Can We Jump-Start Soybeans?



Shaun N. Casteel, Purdue University
Extension Soybean Specialist
scasteel@purdue.edu
Purdue Crop Chat

SOYBEAN STATION

DELIVERING FIRST CLASS SOYBEAN INFORMATION





Phytophthora

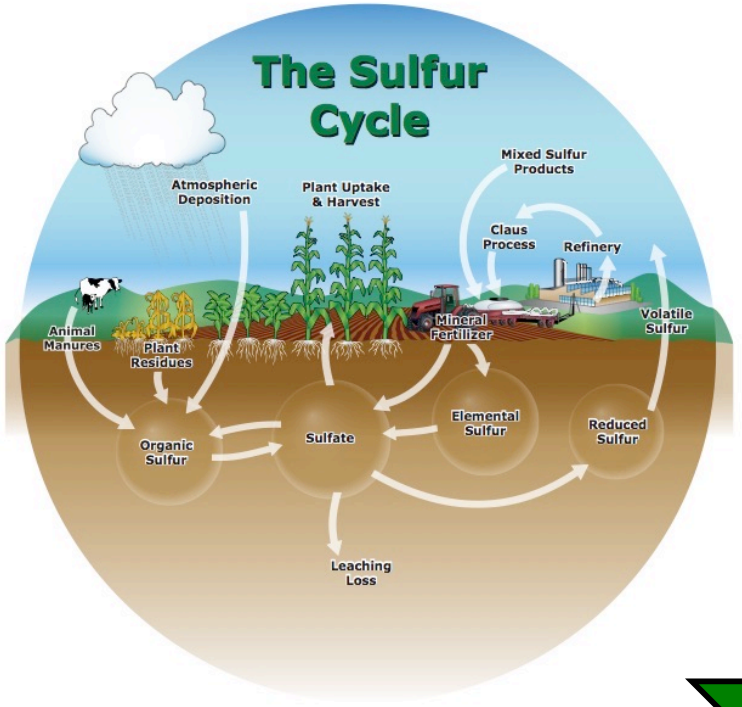


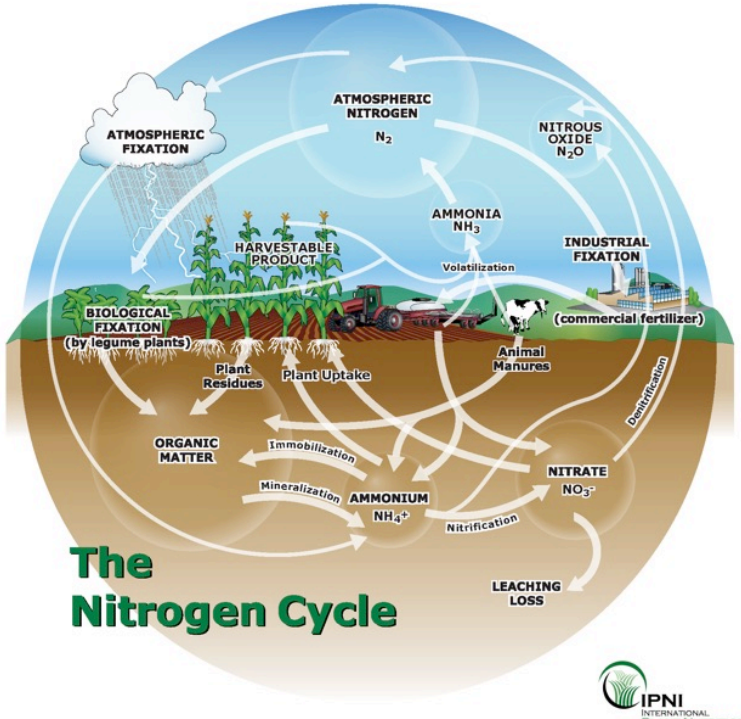


©2021 Casteel, Purdue University - 3



©2021 Casteel, Purdue University - 4





High Yielding Soybeans!

©2021 Casteel, Purdue University - 5

N+S x Planting Date: 2018

EARLY **LATE**

May 11th June 5th



©2021 Casteel, Purdue University - 6

N+S x Planting Date: 2018

- ACRE: **West Lafayette**
- 2 x 10 Factorial in RCBD with 5 reps
- Variety: AG 34x6
- 2 Planting Dates: **May 11th, June 5th**
- 10 N-S Based Treatments

©2021 Casteel, Purdue University - 7

Fertility Treatments			
Treatment	**Timing**	**N**	**S**
		lb N/ac	lb S/ac
UTC	.	.	.
AMS	PRE	17.5	20
ATS	PRE	9.3	20
AMS + UREA	PRE	40	10
AMS + UREA	V4	40	10
V4 + R3	V4 + R3 Dr	80	20
AMS + UAN	R3 Direct	40	10
UAN	R3 Direct	40	.
AMS	R3 Direct	8.75	10
R3 + CORON	R3 Dr + 4x	80	20



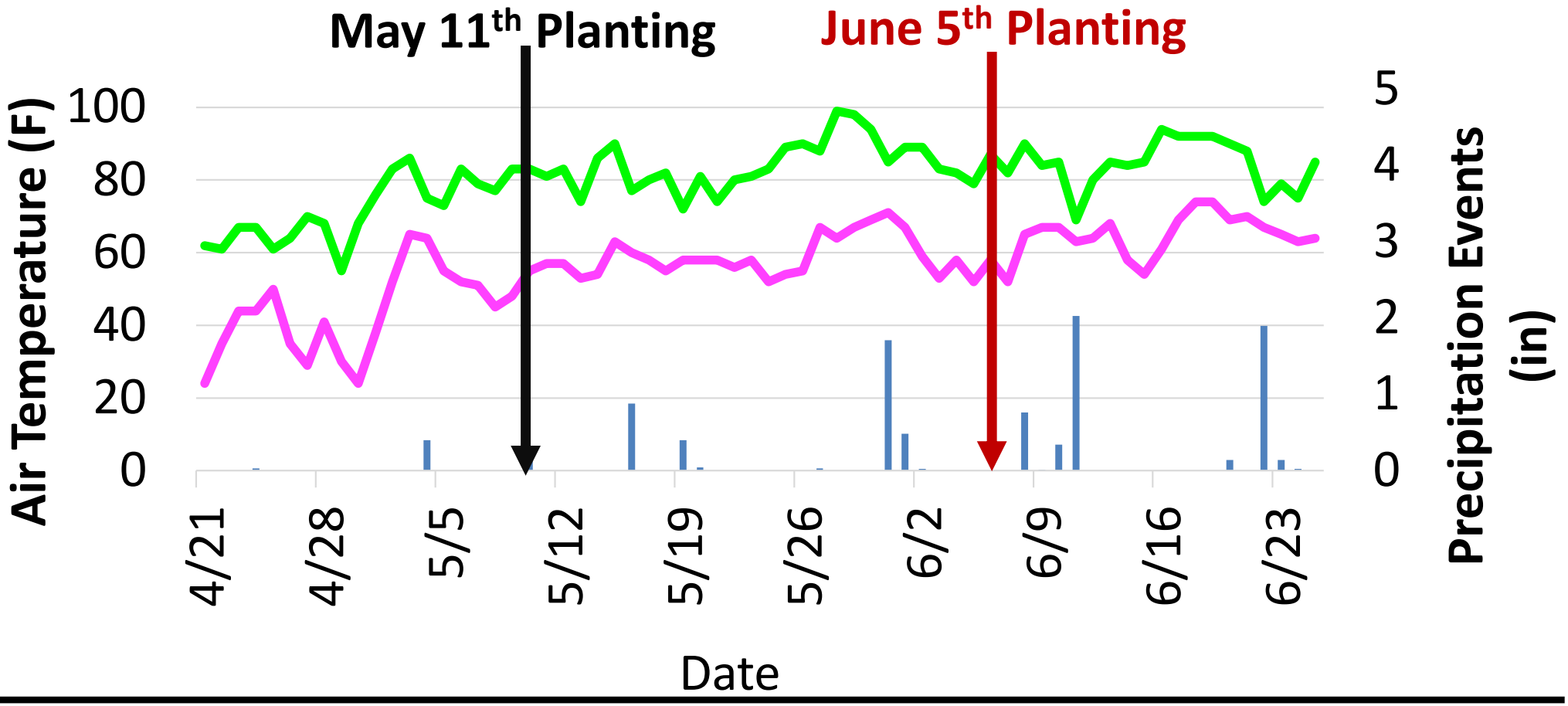


©2021 Casteel, Purdue University - 8

Fertility Treatments				*Yield*			
Treatment	**Timing**	**N**	**S**	**11-May**		**5-Jun**	
		lb N/ac	lb S/ac	bu/ac			
UTC	.	.	.	**62.4**	de	**59.2**	e
AMS	PRE	17.5	20	**69.5**	bc	**60.7**	e
ATS	PRE	9.3	20	**71.5**	abc	**61.9**	e
AMS + UREA	PRE	40	10	**74.2**	ab	**62.8**	de
AMS + UREA	V4	40	10	**75.9**	a	**58.0**	e
V4 + R3	V4 + R3 Dr	80	20	**76.1**	a	**57.6**	e
AMS + UAN	R3 Direct	40	10	**77.3**	a	**59.9**	e
UAN	R3 Direct	40	.	**72.8**	abc	**60.5**	e
AMS	R3 Direct	8.75	10	**68.1**	cd	**59.7**	e
R3 + CORON	R3 Dr + 4x	80	20	**72.4**	abc	**57.2**	e
				$LSD_{0.10} = 6.1$			

