Developing a Fertigation Strategy for Cotton using Subsurface Drip Irrigation

Katie Lewis
Associate Professor
Soil Chemistry and Fertility

Texas A&M AgriLife Research

Fluid Fertilizer Foundation Forum
Phoenix, AZ
20 February 2023

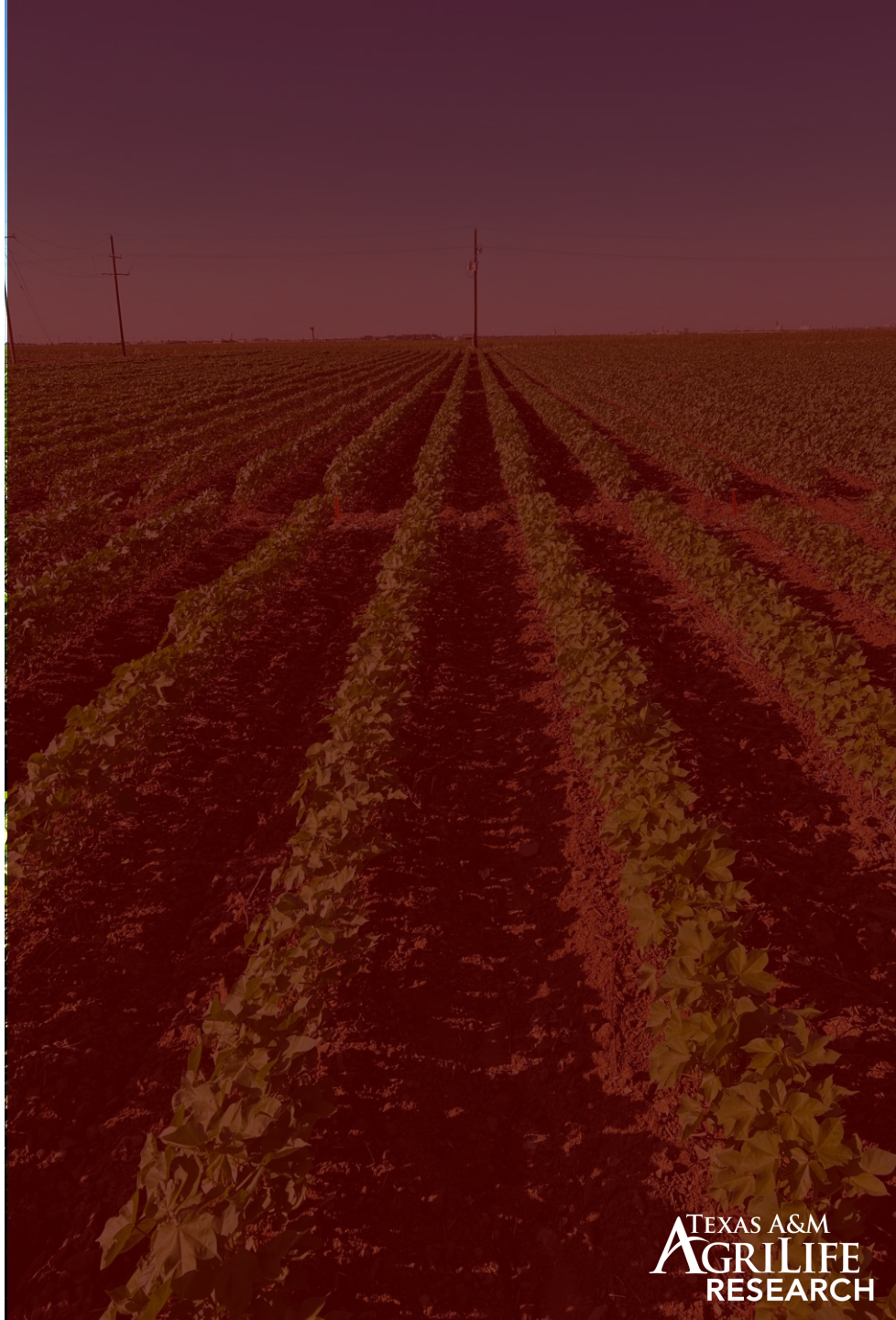
Subsurface Drip Irrigation (SDI)

- ~40% of cotton acres are irrigated in Texas High Plains
  - 3.3 million acres under center pivot irrigation
  - ~75% of irrigated acres statewide

- >30-fold increase in SDI over last 20 years
  - 1998: approximately 20,000 acres
  - 2021: >650,000 acres
    (Mitch Payne, Diversity D, Brownfield, TX)

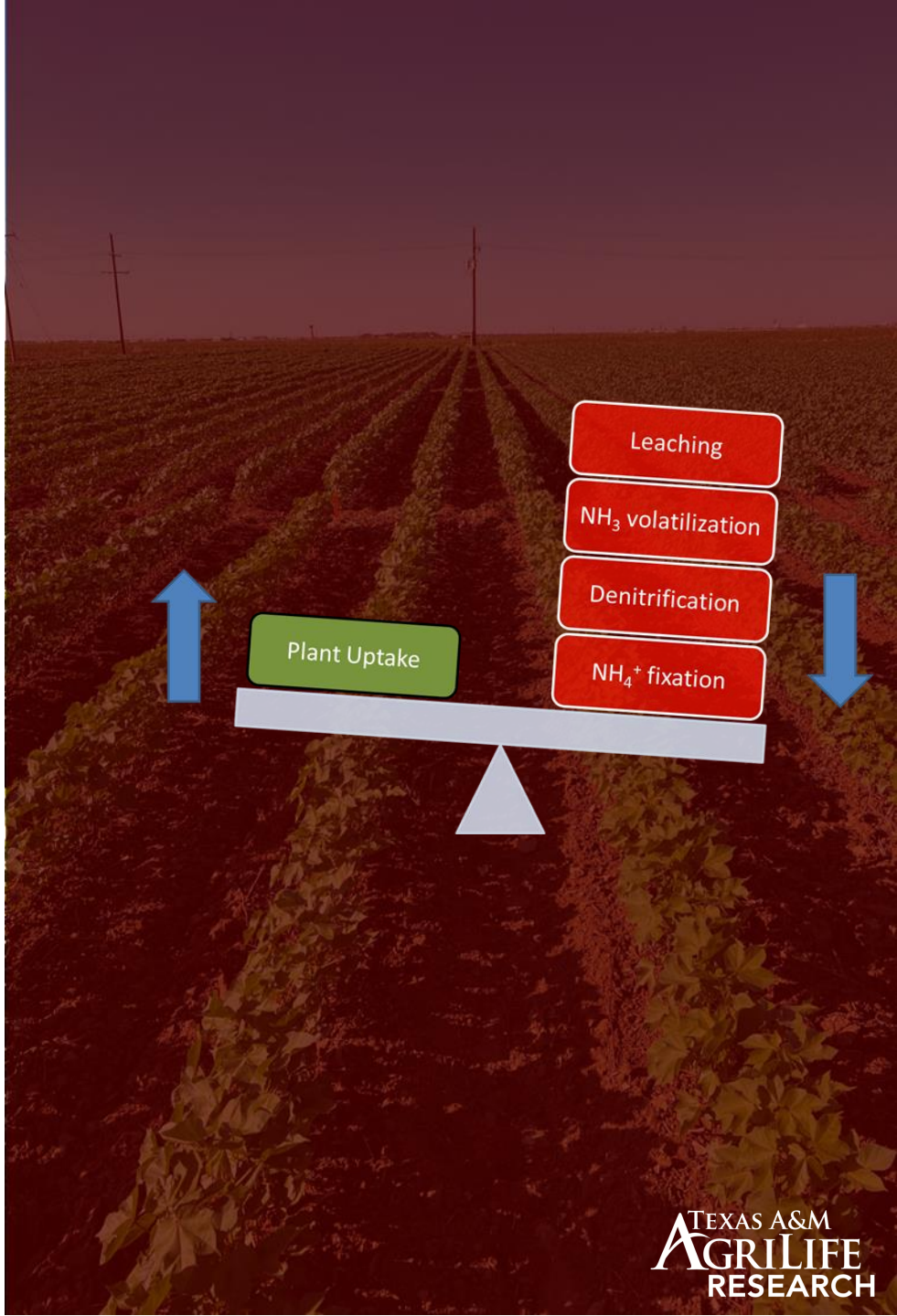
- SDI prevents plant stress compared to center pivot irrigation

- Cotton is primary crop grown with SDI



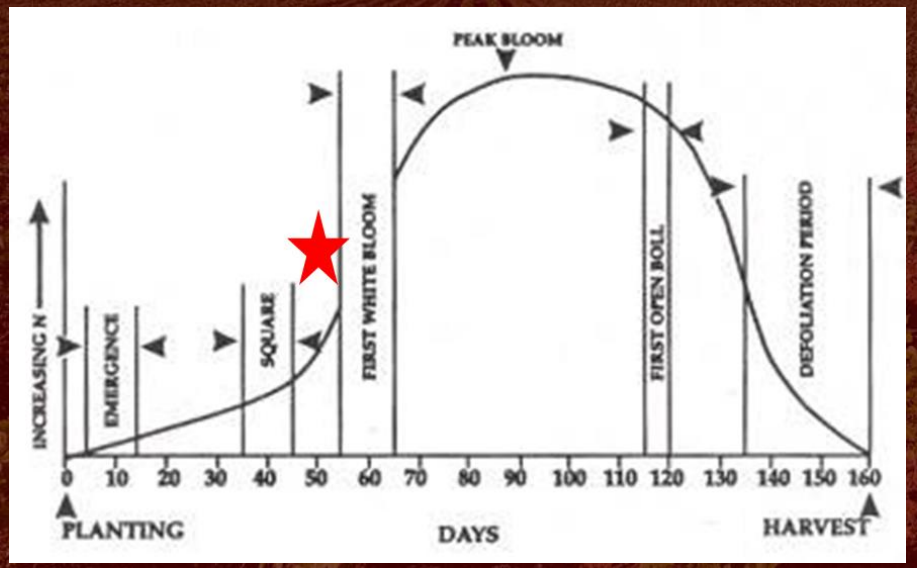
Fertigation and SDI

- SDI can be used to efficiently apply liquid fertilizers
  - Greater plant uptake
  - Less potential negative environmental impacts due to nutrient losses
- Smaller C footprint with fertigation using SDI
- SDI allows for more frequent applications
  - “Spoon-feeding”
- Is this the best approach with all nutrients?



