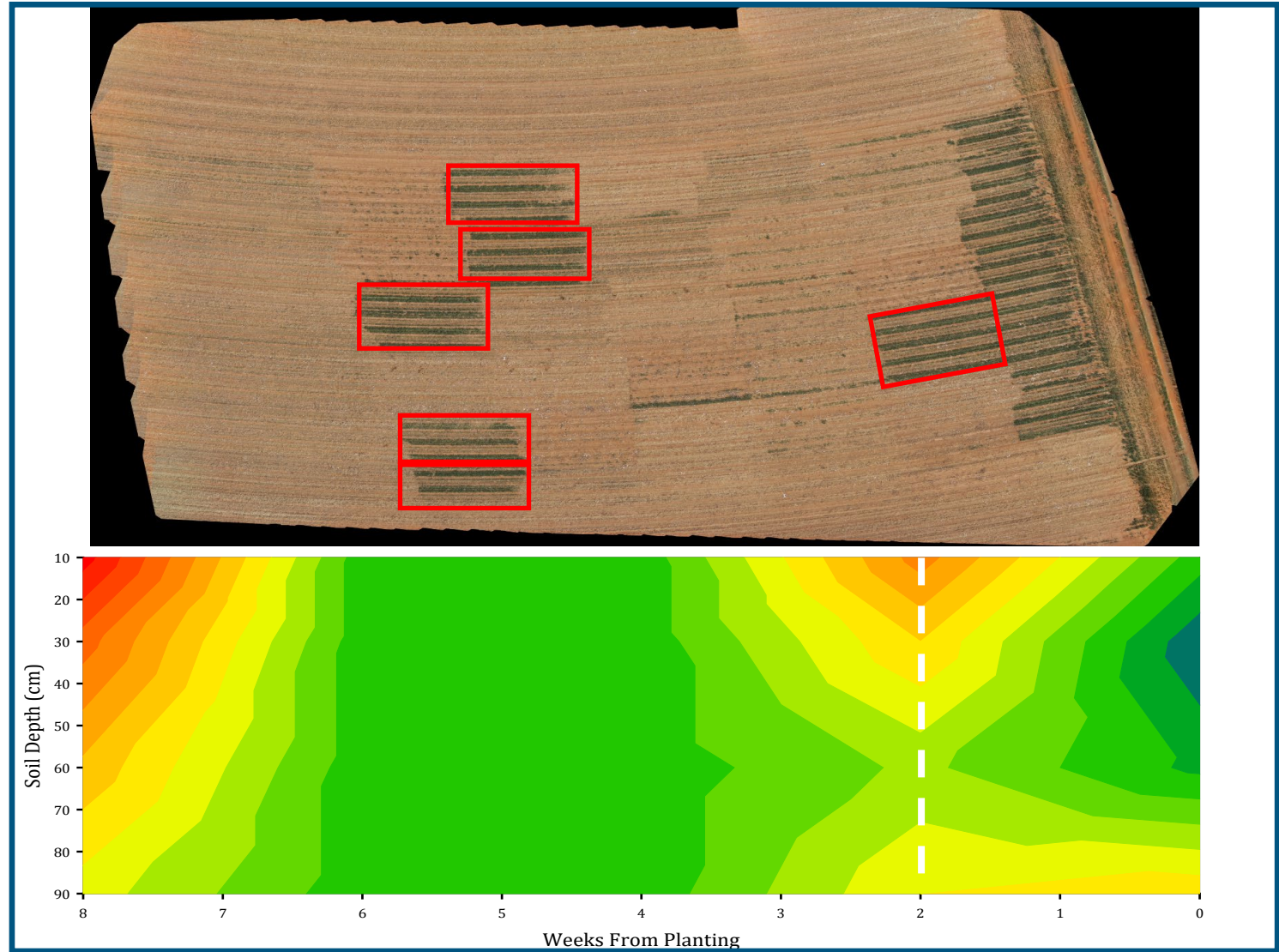
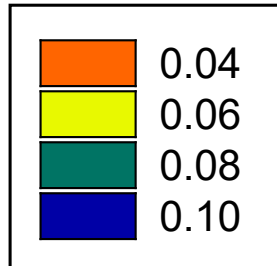