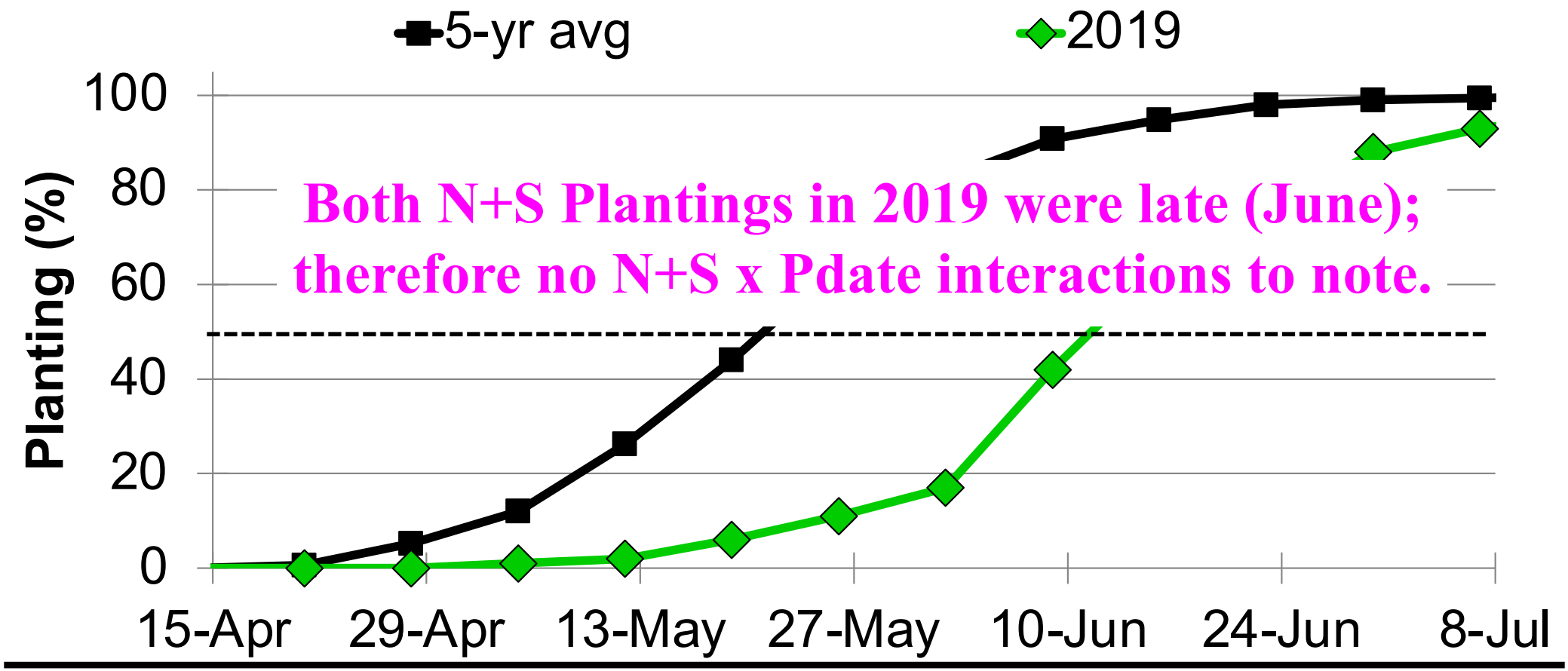
©2021 Casteel, Purdue University - 9

2018 Temperatures + Rain



©2021 Casteel, Purdue University - 10

Indiana Soybean: Late Plantings



Both N+S Plantings in 2019 were late (June); therefore no N+S x Pdate interactions to note.

USDA-NASS, 1981-2019

©2021 Casteel, Purdue University - 11

2020 N+S x Planting Date

Treatment	Timing	N	S
		lb N/ac	lb S/ac
UTC	.		
AMS	PRE	17.5	20
ATS	PRE	9.3	20
AMS + Urea	PRE	40	10
AMS + Urea	V4*	40	10
V4 + R3	V4*+ R3 Dr	80	20
AMS + UAN	R3 Direct	40	10
UAN	R3 Direct	40	.
Gypsum 10	PRE	.	10
Gypsum 20	PRE	.	20

©2021 Casteel, Purdue University - 12

2020 N+S x Planting Date

				Yield			
Treatment	**Timing**	**N**	**S**	**12-May**		**8-Jun**	
		lb N/ac	lb S/ac	bu/ac			
UTC	.			61.9	de	61.9	de
AMS	PRE	17.5	20	79.8	a	68.6	bcd
ATS	PRE	9.3	20	76.0	ab	66.1	de
AMS + Urea	PRE	40	10	82.6	a	66.5	cde
AMS + Urea	V4*	40	10	81.3	a	65.0	de
V4 + R3	V4*+ R3 Dr	80	20	83.0	a	69.7	bcd
AMS + UAN	R3 Direct	40	10	70.7	bcd	65.0	de
UAN	R3 Direct	40	.	68.0	bcd	59.1	e
Gypsum 10	PRE	.	10	76.7	ab	68.5	bcd
Gypsum 20	PRE	.	20	75.2	abc	66.7	cde

©2021 Casteel, Purdue University - 13

N+S x Planting Interactions

- **EARLY** planting still proves to increase yield.
- **N+S Fertility** increased yield in **EARLY** planted soybeans in 2018 and 2020 (10+ bu/ac)
  - Consistent protein concentrations in 2018 and 2020 TBD
- **N+S Fertility** did not affect the yield of **LATE** planted soybeans in 2018, 2019, 2020.
- **Cool and/or wet conditions** associated with **EARLY** plantings likely increased the yield response to the **N+S Fertility** due to limited mineralization of soil organic matter and slow soybean growth (roots, nodules).

©2021 Casteel, Purdue University - 14

Sulfur Starters: Rate + Placement



Objective

To determine the optimal S rate and placement for starter application

Hypothesis

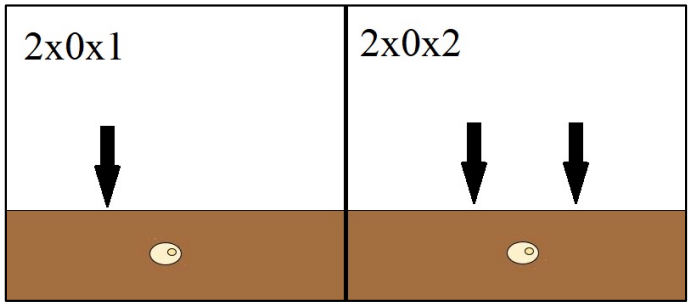
- ~10 lb S/ac will optimize the S rate response in single, but more for dual
- Dual will be better than single with more exposure to roots to improve nodulation

©2021 Casteel, Purdue University - 15

Sulfur Starters: Rate + Placement

2 x 3 x 4 Factorial + 1 UTC + 1 Standard

- **2 Methods**: Single 0 x 2, Dual 0 x 2
- **3 Sources:** **ATS** (12-0-0-26S)
  KTS (0-0-25-17S)
  K-Fuse (6-0-12-12S)
- **4 Rates:** 5, 10, 15, 20 lb S/ac
- **1 Untreated Control**
- **1 Standard:** 20 lb S/ac via Ammonium Sulfate (21-0-0-24S)



©2021 Casteel, Purdue University - 16

Fertilizer Treatments and Resulting Nutrients

Fertilizer	S Rate (lb/ac)	GPA	N (lb/ac)	K_2O (lb/ac)
ATS (12-0-0-26S)	5	1.7	2.3	.
	10	3.5	4.6	.
	15	5.2	7.0	.
	20	6.9	9.2	.
KTS (0-0-25-17S)	5	2.4	.	7.3
	10	4.8	.	14.7
	15	7.2	.	22.0
	20	9.6	.	29.3
K-Fuse (6-0-12-12S)	5	3.9	2.5	5
	10	7.7	5.0	10
	15	11.6	7.5	15
	20	15.4	10.0	20

Sulfur Starters: Rate + Placement

- **West Lafayette**
  - June 12, 2019
  - **May 13, 2020**
- **Wanatah**
  - June 7, 2019
  - June 2, 2020