Fertigation and SDI

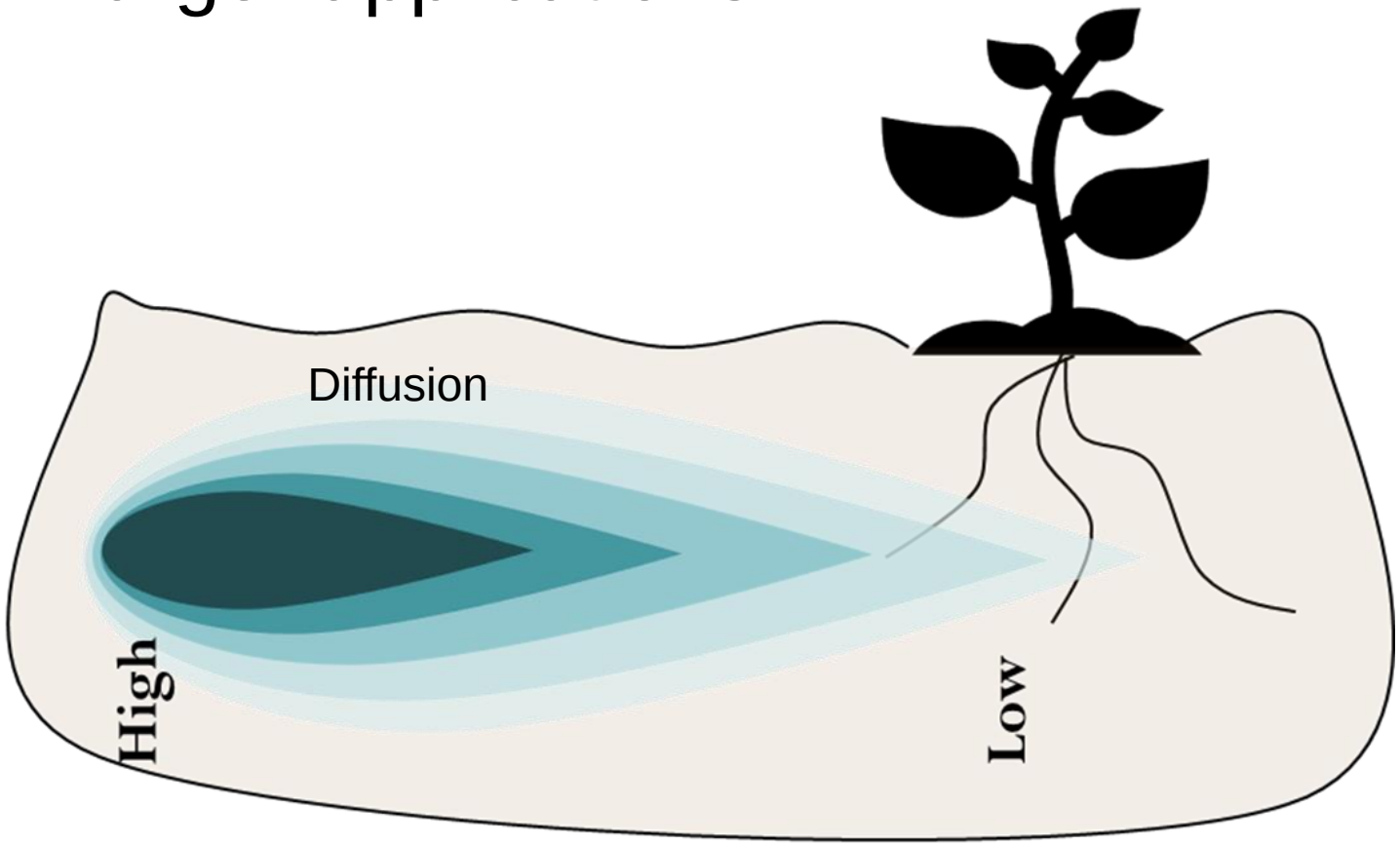
- Spoon-feeding method may result in less chance of missing peak demand because fertilizer is constantly being applied
  - May be a better approach for N fertigation
- May lead to excessive growth due to prolonged N applications later into the season
- Research is aimed at answering the spoon-feeding questions



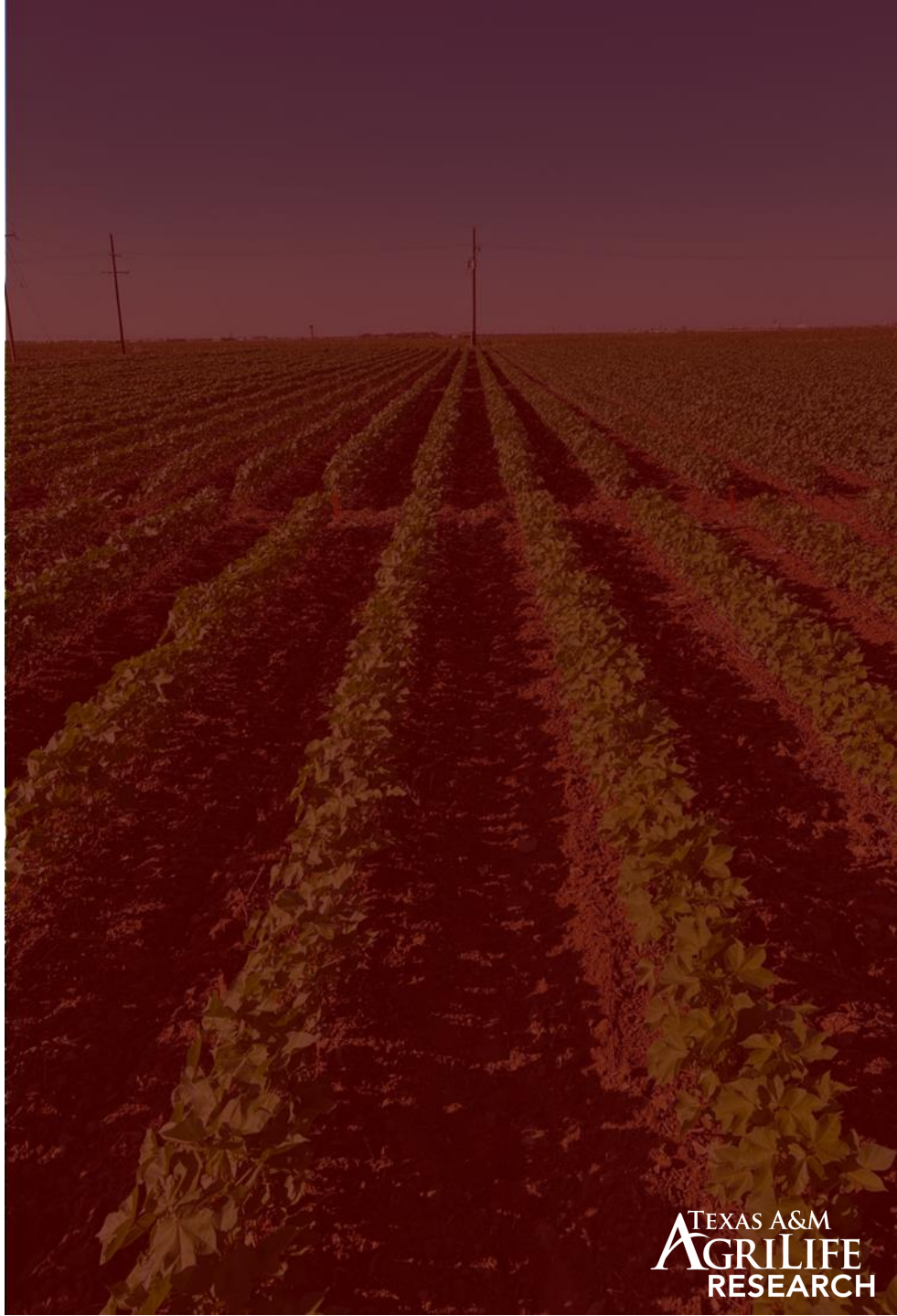
TEXAS A&M AGRILIFE RESEARCH

Fertigation and SDI

- Hypothesize greater use efficiency of P when applied in less frequent, larger applications



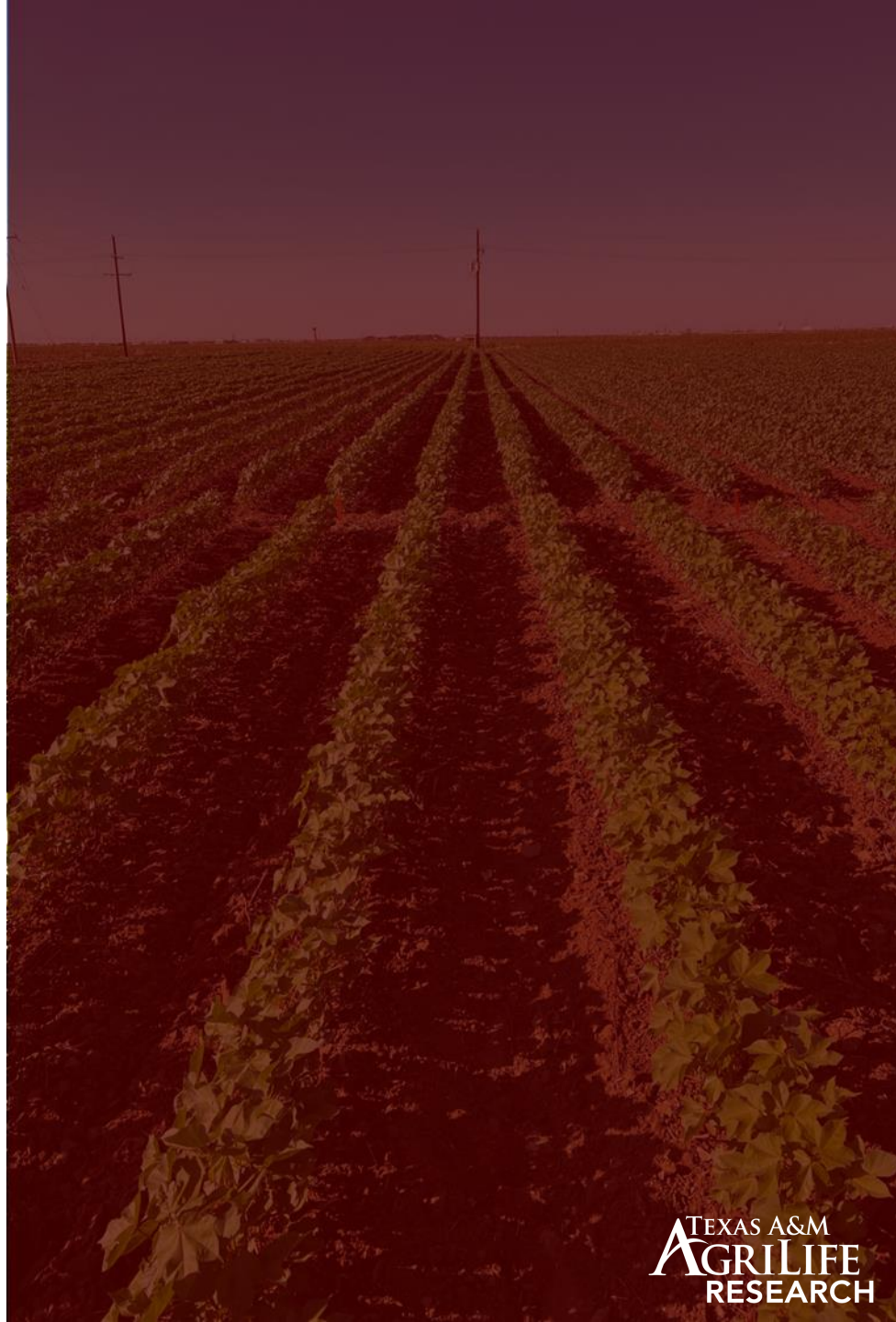
K. Lewis



Research Objective

- Develop N and P fertigation strategies using SDI that increase nutrient use efficiency, cotton lint yield, and fertilizer return on investment.

- More specifically, we will determine the number of fertilizer applications that results in the greatest nutrient uptake and yield when using SDI.