2 weeks prior to
cotton planting

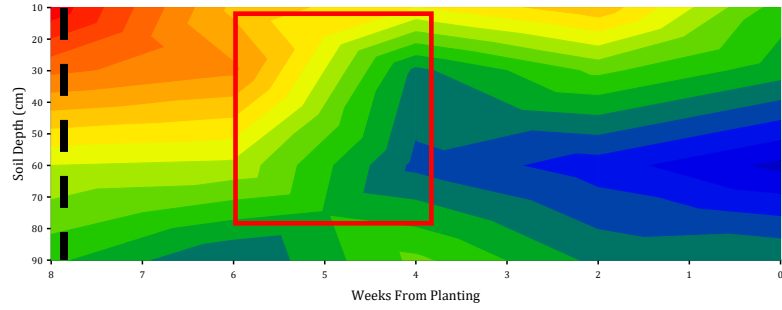


Dough

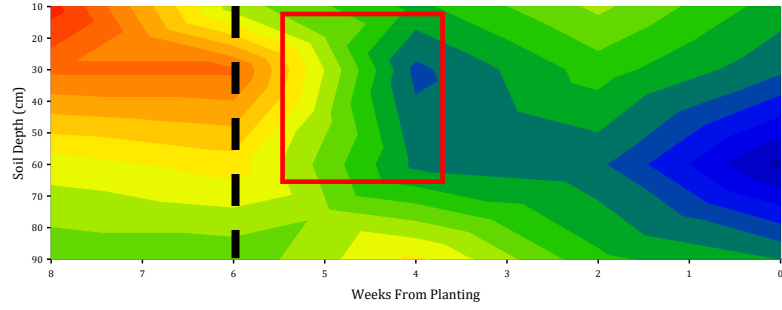
*Volumetric
Water Content
(cm^3/cm^3)*



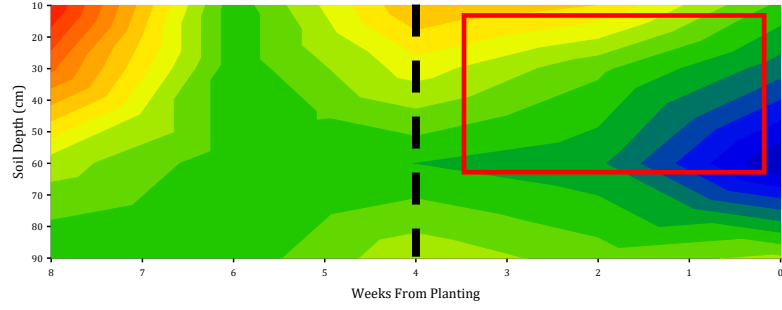
**8 weeks prior to
cotton planting**



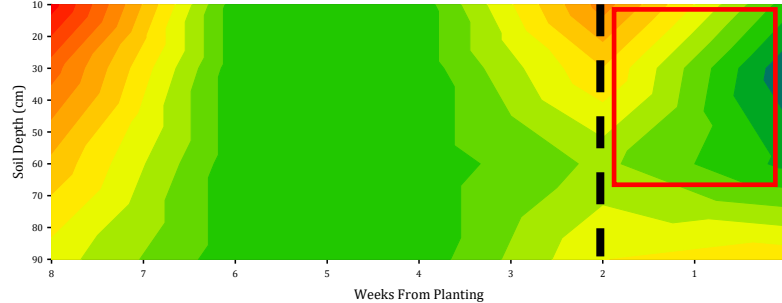
**6 weeks prior to
cotton planting**



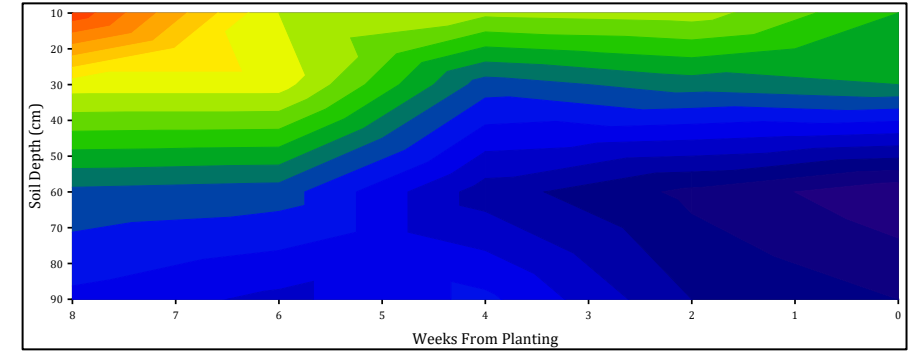
**4 weeks prior to
cotton planting**



**2 weeks prior to
cotton planting**



No cover control



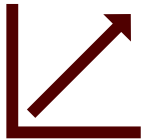
Summary



Soil moisture is reduced by cover crops, but it can be rapidly replenished with irrigation or timely rainfall



Water use following cover crops following distinct trends each year



Cotton-wheat-fallow rotations increased water storage and yield compared to continuous cotton



Terminating at 6 to 8 weeks prior to ideal cotton planting resulted in greater water at planting



THANK ***YOU***

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