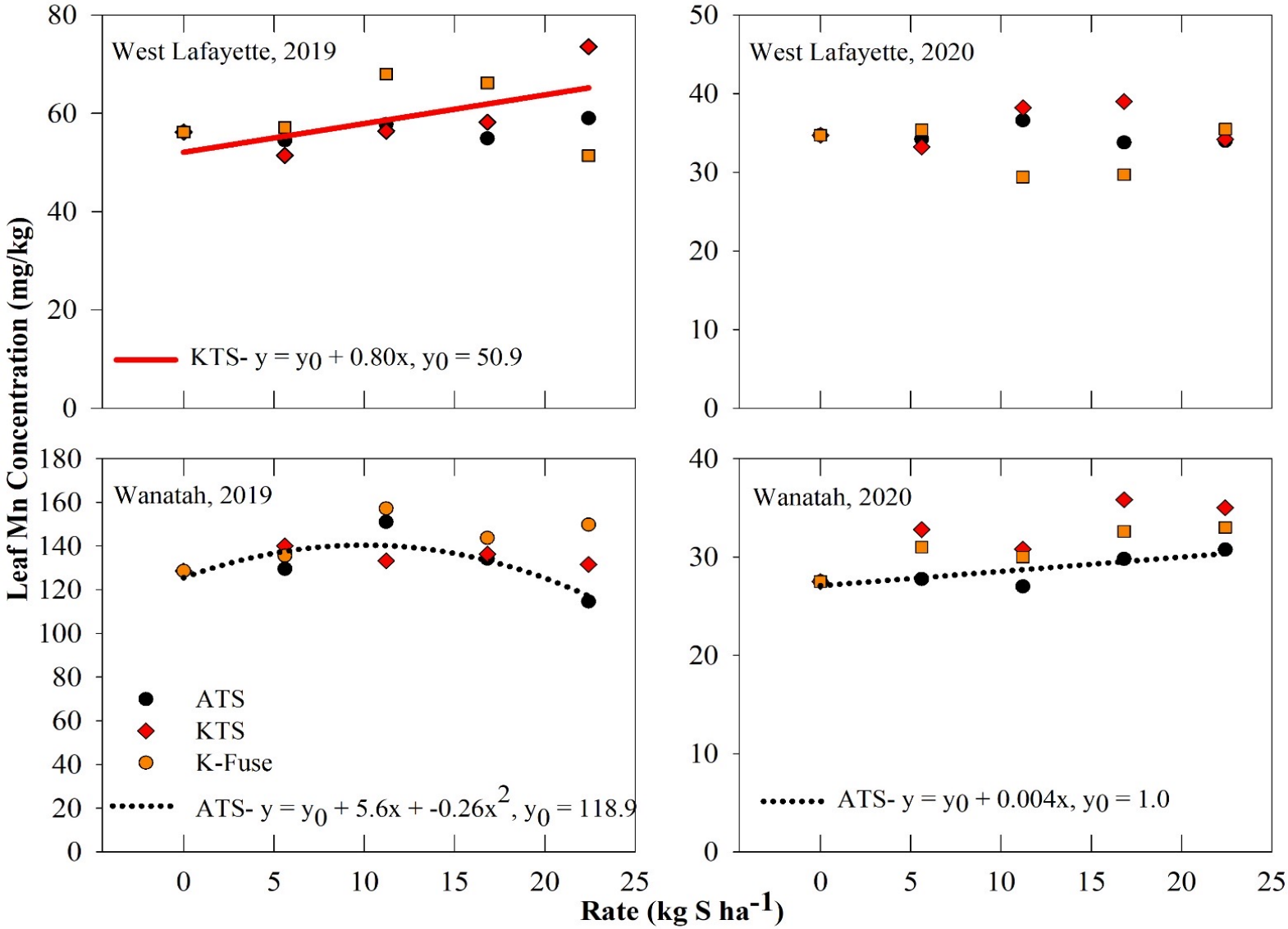
Leaf Nutrition: S, N, K

- **Sulfur** averaged 0.30% S with no differences

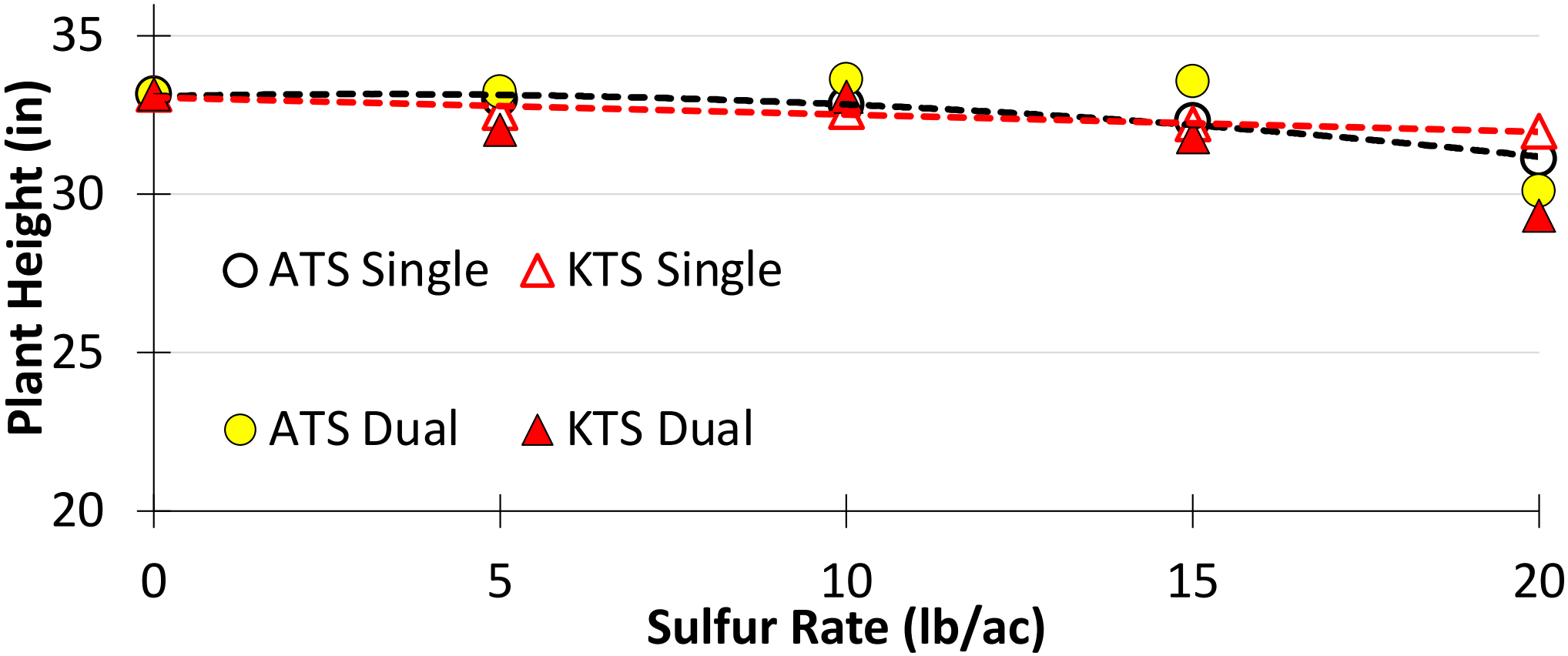
- **Nitrogen** was 5 to 6% N with no differences
- **N:S Ratio**
  - As more ATS was applied **N:S ratio decreased in quadratic manner** in West Lafayette in 2020.
  - Other site years were 15-20 N:S
- **Potassium** averaged 1.5 to 2.0% K with no differences

©2021 Casteel, Purdue University - 19

Mn


West Lafayette, 2019
KTS- y = y0 + 0.80x, y0 = 50.9
West Lafayette, 2020
Wanatah, 2019
ATS
KTS
K-Fuse
ATS- y = y0 + 5.6x + -0.26x2, y0 = 118.9
Wanatah, 2020
ATS- y = y0 + 0.004x, y0 = 1.0
Leaf Mn Concentration (mg/kg)
Rate (kg S ha-1)