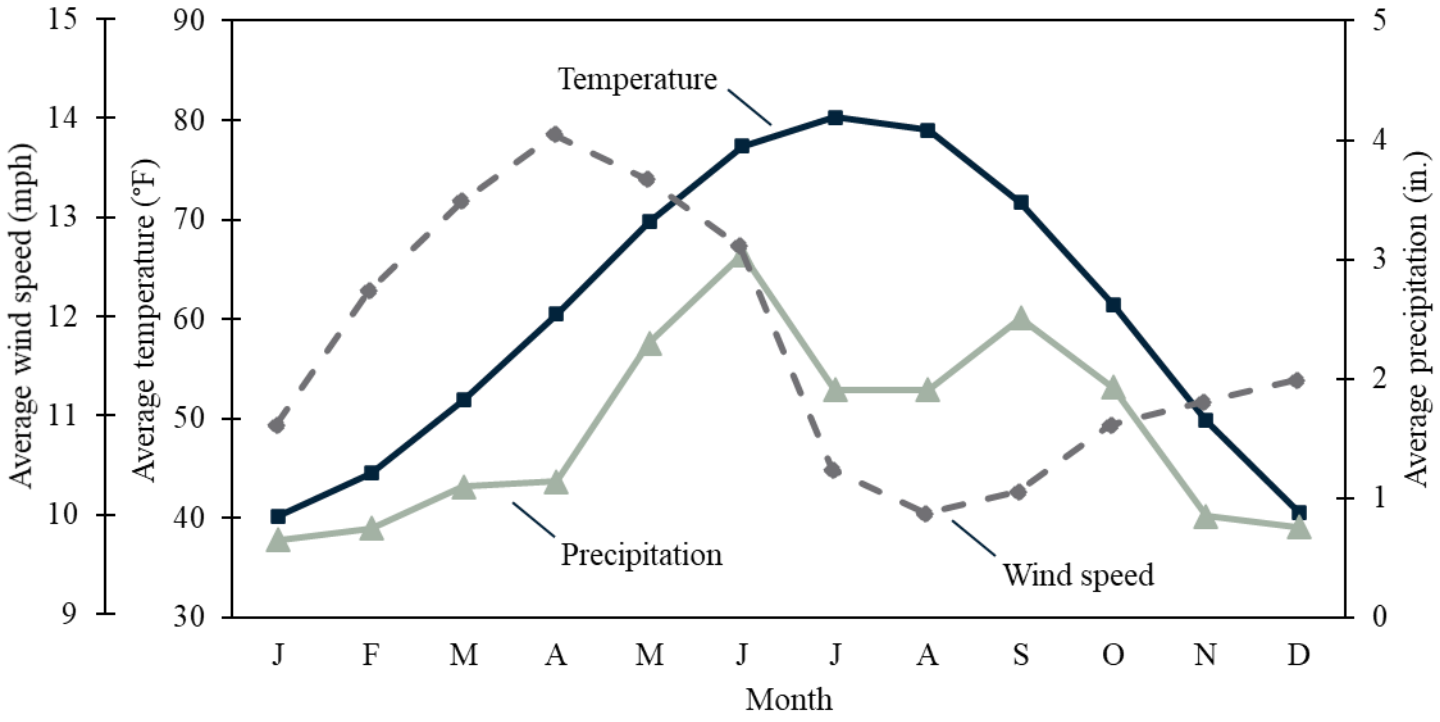
The Southern High Plains climate

55 – 63°F

12.3 mph

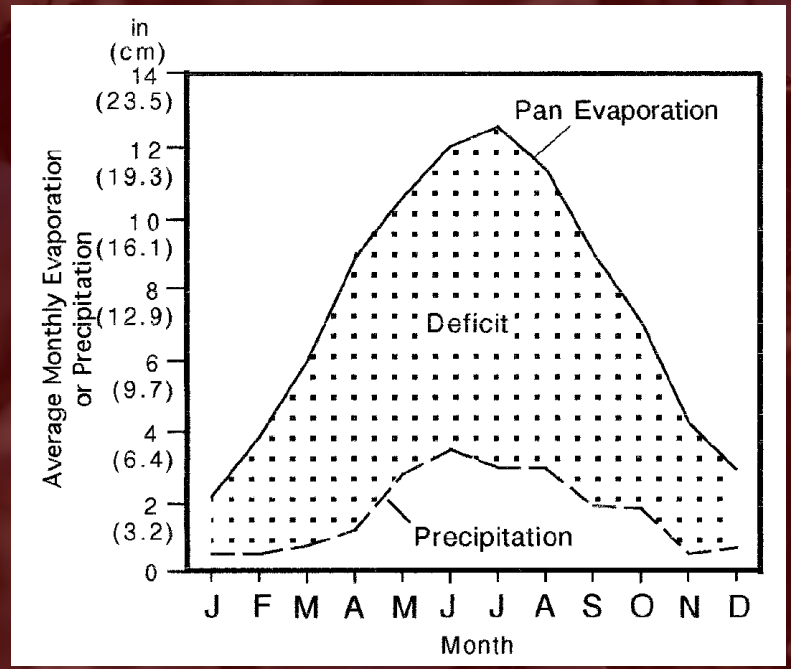
16 – 22 inches

195 – 255 days y^{-1}



Potential evapotranspiration (PET)

- Average annual PET exceeds precipitation by 2-3 times



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

The experimental design

LOCATION: Lubbock, Lubbock County, TX

VARIETIES: DP 2143NR B3XF and DP 2020 B3XF

PLANTING DATE: 5/13/2021, replanted on 6/7/2021
5/27/2022

TREATMENTS (4 replications):

N	P
frequency	
3	0
3	1
3	3
3	9
9	0
9	1
9	3
9	9

N applied at 150 lb/a as UAN-32
P applied at 45 lb/a as 0-54-0

Applied using chemigation pump

3x applied every 20 d
9x applied every 10 d

The experimental design

APPLICATION DATES 2021:

Applic Freq: 1		Applic Freq: 3		Applic Freq: 9	
2021	2022	2021	2022	2021	2022
9-May	7-Jun	9-May	7-Jun	9-May	7-Jun
				28-May	17-Jun
			24-Jun	18-Jun	24-Jun
				8-July	1-July
		20-July	8-July	20-July	8-July
				2-Aug	18-July
		11-Aug		11-Aug	29-July
				20-Aug	12-Aug
				30-Aug	26-Aug

The variables

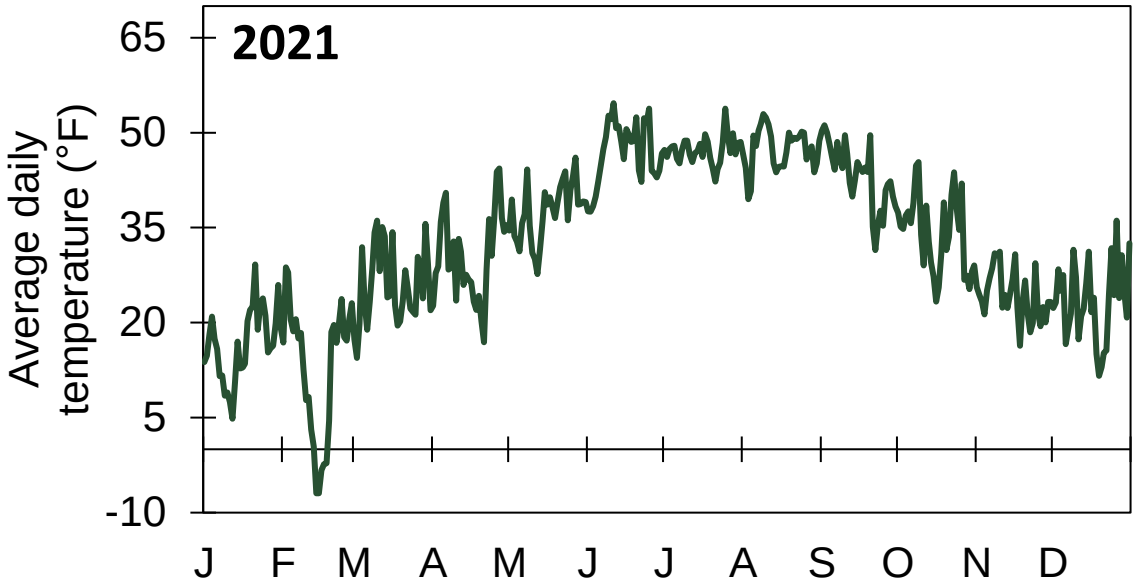
- Soil characterization
  - Samples collected at depth (0-6”, 6-12”, 12-24”, and 24-36”) prior to planting and fertilizer application
  - Elemental concentrations determined

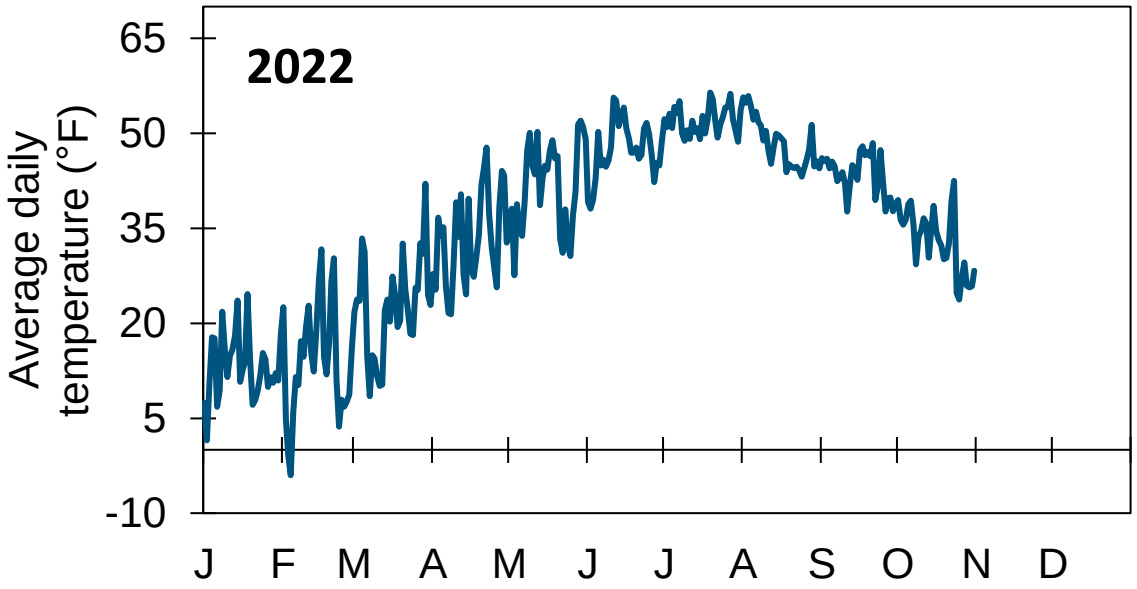
- Plant growth and health
  - Stand establishment
  - Morphological measurements
  - NDVI

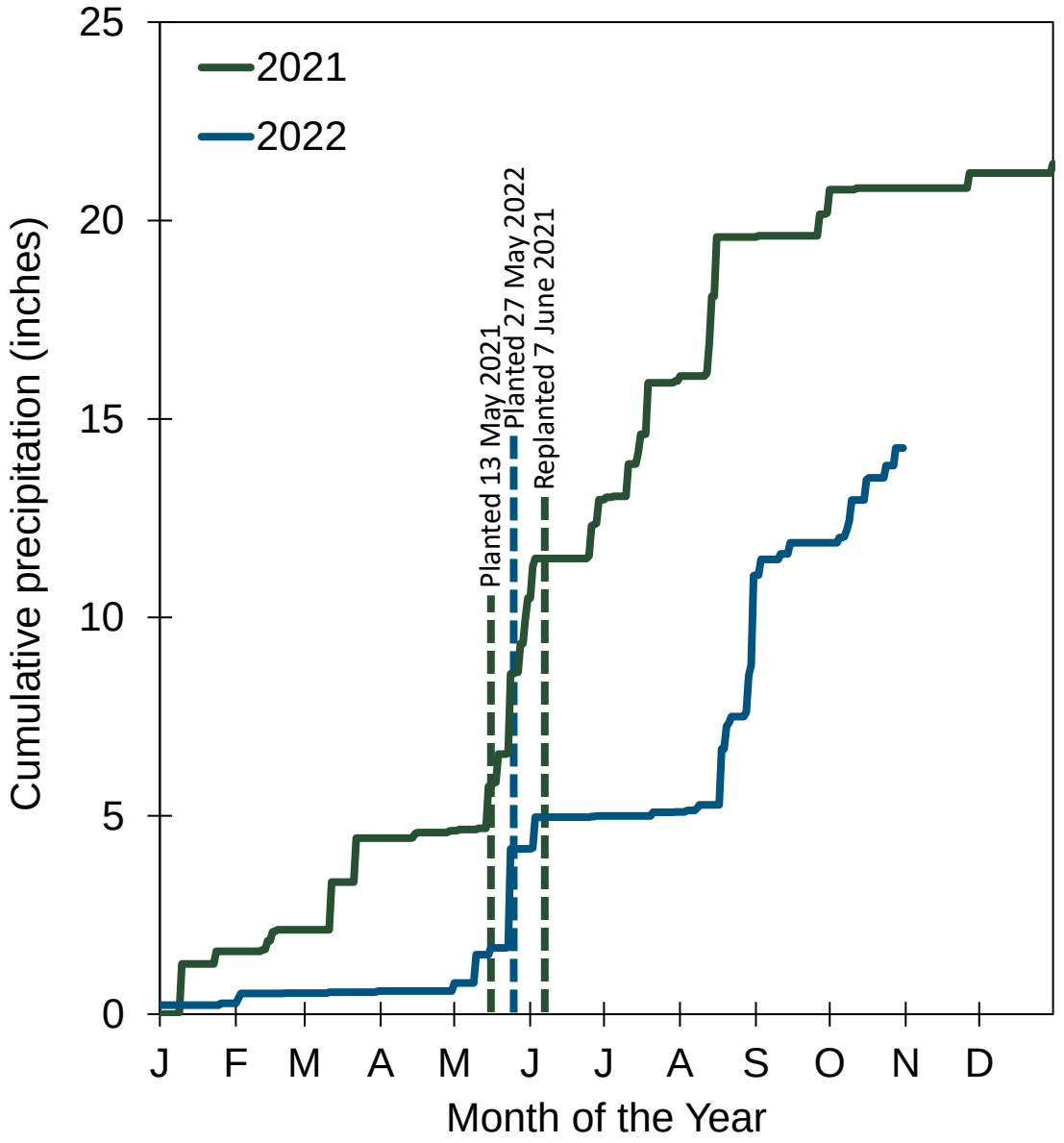
- Plant nutrient uptake
  - Plants collected at first open boll and separated into plant parts, dried, and weighed
  - Elemental concentrations determined and uptake calculated