R5.5 Height: W. Lafayette

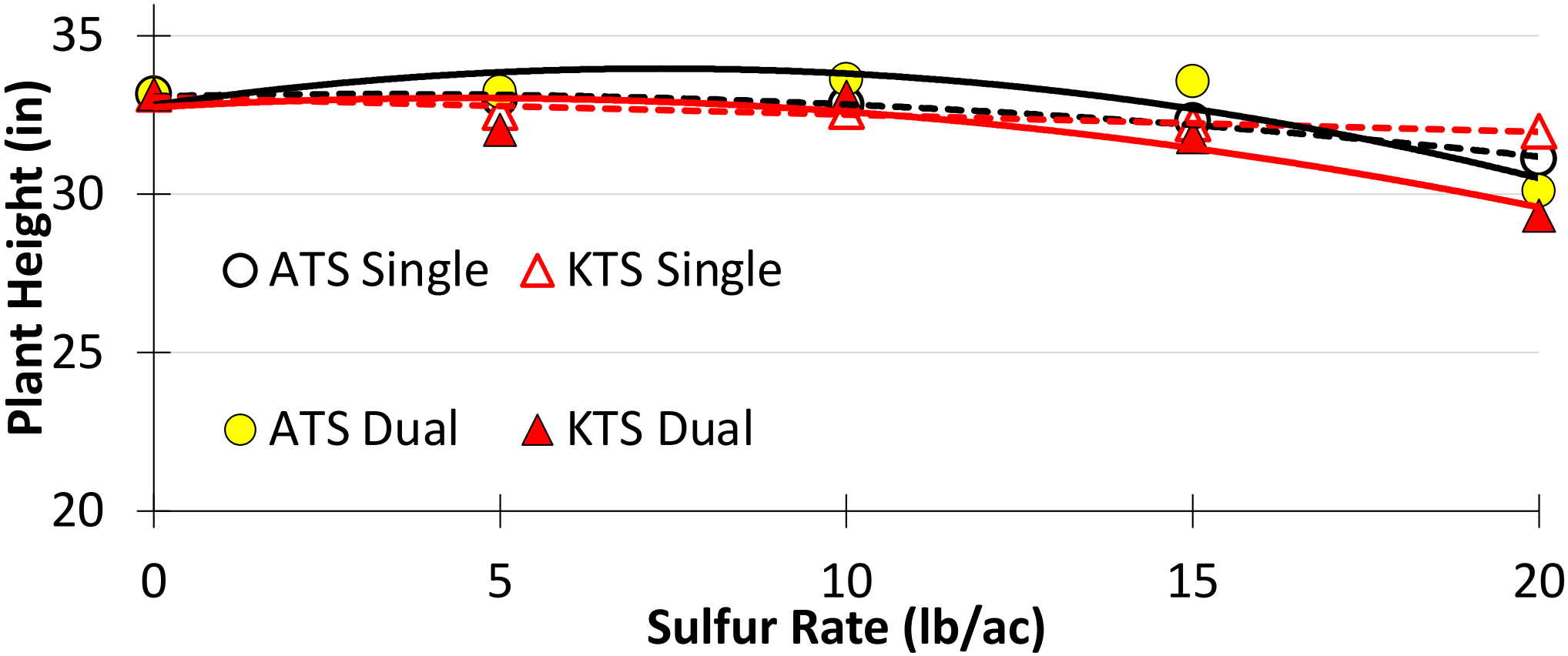


SOYBEAN STATION

DELIVERING FIRST CLASS INFORMATION

©2021 Casteel, Purdue University - 21

R5.5 Height: W. Lafayette

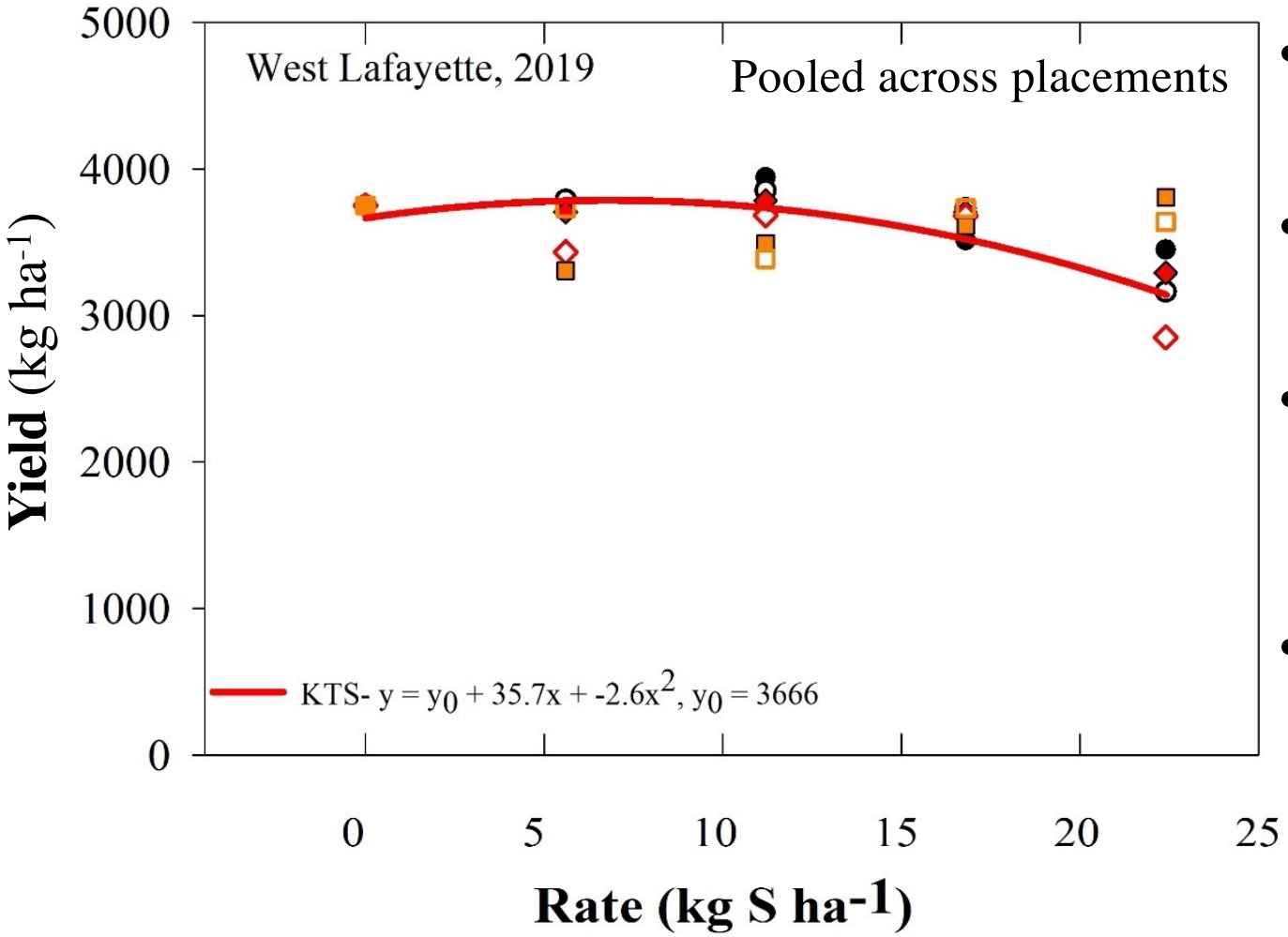


SOYBEAN STATION

DELIVERING FIRST CLASS INFORMATION

©2021 Casteel, Purdue University - 22

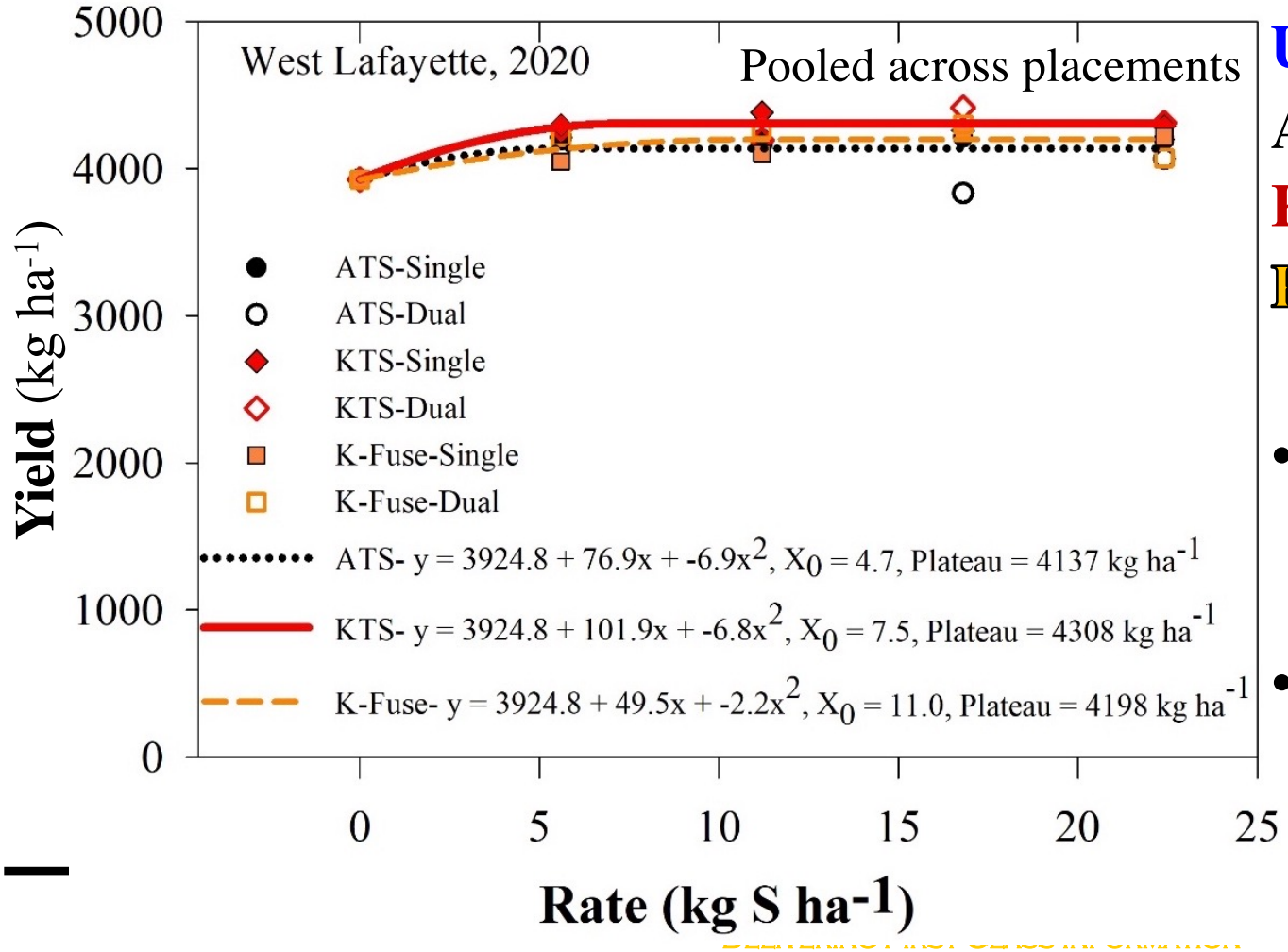
2019 Yield → S Starters: Rate + Placement



- Stands impeded ~4000 ppa by Dual
- R5.5 Height (~2 in) stunted at high KTS
- Nutrient conc at R3 did not change, except Mn increase
- Protein and oil did not change

©2021 Casteel, Purdue University - 23

2020 Yield → S Starters: Rate + Placement



UTC: **58.3 bu**

ATS: 4.2 lb S/ac, 61.5 bu

KTS: 6.7 lb S/ac, 64.0 bu

K-Fuse: 9.8 lb S/ac, 62.4 bu

- Stands, R3 nutrient conc., plant ht at R5, and oil did not differ.
- Protein increased ~1.5%

©2021 Casteel, Purdue University - 24

Preliminary Thoughts on S Starters

- Starter S rates of 4 – 10 lb S/ac has the potential of **increasing yield and protein** based on timely planting in 2020 of a prairie soil (~3.5% OM).
- Starter S rates should **NOT** be applied above 15 lb S/ac or in Dual placement

©2021 Casteel, Purdue University - 26

Starter x Planting: West Lafayette 20-21

	N	P	K2O	S
UTC	.	.	.	.
AMS	13.1	.	.	15
ATS	7.0	.	.	15
Fuse	7.5	.	15	15
KTS	.	.	22	15
UAN	7.0	.	.	.

©2021 Casteel, Purdue University - 27

Starter x Planting: West Lafayette 20-21

	N	P	K2O	S	Pdate 1		Pdate 2	
UTC	.	.	.	.	66.0	ab	55.5	c
AMS	13.1	.	.	15	63.1	b	59.0	c
ATS	7.0	.	.	15	67.5	ab	55.2	c
Fuse	7.5	.	15	15	67.9	a	56.7	c
KTS	.	.	22	15	69.2	a	57.2	c
UAN	7.0	.	.	.	68.9	a	56.4	c
					67.1		**56.7**	

©2021 Casteel, Purdue University - 28

AMS
20 lb S



UTC

©2021 Casteel, Purdue University - 29



S Fertilizer Blends Broadcasted at Planting of Soybean

©2021 Casteel, Purdue University - 30

Treatment	Sulfur	Nitrogen	Phosphorus	Potassium
	lb S/ac	lb N/ac	lb P_2O_5/ac	lb K_2O/ac
Untreated	.	.	.	.
N	.	17.5	.	.
P	.	.	40	.
K	.	.	.	60
NPK	.	17.5	40	60

©2021 Casteel, Purdue University - 31

Treatment	Sulfur	Nitrogen	Phosphorus	Potassium
	lb S/ac	lb N/ac	lb P_2O_5/ac	lb K_2O/ac
Untreated	.	.	.	.
N	.	17.5	.	.
P	.	.	40	.
K	.	.	.	60
NPK	.	17.5	40	60
Sulfur + N	20	17.5	.	.
Sulfur + P	20	17.5	40	.
Sulfur + K	20	17.5	.	60
Sulfur + NPK	20	17.5	40	60

©2021 Casteel, Purdue University - 32

2019 Sulfur x NPK

	No AMS		AMS	
UTC	50.0	b		
N	50.0	b	53.4	b
P	53.5	b	57.8	a
K	45.3	c	50.9	b
NPK	50.8	b	50.7	b



- K impeded yield ~ 5 bu/ac
  - Addition of N and P alleviated the yield hit (same as UTC)
  - Addition of N and S alleviated the yield hit (same as UTC)
- ~8 bu/ac improvement with AMS + P

©2021 Casteel, Purdue University - 33

2020 Sulfur x NPK

	No AMS		AMS	
UTC	50.6			
N	54.4	cde	63.3	a
P	56.8	bcd	58.9	abc
K	51.4	e	62.3	a
NPK	53.7	de	60.2	ab

- K did not have negative impact
- 6.2 bu/ac improvement with P
- 12.7 bu/ac improvement with AMS
  - 3.8 bu/ac numeric improvement with N (urea alone)

©2021 Casteel, Purdue University - 34

21 W. Lafayette: S+NPK x Variety

	Chloride Includer			Chloride Intermed.	
Source	No AMS	AMS		No AMS	AMS
UTC	64.2			71.6	
N	65.8	72.8		71.1	77.2
P	65.0	75.1		73.2	81.8
K	65.2	70.7		69.1	79.2
NPK	66.0	69.4		70.6	78.3

©2021 Casteel, Purdue University - 35

21 Wanatah: S+NPK x Variety

	Chloride Includer			Chloride Intermed.	
Source	No AMS	AMS		No AMS	AMS
UTC	71.0			69.0	
N	72.2	74.2		69.2	69.2
P	72.1	75.9		69.7	69.9
K	70.9	75.7		68.4	70.5
NPK	74.5	74.7		68.5	69.5

©2021 Casteel, Purdue University - 36

Sulfur Fertilizers for Soybean

- **Broadcast of 15 to 20 lb S/ac** with soluble source near planting such as AMS, MES10, or pelletized Gypsum
  - 2nd Tier: ATS prior to emergence or K-Mag
- **Leaf Nutritional Snapshots then Apply Sulfur**
  - "Close" to **critical S levels (0.25%)**
  - **N:S ~18:1 or higher**
- **Do NOT blend with Potash (0-0-60, KCl) for applications near planting. Increased risk of Cl injury to roots and nodules. More recommendations forthcoming.**
- **Blending with Phosphorus sources more promising**

©2021 Casteel, Purdue University - 37

Funding Support





©2021 Casteel, Purdue University - 38

QUESTIONS?



Shaun Casteel, scasteel@purdue.edu

Purdue Crop Chat



©2021 Casteel, Purdue University - 40

18-19 Synergy: Addition

		Seed	——Plant——			——R1——		———R3-R4———		
	TREATMENT	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
1	Untreated (UTC)	.	.	.	.	.	.	.	.	.
2	Inoculant	Inoc	.	.	.	.	.	.	.	.
3	TSP: 40 lb P_2O_5	.	TSP	.	.	.	.	.	.	.
4	AMS: 20 lb S	.	.	AMS	.	.	.	.	.	.
5	In-Furrow: 8 lb P_2O_5	.	.	.	OP	.	.	.	.	.
6	EMS: 0.5 lb S	.	.	.	.	EMS	.	.	.	.
7	PGR: Utilize	.	.		.	.	PGR	.	.	.
8	Fung: Viathon	.	.	.	.	.	.	Fung	.	.
9	Insect: Sultrus	.	.	.	.	.	.	.	Insect	.
10	Coron: 5.1 lb N	.	.	.	.	.	.	.	.	Coron
11	FULL	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron

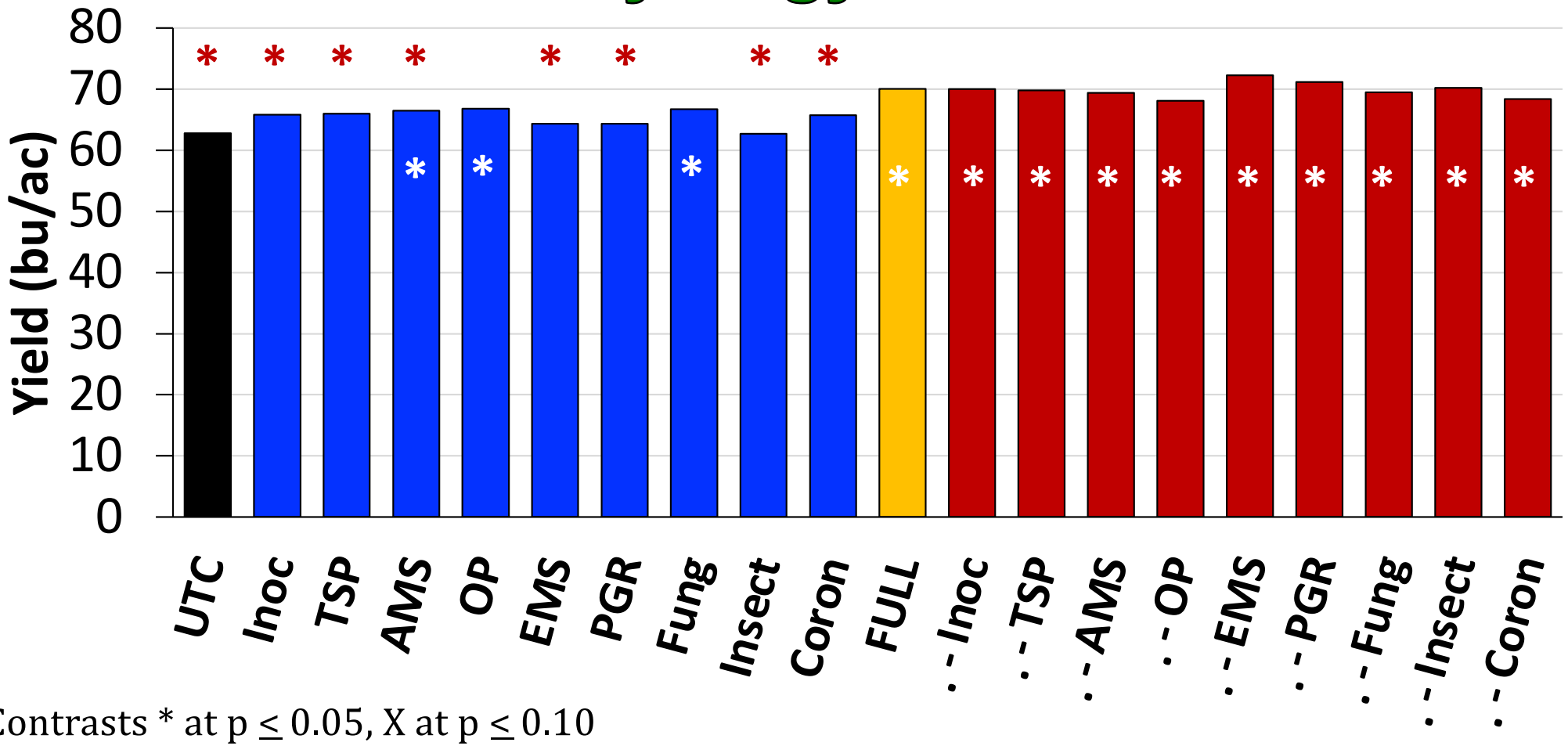
DELIVERING FIRST CLASS INFORMATION

18-19 Synergy: Omission

		Seed	——Plant——			——R1——		———R3-R4———		
	TREATMENT	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
1	Untreated (UTC)	.	.	.	.	.	.	.	.	.
11	FULL	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
12	FULL - Inoc	.	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
13	FULL - TSP	Inoc	.	AMS	OP	EMS	PGR	Fung	Insect	Coron
14	FULL - AMS	Inoc	TSP	.	OP	EMS	PGR	Fung	Insect	Coron
15	FULL - OP	Inoc	TSP	AMS	.	EMS	PGR	Fung	Insect	Coron
16	FULL - EMS	Inoc	TSP	AMS	OP	.	PGR	Fung	Insect	Coron
17	FULL - PGR	Inoc	TSP	AMS	OP	EMS	.	Fung	Insect	Coron
18	FULL - Fung	Inoc	TSP	AMS	OP	EMS	PGR	.	Insect	Coron
19	FULL - Insect	Inoc	TSP	AMS	OP	EMS	PGR	Fung	.	Coron
20	FULL - Coron	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	.