- Lint yield and fiber quality

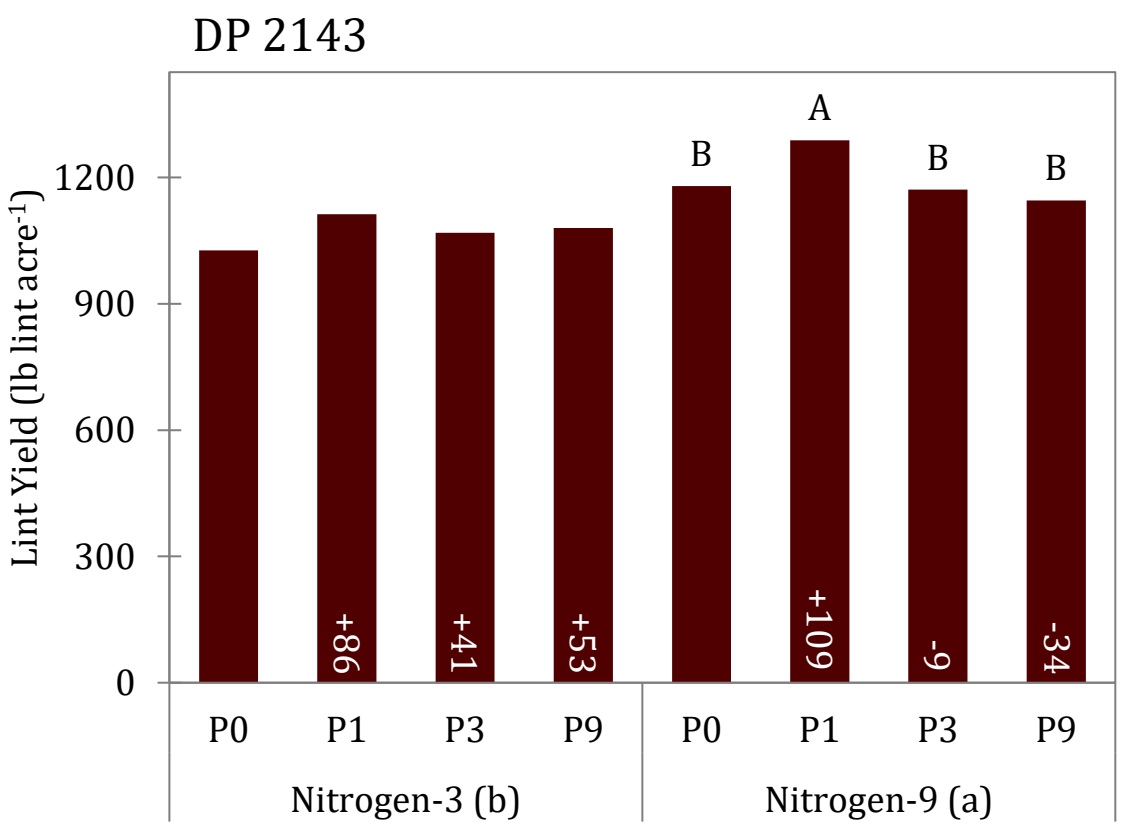
The weather (2021 and 2022)

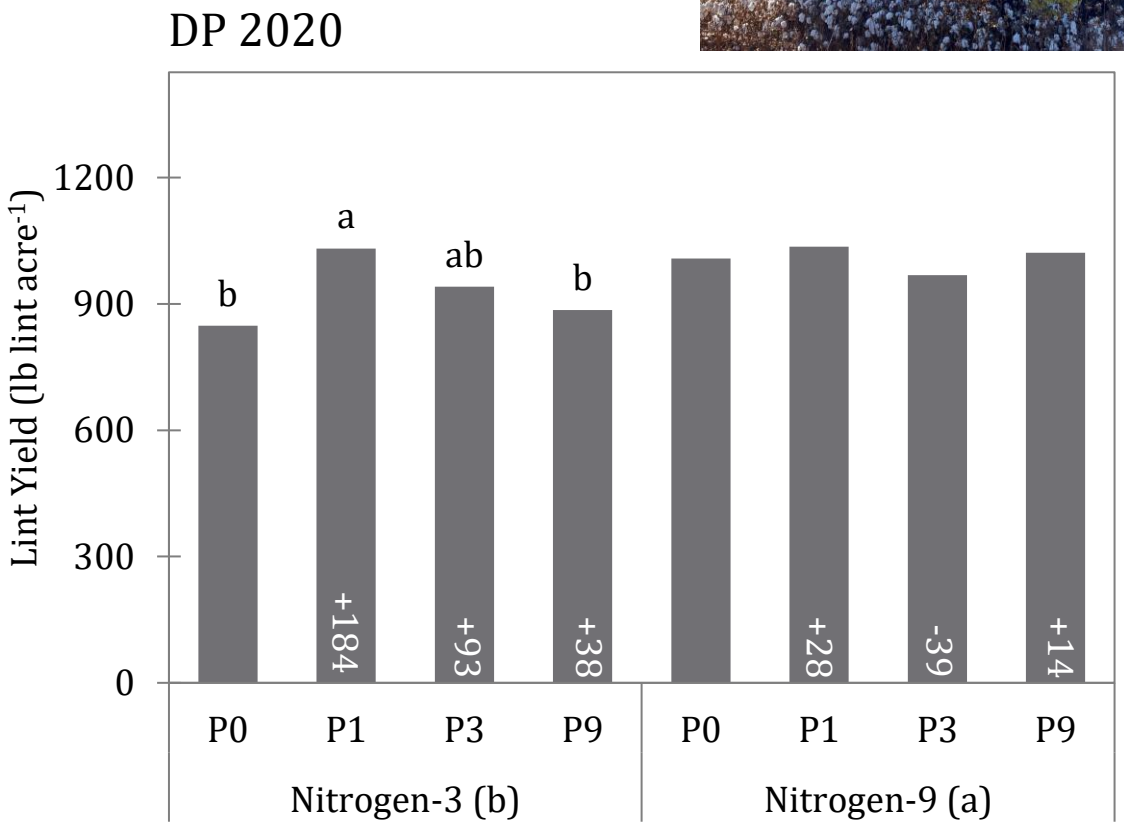






Cotton lint yield (2021)





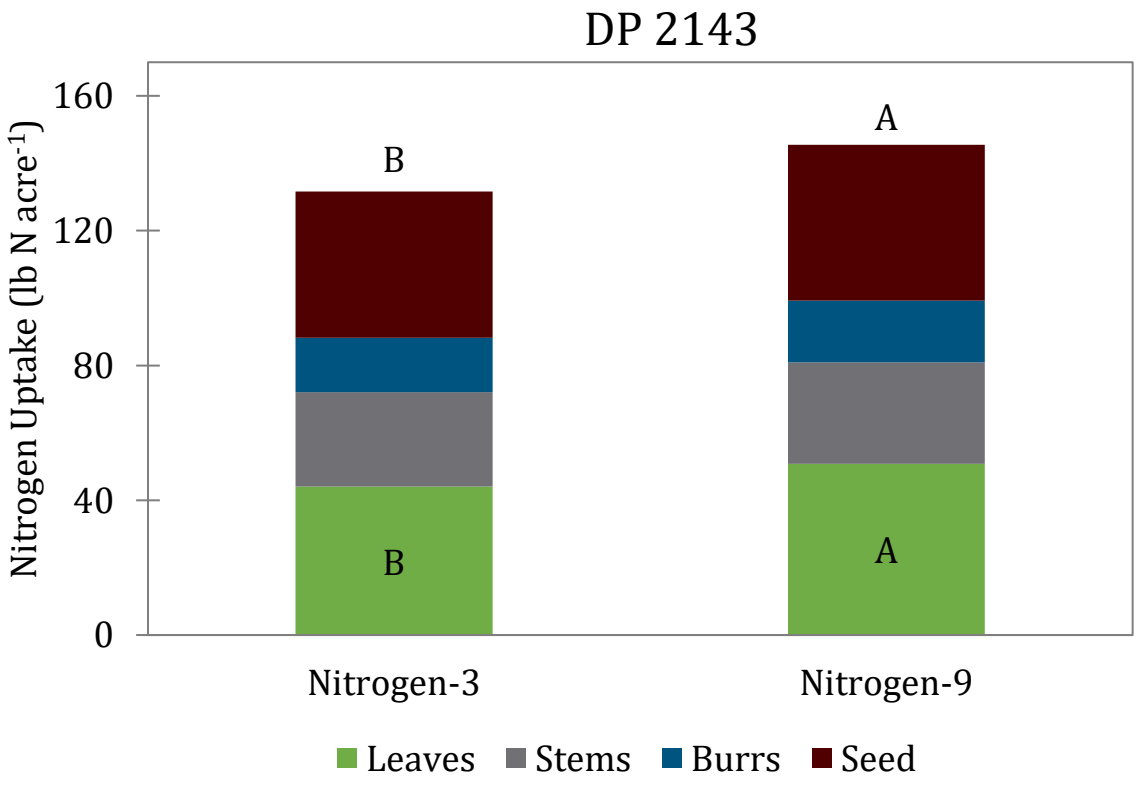
Texas A&M AgriLife Research

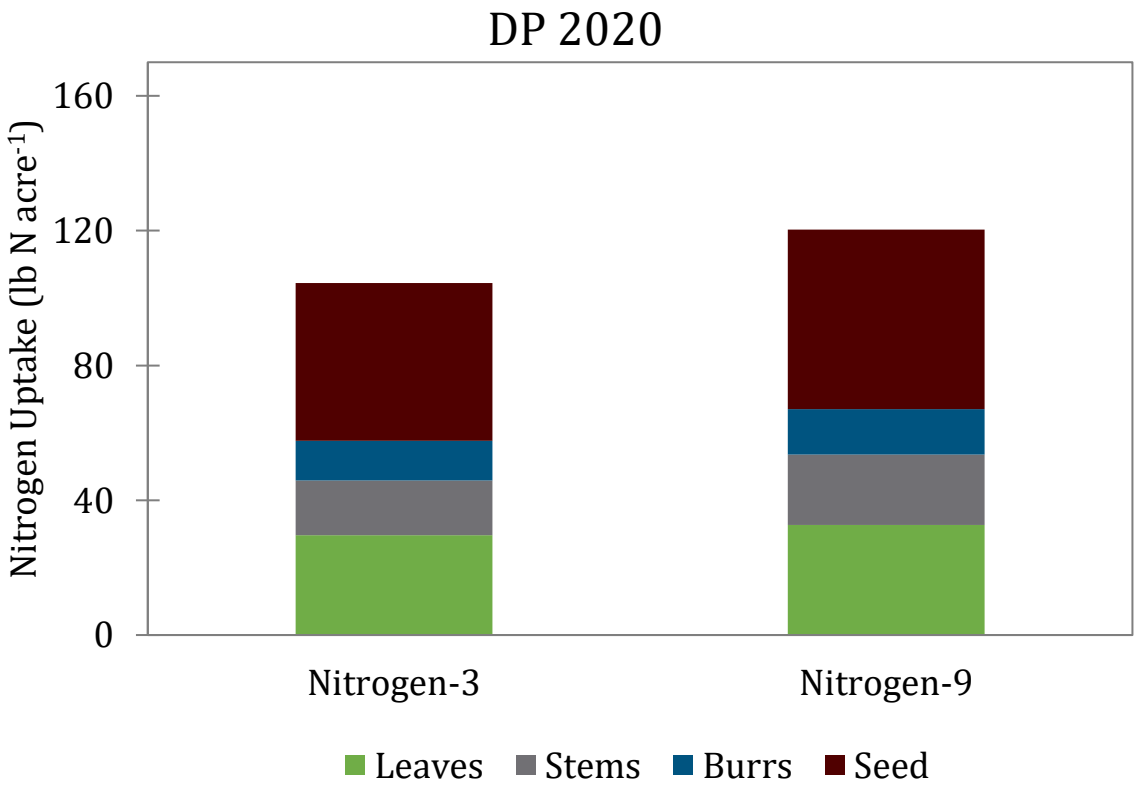
Agronomic Use Efficiency (2021)