Soybean Station
Delivering First Class Information
©2021 Casteel, Purdue Univ

18 Synergy: Yield

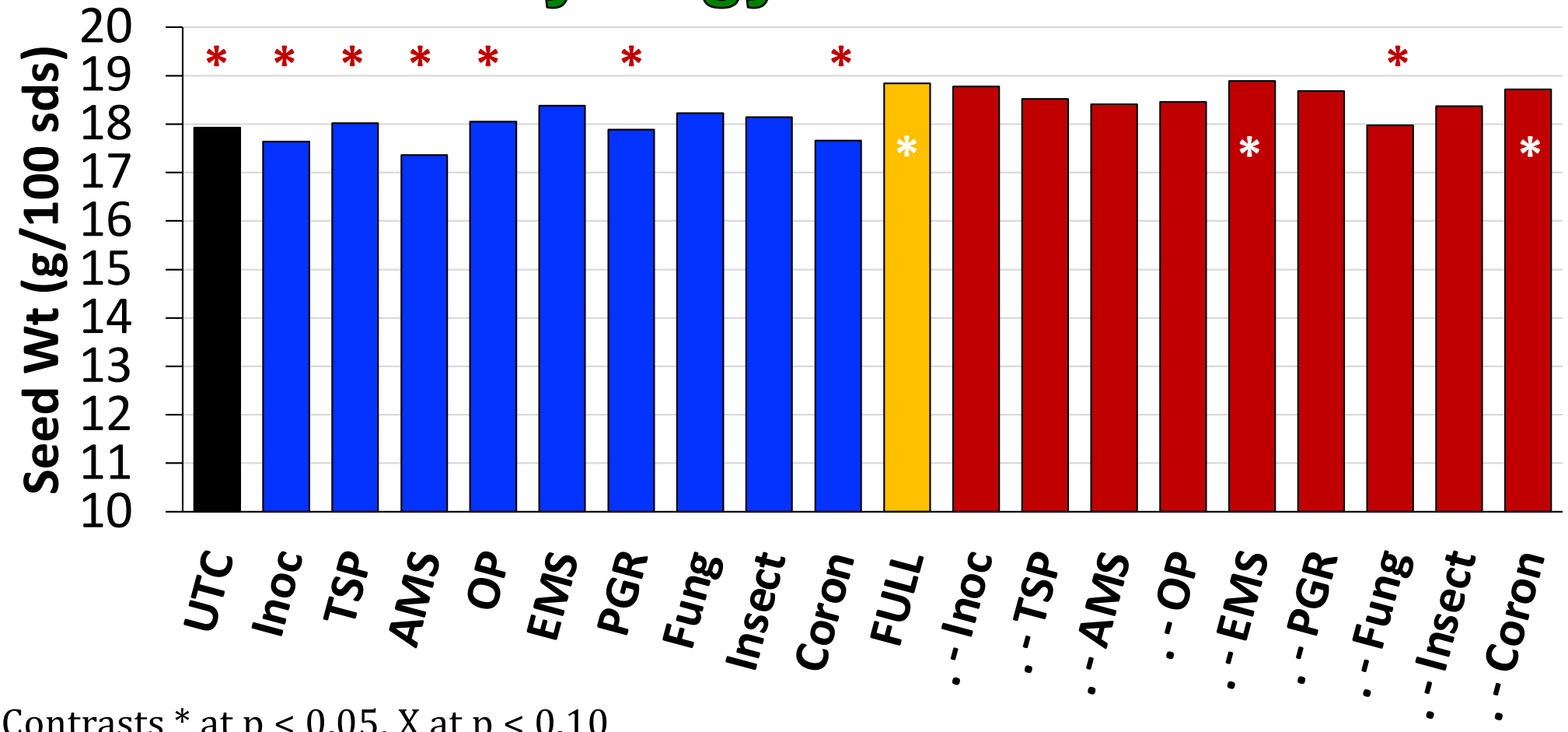


Contrasts * at p ≤ 0.05, X at p ≤ 0.10

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 43

18 Synergy: Seed Size

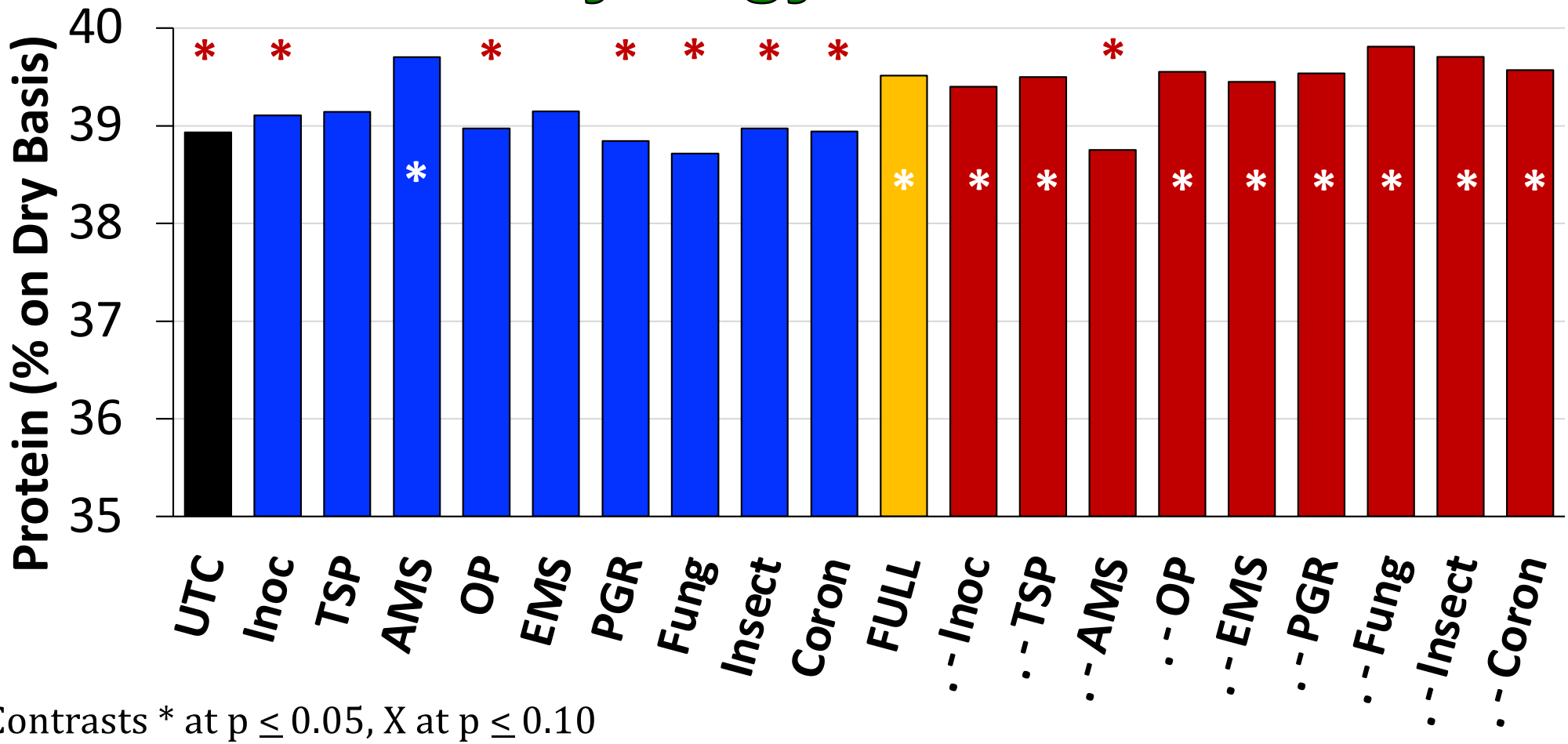


Contrasts * at $p \leq 0.05$, X at $p \leq 0.10$

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 44

18 Synergy: Protein

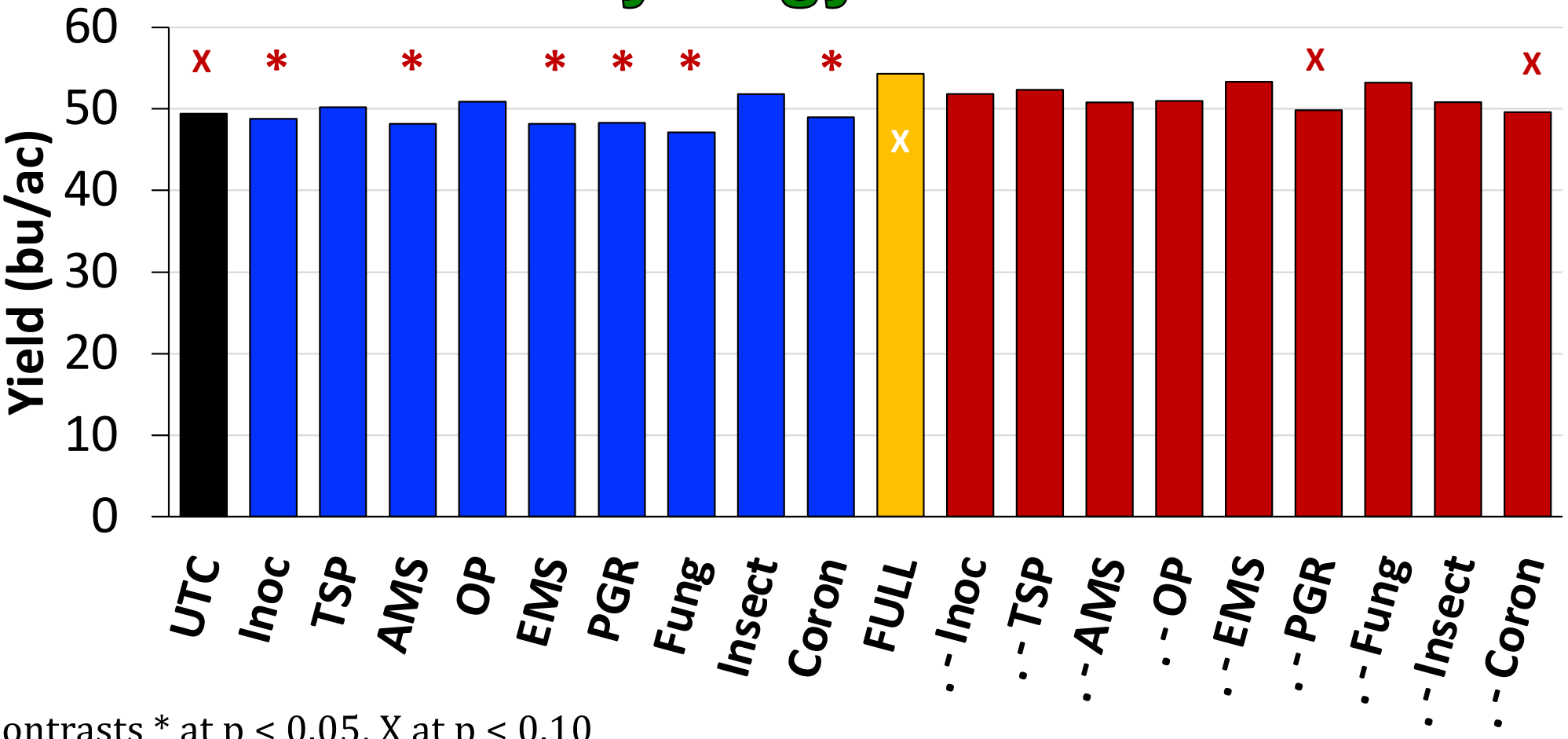


Contrasts * at p ≤ 0.05, X at p ≤ 0.10

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 45

19 Synergy: Yield



Contrasts * at $p \leq 0.05$, X at $p \leq 0.10$

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 47

©2021 Casteel, Purdue University - 48

In-Furrow

- K-Row 2016 and 2017
  - 2016
    - West Lafayette
    - Wanatah
  - 2017
    - West Lafayette
    - Wanatah
  - K-Row Nutrients