AUE = (LY_F – LY_0)/45 lb P

N	P	AUE-P (lb lint/lb P)	
		DP 2143	DP 2020
3	1	1.90	4.08
	3	0.92	2.06
	9	1.18	0.83
9	1	2.41	0.63
	3	-0.20	-0.87
	9	-0.76	0.32

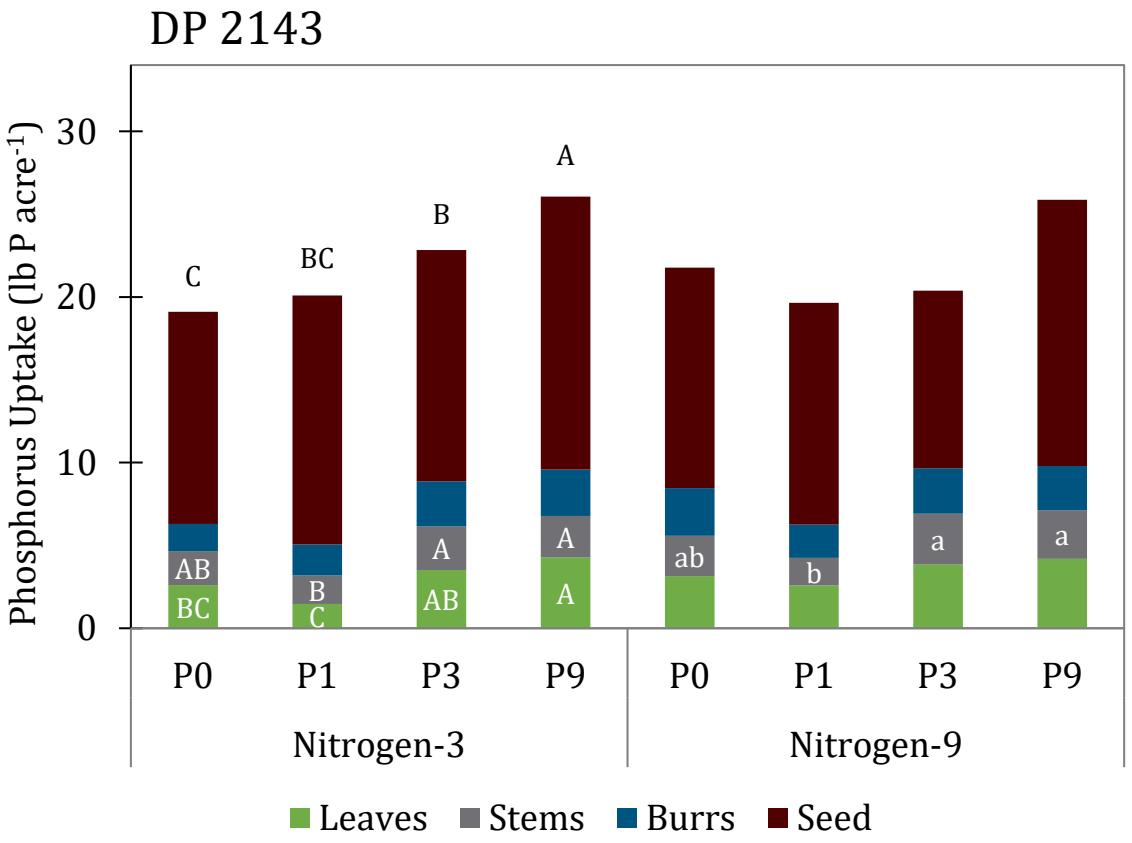
Nitrogen Uptake and Partitioning (2021)

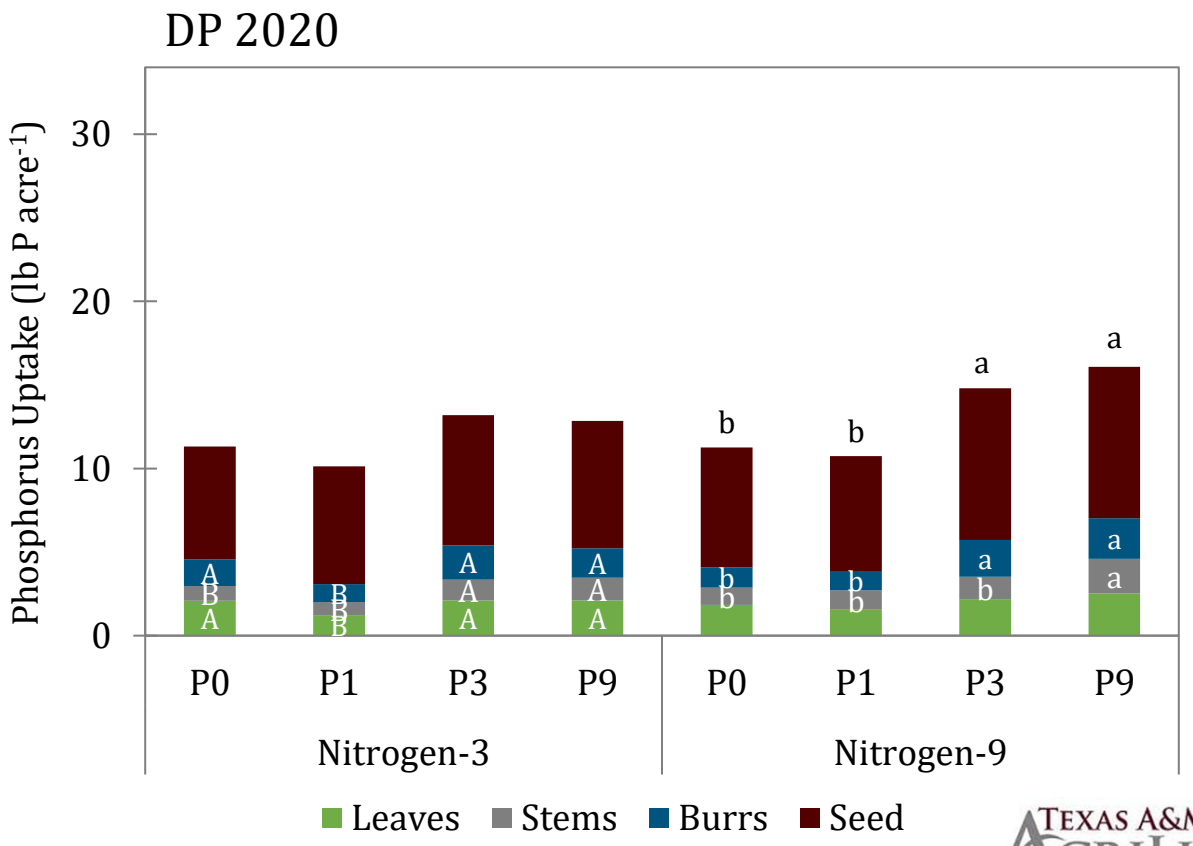




Phosphorus Uptake and Partitioning (2021)

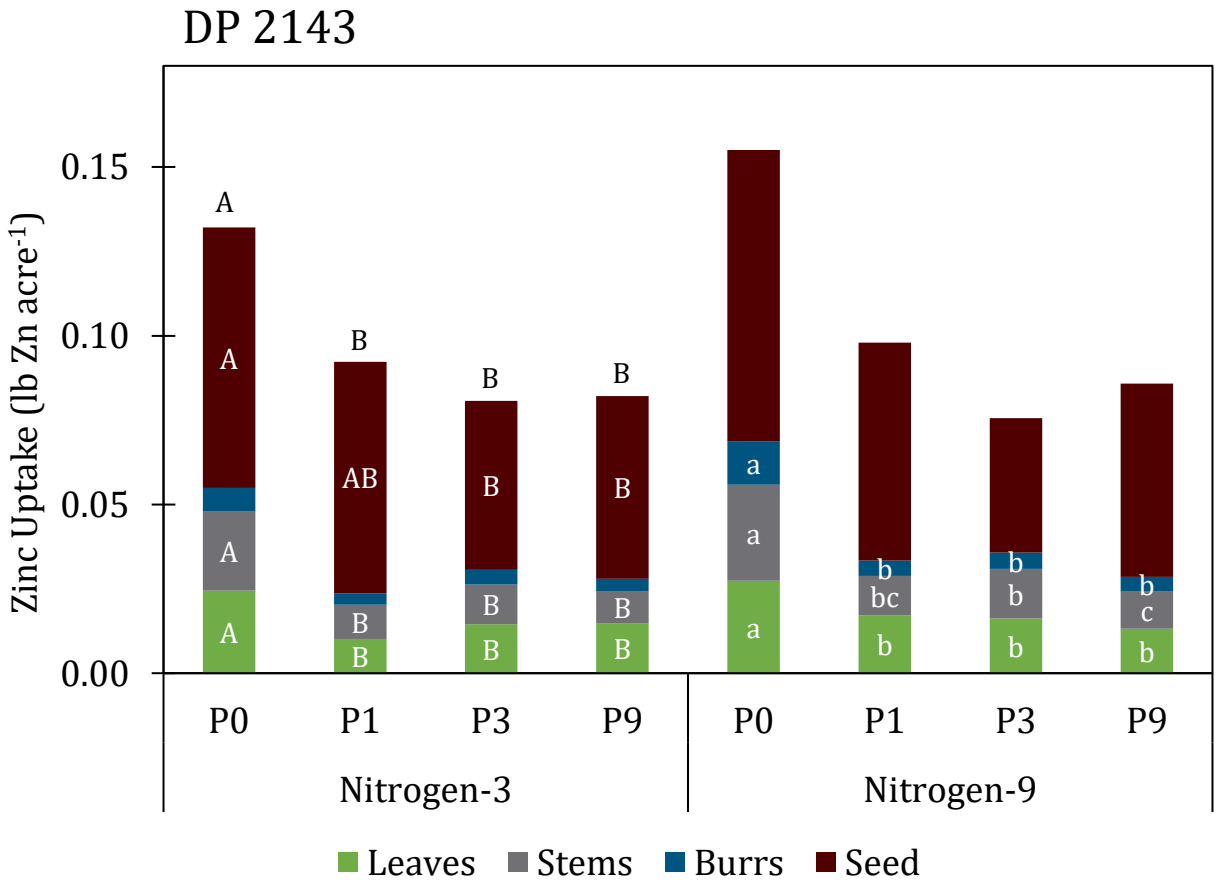
N	P	RE-P (lb/lb) DP 2143	DP 2020
3	1	0.02	-0.03
	3	0.08	0.04
	9	0.15	0.03
9	1	-0.05	-0.01
	3	-0.03	0.08
	9	0.09	0.11