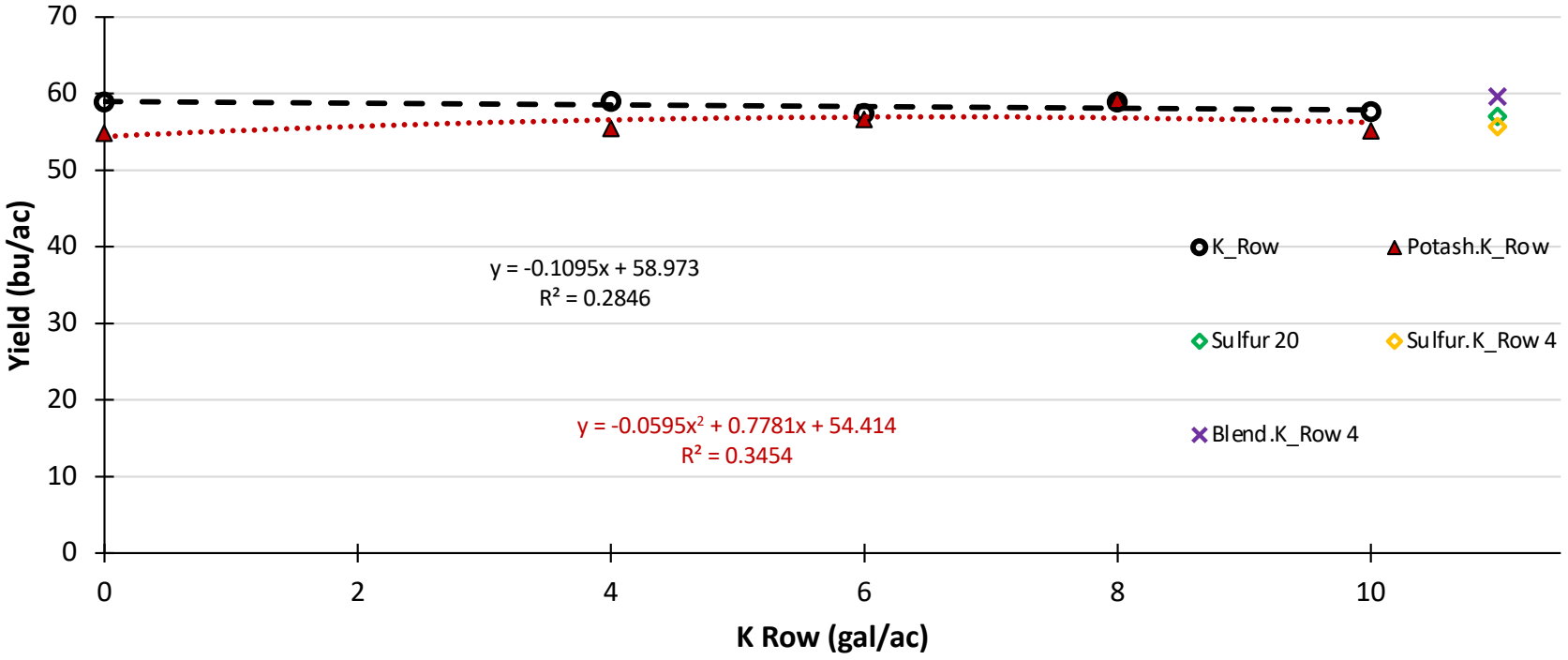
©2021 Casteel, Purdue University - 49

K-Row In Furrow: 2016 and 2017

- West Lafayette
  - Planting
- Wanatah
  - Planting
- Treatments

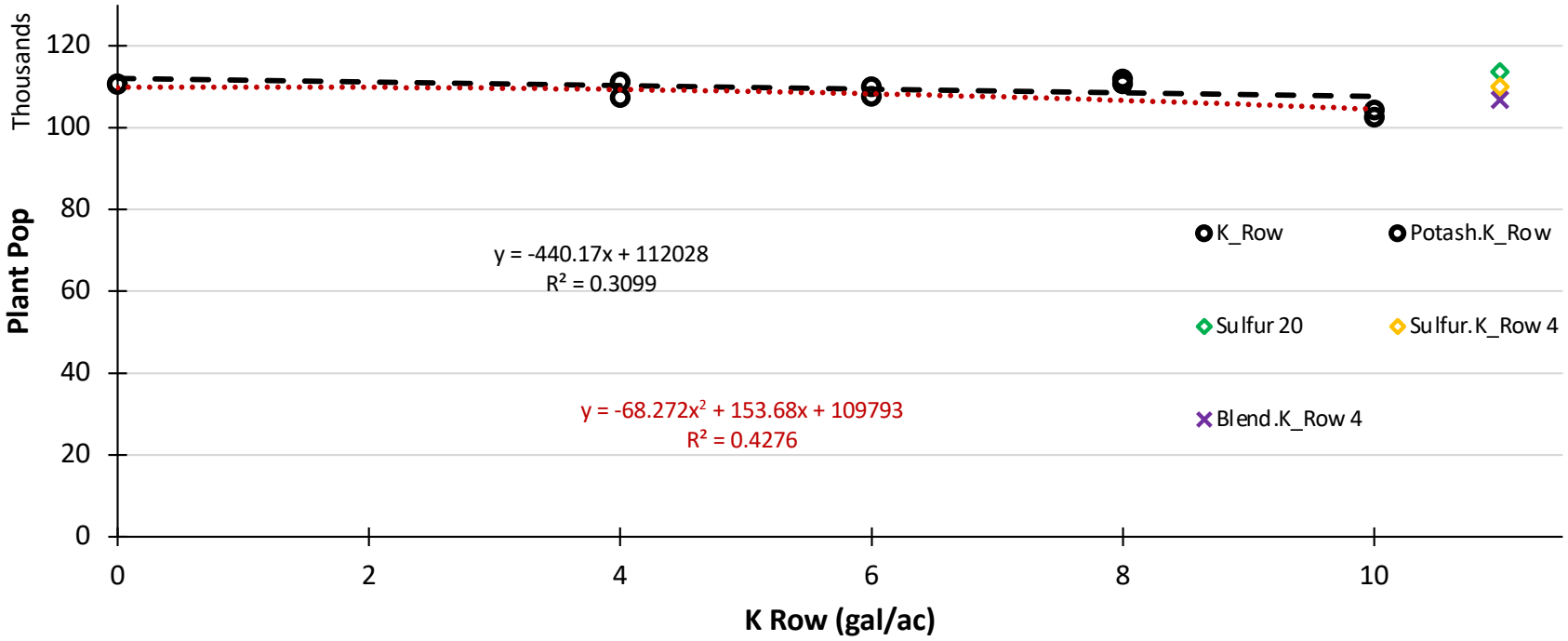
©2021 Casteel, Purdue University - 50

K-Row (0-0-23-8S) In-Furrow: 2017 Yield



©2021 Casteel, Purdue University - 51

K-Row (0-0-23-8S) In-Furrow: 2017 Pop'n



©2021 Casteel, Purdue University - 52

O-Phos In-furrow

©2021 Casteel, Purdue University - 53



NS Fixation: 21 W. Lafayette

Fertilizer	Nitrogen	Sulfur	Yield
UTC	0	0	61.4
AMS	26	30	75.8
Gypsum	0	30	75.0
Urea	26	0	62.4
Full NS	150 + 150	15 + 15	77.7
	Pre + R3	Pre + R3	

©2021 Casteel, Purdue University - 55

NS Fixation: 21 Wanatah

Fertilizer	Nitrogen	Sulfur	Yield
UTC	0	0	66.6
AMS	26	30	73.2
Gypsum	0	30	75.2
Urea	26	0	71.0
Full NS	150 + 150	15 + 15	73.3
	Pre + R3	Pre + R3	

©2021 Casteel, Purdue University - 56

Sulfur Synergies with Foliar Protection?