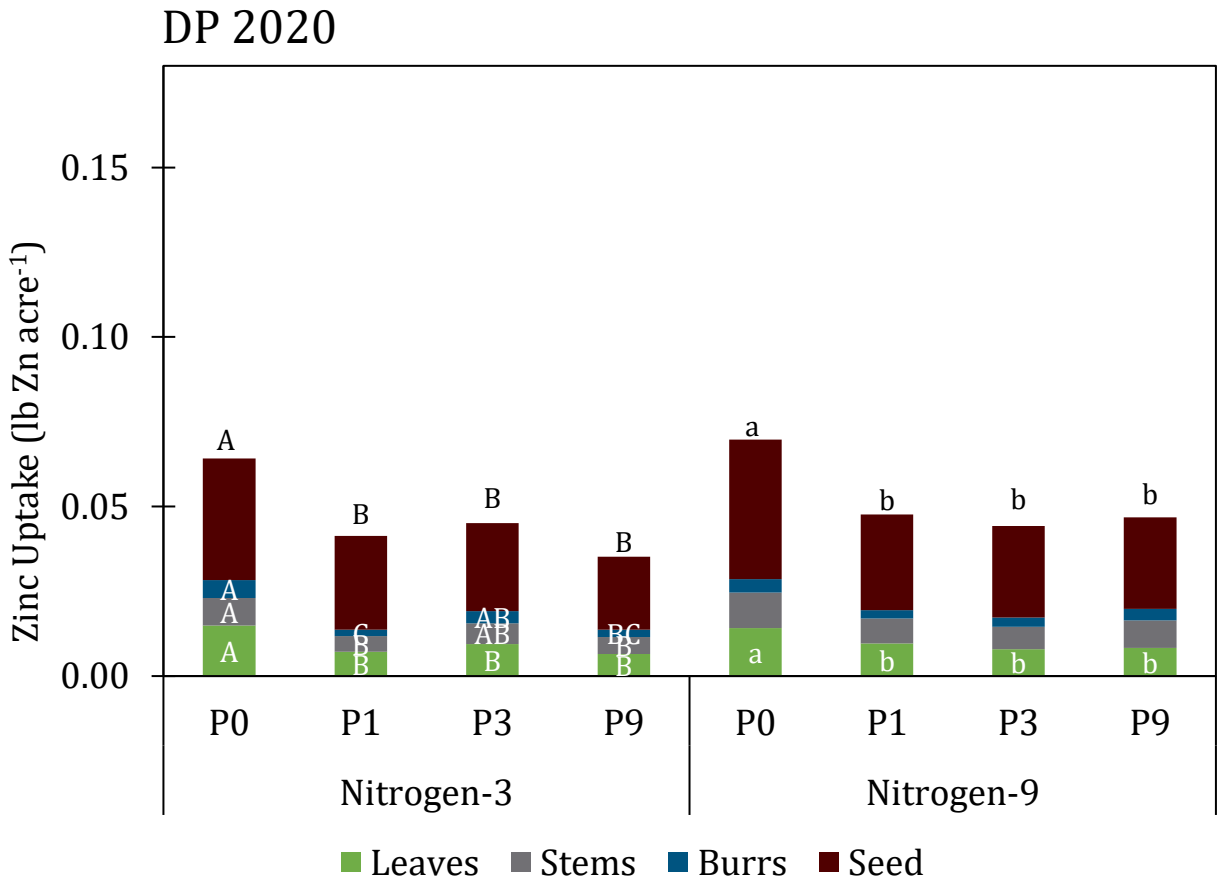




TEXAS A&M AGRILIFE RESEARCH

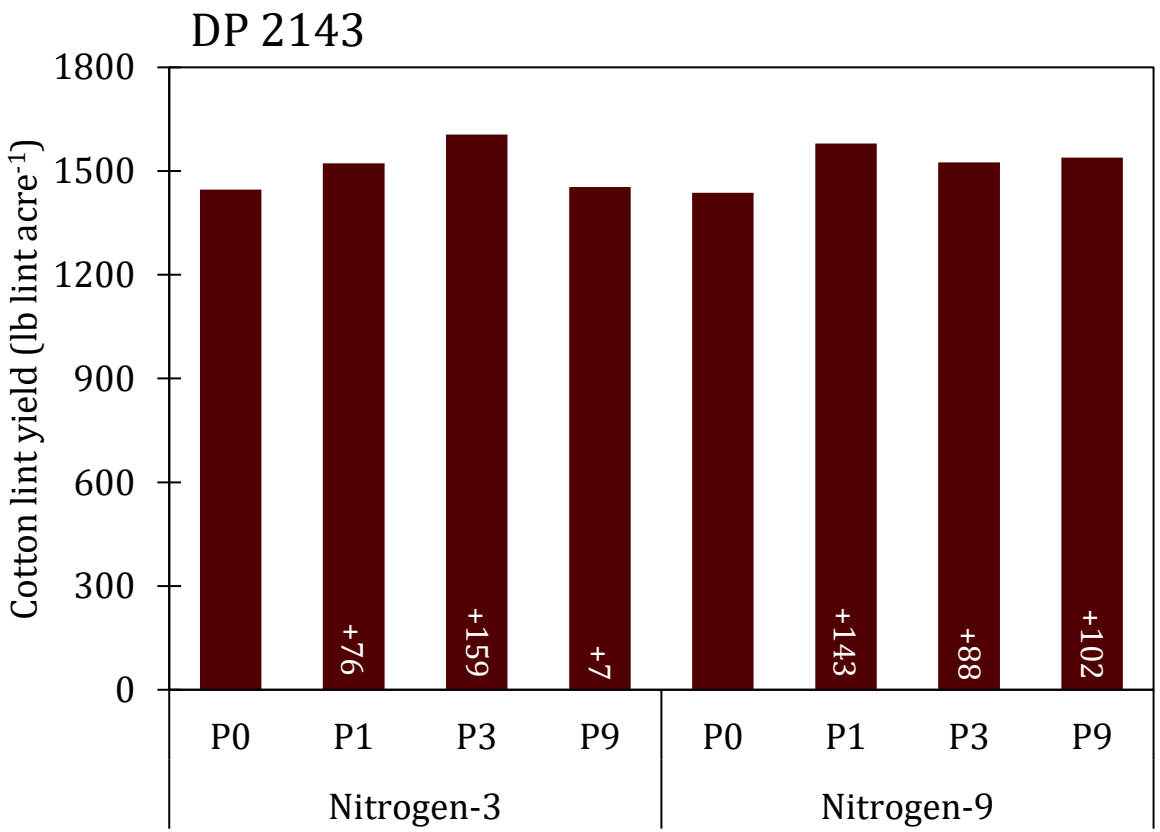
Zinc Uptake and Partitioning (2021)

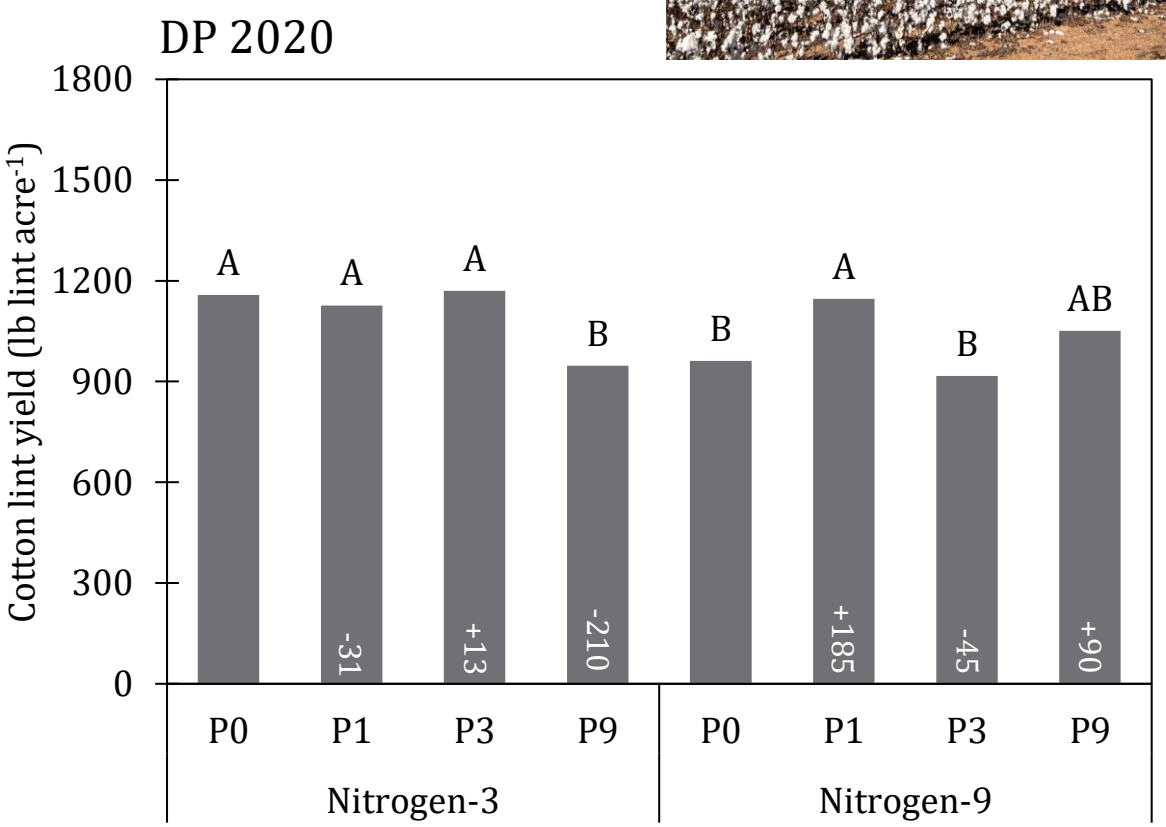




Cotton growth (2022)

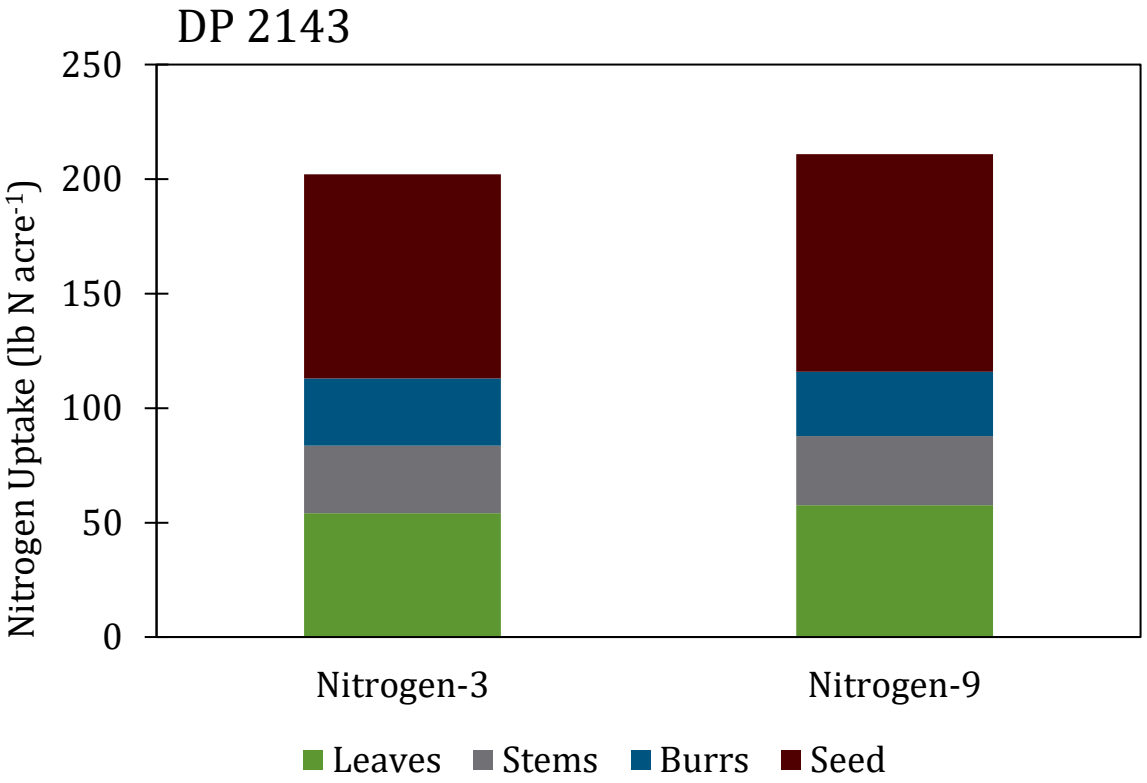
Cotton lint yield (2022)

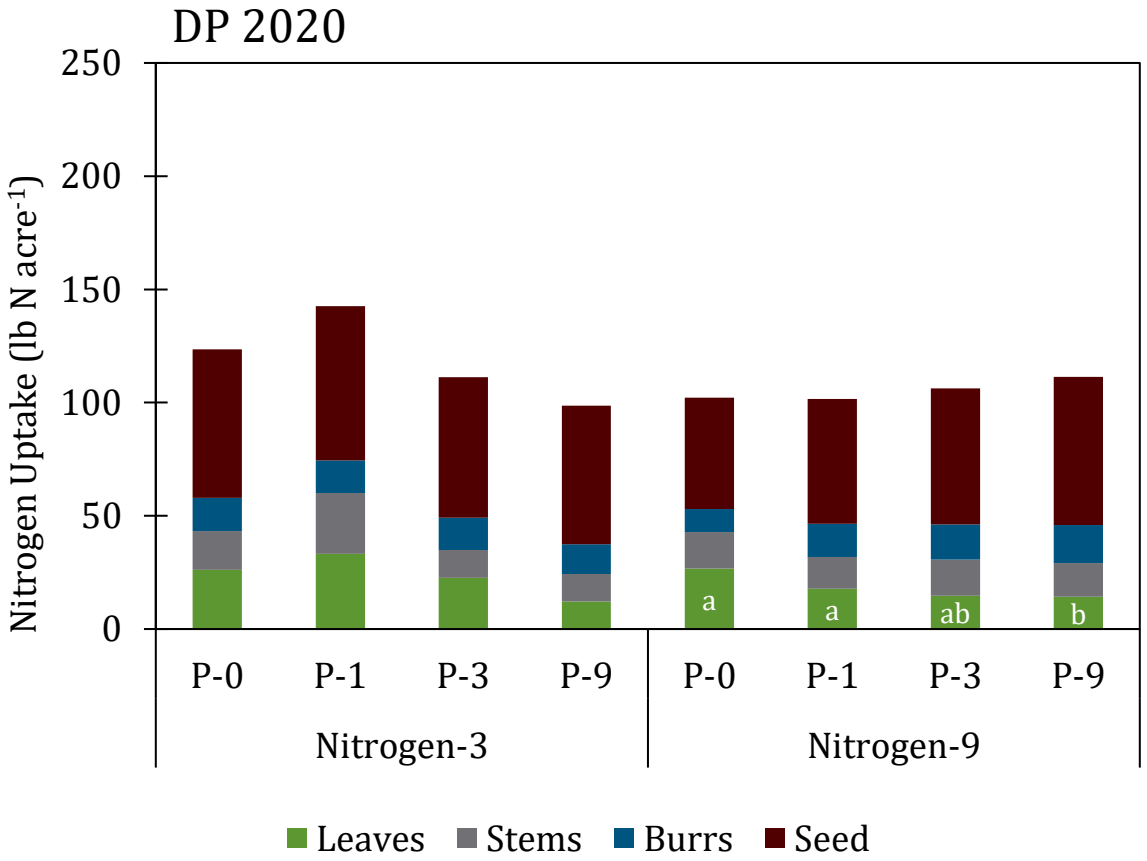




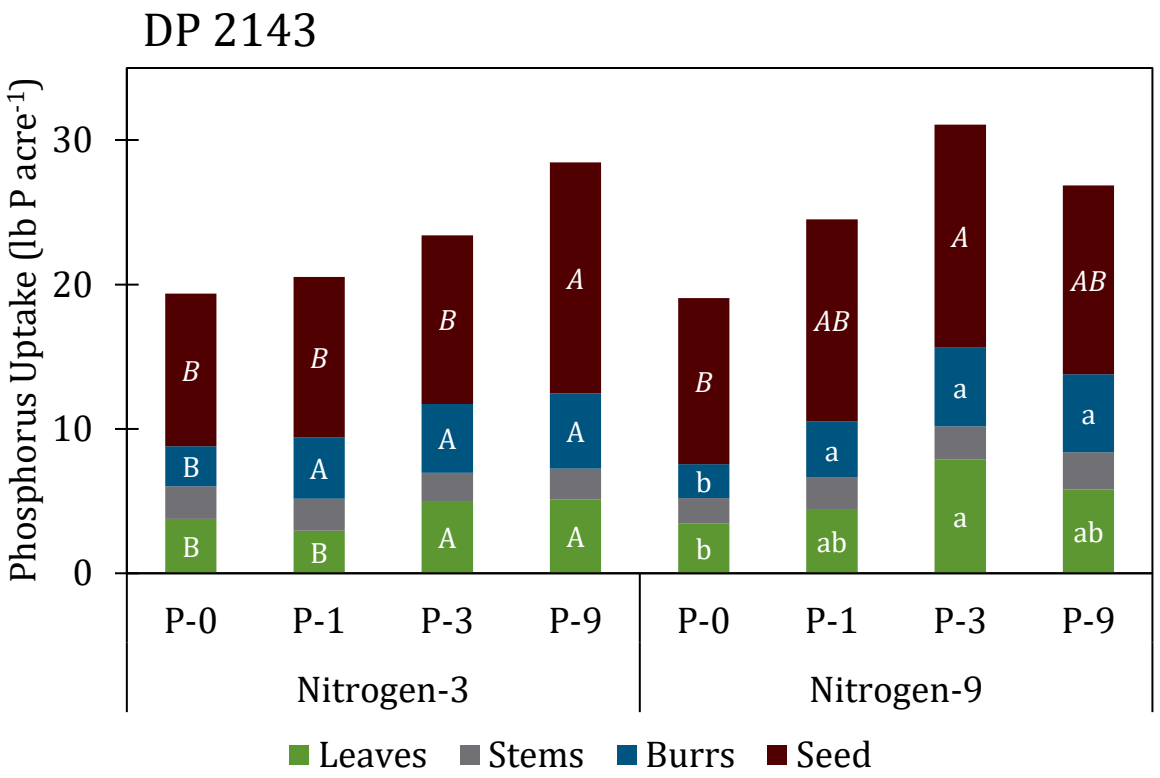
Texas A&M AgriLife Research

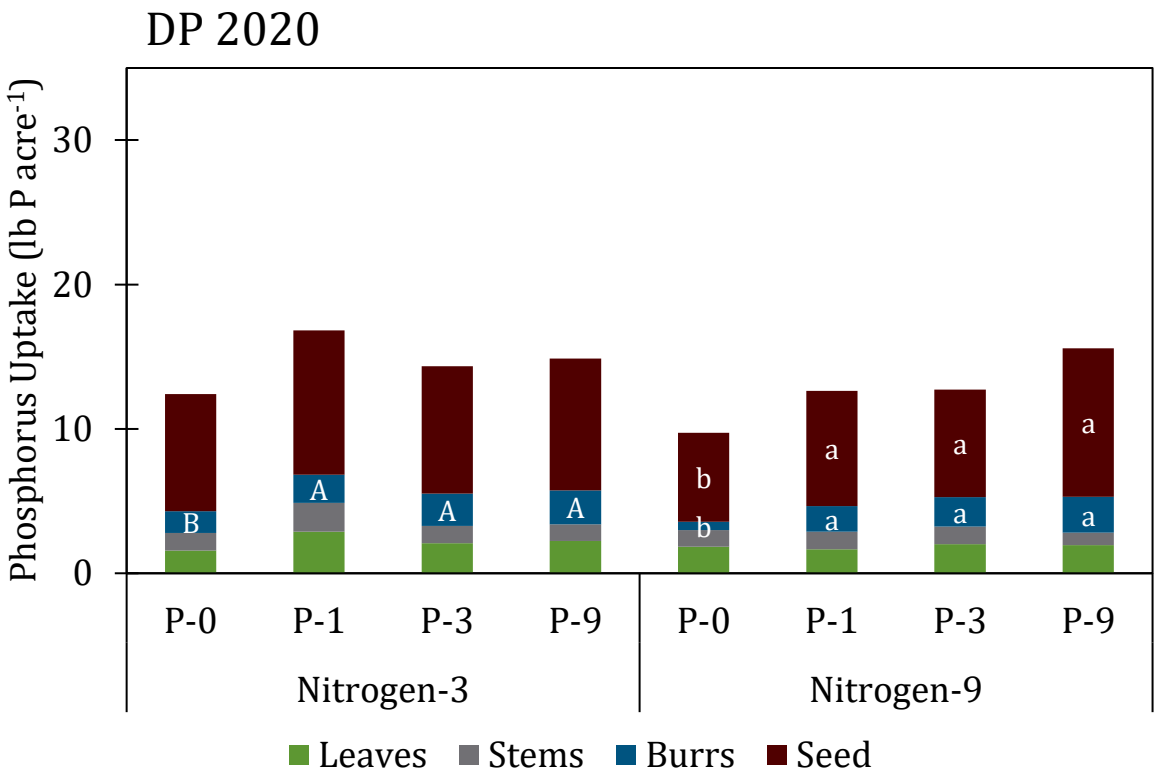
Nitrogen Uptake and Partitioning (2022)



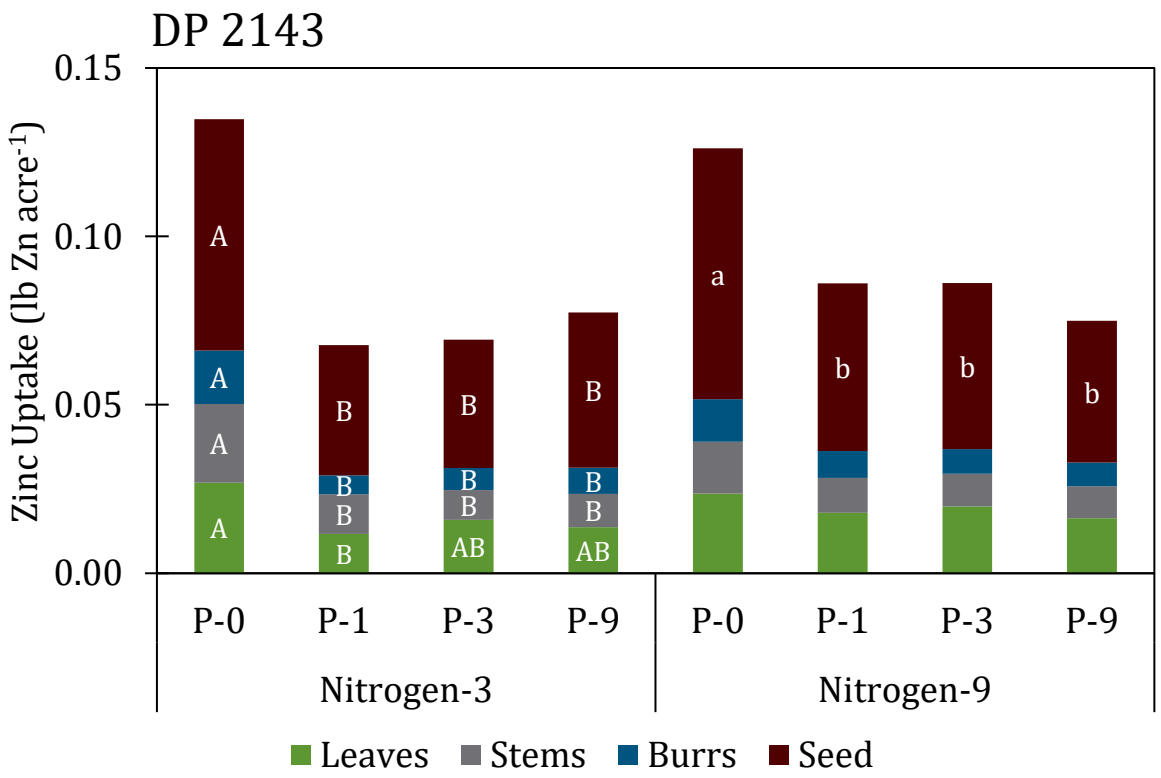


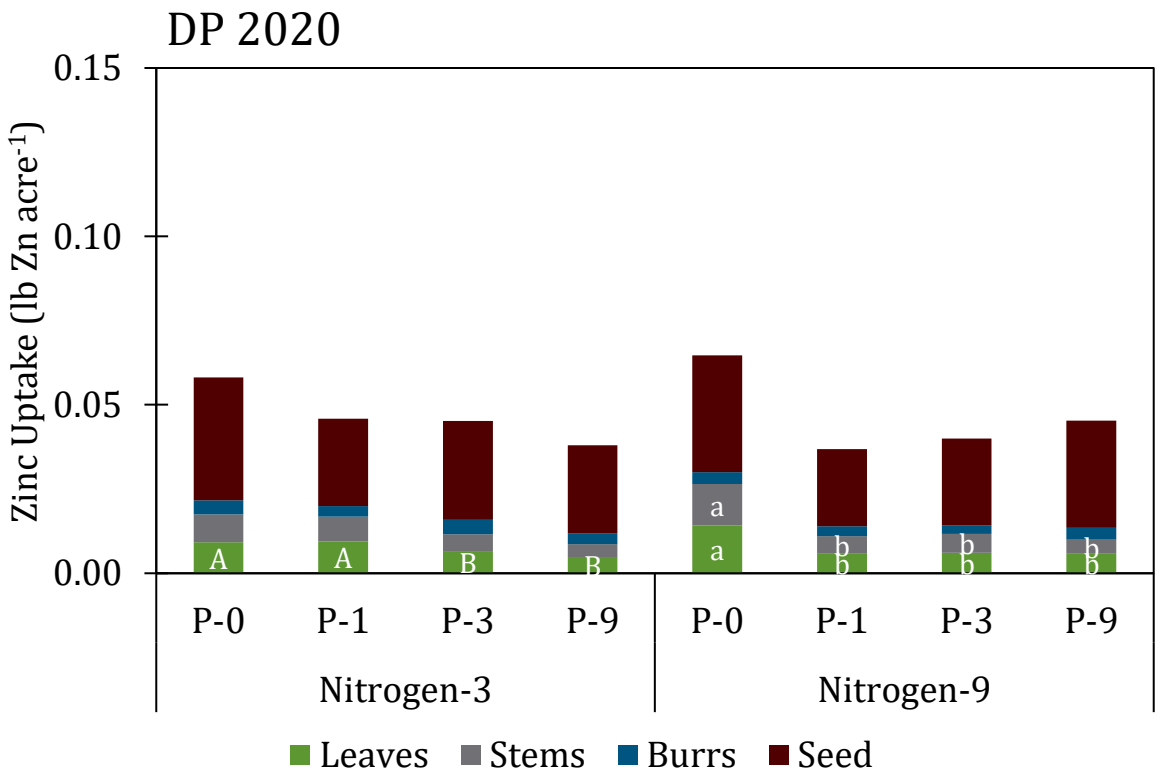
Phosphorus Uptake and Partitioning (2022)



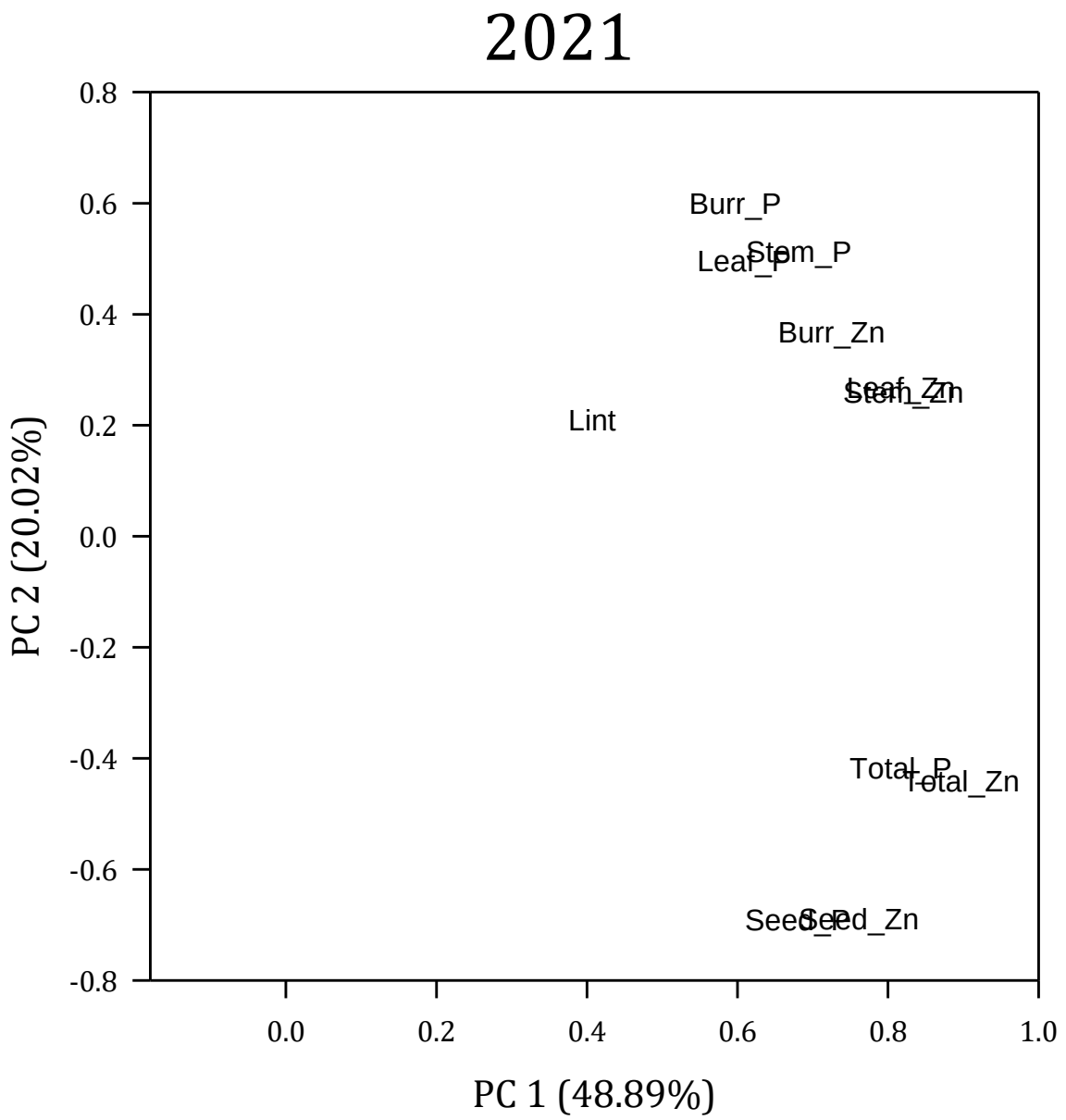


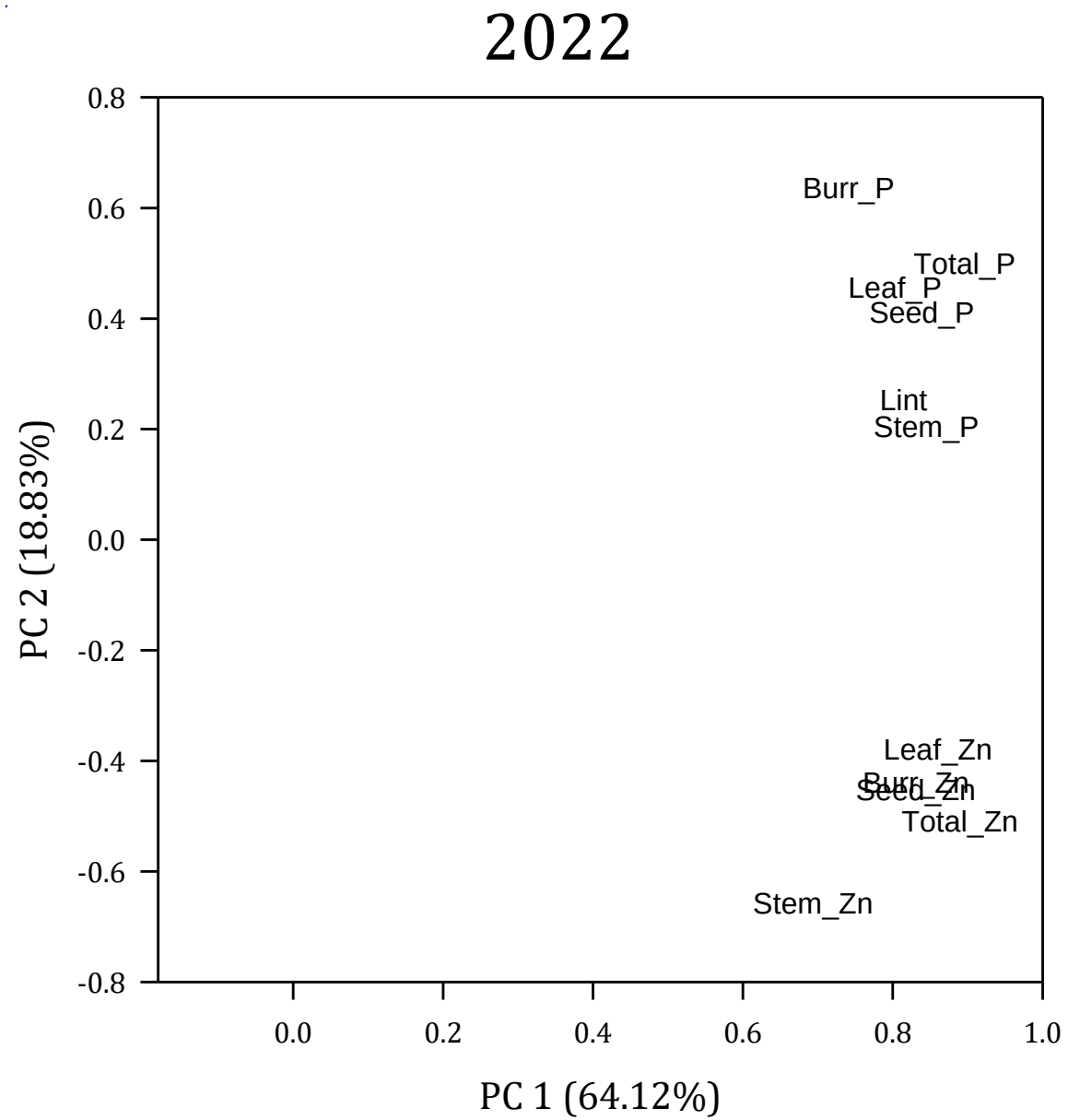
Zinc Uptake and Partitioning (2022)





Relationship between P and Zn





Summary

- Preliminary data suggest different management approaches needed for N and P when fertigating using SDI

- N resulted in generally greater yield response with greater application frequency
  - Greater uptake corresponded to greater lint yield

- Greater uptake and recovery efficiency of P when applied at a greater frequency
  - Did not result in greater yield response and AUE
  - Possibly an antagonistic effect between P and Zn uptake

Thoughts moving forward

- Year 3 results will be compiled with years 1 and 2
- Third year of data need to make farmer fertigation recommendations for cotton
- Research will direct fertigation decisions when using SDI and has the potential to make positive economic and environmental impacts

Fluid Fertilizer Foundation

Texas State Support Committee
Cotton Research and Promotion Program

THANK YOU

Katie Lewis
Associate Professor
361-815-3836
katie.lewis@ag.tamu.edu

Texas A&M AgriLife Research