- **2 x 4 Factorial** with 5 replications
- **2 Sulfur** → 0, 20 lb S/ac
- **4 Foliar Protection @ R4 (prophylactic)**
  - None
  - Fungicide: Priaxor 4 oz/ac
  - Insecticide: Fastac 3.2 oz/ac
  - Both: Priaxor + Fastac
- West Lafayette, Wanatah
- 2019, 2020, 2021



©2021 Casteel, Purdue University - 57

S x R4 Protect: 19 W. Lafayette

R4 Foliar	No Sulfur		Sulfur	
None	67.0	d	69.2	cd
Fung.	68.4	cd	71.6	abc
Insect.	66.7	d	73.4	ab
Both	66.7	d	74.5	a

- No benefit from R4 protection alone
- 6.7 bu/ac increase with pre-S + R4 Insecticide
- 7.5 bu/ac increase with pre-S + R4 Both
- **Leaf retention and "stay-green" during seed fill?**

©2021 Casteel, Purdue University - 58

S x R4 Protect: 20 W. Lafayette

R4 Foliar	No Sulfur	Sulfur
None	62.2	62.2
Fung.	68.1	66.0
Insect.	64.0	64.1
Both	67.4	67.4

- Fung. and Both improved yield regardless of Sulfur
- Sulfur did not improve yield nor did it provide synergies w/ R4 Foliar
- **Late planting (June 3, 2020) coupled with late season dry conditions during seed fill negated responses.**

©2021 Casteel, Purdue University - 60

S x R4 Protect: 21 W. Lafayette

R4 Foliar	No Sulfur	Pre-AMS	V4_AMS
None	74.0	82.3	81.7
Fung.	74.0	83.5	83.3
Insect.	73.8	86.9	82.7
Both	78.4	87.3	82.4

- **AMS PRE to V4 increased yield ~8 bu/ac**
- **Additional 4-6 bu/ac with R4 insect with pre-AMS**
  but no other improvements with R4 foliar protection.

©2021 Casteel, Purdue University - 61

Sulfur Management Considerations

- **Soluble S Fertilizer applied PRE to early V stages** of greatest benefit and flexibility
- **Broadcast of 15 to 20 lb S/ac** with soluble source near planting such as AMS, MES10, pelletized Gypsum, or before emergence with ATS.
- **Leaf Nutritional Snapshots then Apply Sulfur**
  - "Close" to **critical S levels (0.25%)**
  - **N:S ~18:1 or higher**

©2021 Casteel, Purdue University - 63

Sulfur Management Considerations

- **Nutrient interactions** can mask yield reductions and limit yield improvements based on timing of potash.
- **Phosphorus blending** is promising.
- **Timely planting is foundational** for high yielding soybeans; which seems to be intensified when coupled with PRE applications of N + S.
- **Field conditions** that affect sulfur availability and nodulation + N fixation (e.g., soil temp, planting, residue)

©2021 Casteel, Purdue University - 64

Preliminary Thoughts on S Starters

- Starter S rates of 4 – 10 lb S/ac has the potential of **increasing yield and protein** based on timely planting in 2020 of a prairie soil (~3.5% OM).
- Starter S rates should **NOT** be applied above 15 lb S/ac or in Dual placement

©2021 Casteel, Purdue University - 65

Thanks for the support!





©2021 Casteel, Purdue University - 66

QUESTIONS?



Shaun Casteel, scasteel@purdue.edu

Purdue Crop Chat



©2021 Casteel, Purdue University - 68

Potash (0-0-60): 2016 ACRE + Pinney

- Subset of In-Furrow Fert. Trial on 30-in rows
  - **75 lb P_2O_5/ac + 120 lb K_2O/ac**
- Pinney PAC: Wanatah, IN → May 23, 2016
  - **UTC: 65.7 bu/ac | PK: 66.7 bu/ac^{NS}**
  - Irrigated
- ACRE: West Lafayette, IN → May 25, 2016
  - **UTC: 62.5 bu/ac | PK: 58.7 bu/ac***
- **No early season crop injury or stand reductions**

©2021 Casteel, Purdue University - 69

Potash (0-0-60): 2017 ACRE + Pinney

- Subset of In-Furrow Fert. Trial on 30-in Rows
  - **120 lb K_2O/ac**
- ACRE: West Lafayette, IN → June 1, 2017
- Pinney PAC: Wanatah, IN → May 30, 2017

Treatment	Rate	Yield		Moisture	Harvest Stand
	per ac	bu/ac		%	ppa
UTC	0	58.9	a	12.4	110,643
Potash	120 lb K_2O	54.8	b	12.6	110,466
AMS	20 lb S	57.0	ab	12.4	113,652

©2021 Casteel, Purdue University - 70

18-19 Synergy: Addition

		Seed	——Plant——			——R1——		———R3-R4———		
	TREATMENT	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
1	Untreated (UTC)	.	.	.	.	.	.	.	.	.
2	Inoculant	Inoc	.	.	.	.	.	.	.	.
3	TSP: 40 lb P_2O_5	.	TSP	.	.	.	.	.	.	.
4	AMS: 20 lb S	.	.	AMS	.	.	.	.	.	.
5	In-Furrow: 8 lb P_2O_5	.	.	.	OP	.	.	.	.	.
6	EMS: 0.5 lb S	.	.	.	.	EMS	.	.	.	.
7	PGR: Utilize	.	.		.	.	PGR	.	.	.
8	Fung: Viathon	.	.	.	.	.	.	Fung	.	.
9	Insect: Sultrus	.	.	.	.	.	.	.	Insect	.
10	Coron: 5.1 lb N	.	.	.	.	.	.	.	.	Coron
11	FULL	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron

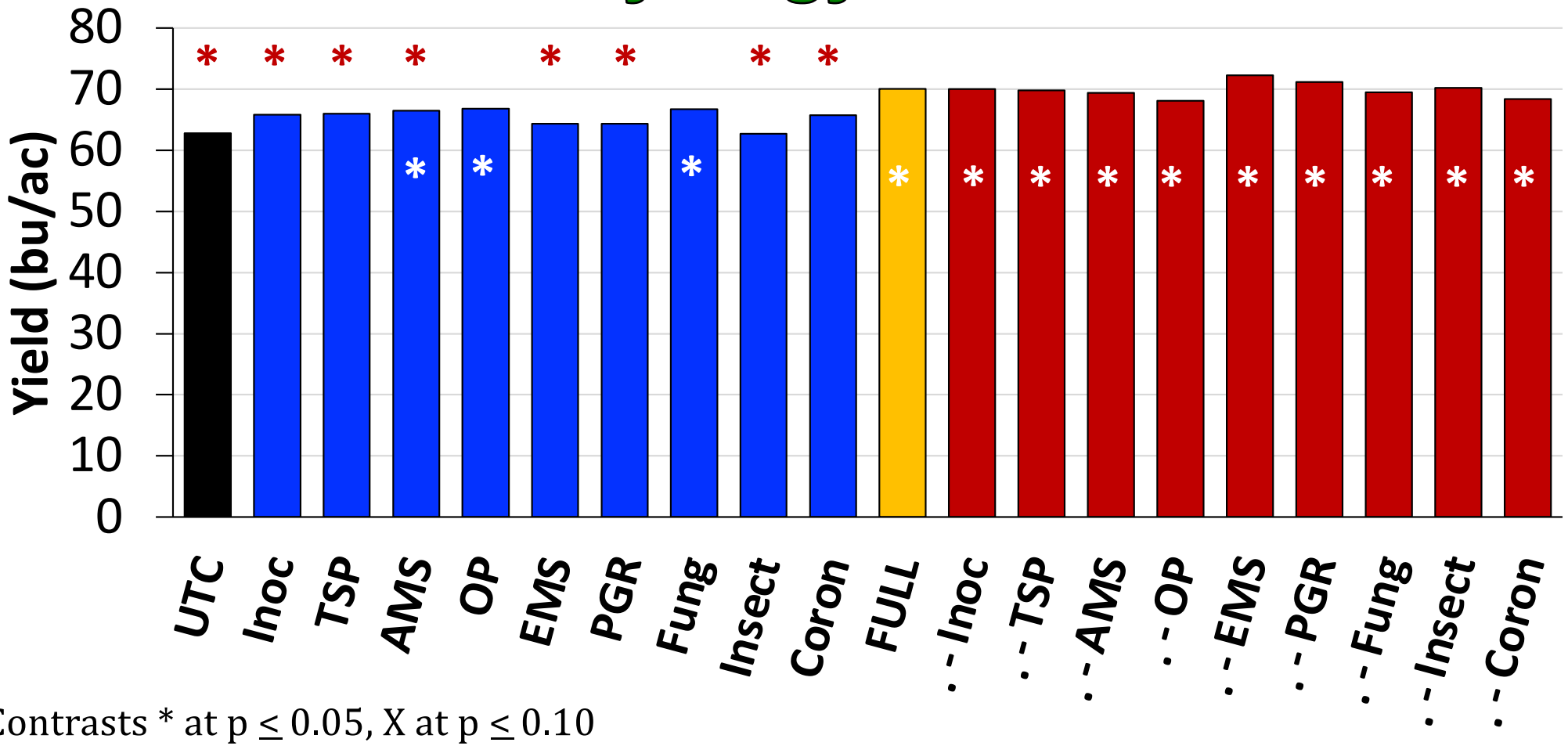
DELIVERING FIRST CLASS INFORMATION

18-19 Synergy: Omission

		Seed	——Plant——			——R1——		———R3-R4———		
	TREATMENT	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
1	Untreated (UTC)	.	.	.	.	.	.	.	.	.
11	FULL	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
12	FULL - Inoc	.	TSP	AMS	OP	EMS	PGR	Fung	Insect	Coron
13	FULL - TSP	Inoc	.	AMS	OP	EMS	PGR	Fung	Insect	Coron
14	FULL - AMS	Inoc	TSP	.	OP	EMS	PGR	Fung	Insect	Coron
15	FULL - OP	Inoc	TSP	AMS	.	EMS	PGR	Fung	Insect	Coron
16	FULL - EMS	Inoc	TSP	AMS	OP	.	PGR	Fung	Insect	Coron
17	FULL - PGR	Inoc	TSP	AMS	OP	EMS	.	Fung	Insect	Coron
18	FULL - Fung	Inoc	TSP	AMS	OP	EMS	PGR	.	Insect	Coron
19	FULL - Insect	Inoc	TSP	AMS	OP	EMS	PGR	Fung	.	Coron
20	FULL - Coron	Inoc	TSP	AMS	OP	EMS	PGR	Fung	Insect	.

Soybean Station
Delivering First Class Information
©2021 Casteel, Purdue Univ

18 Synergy: Yield

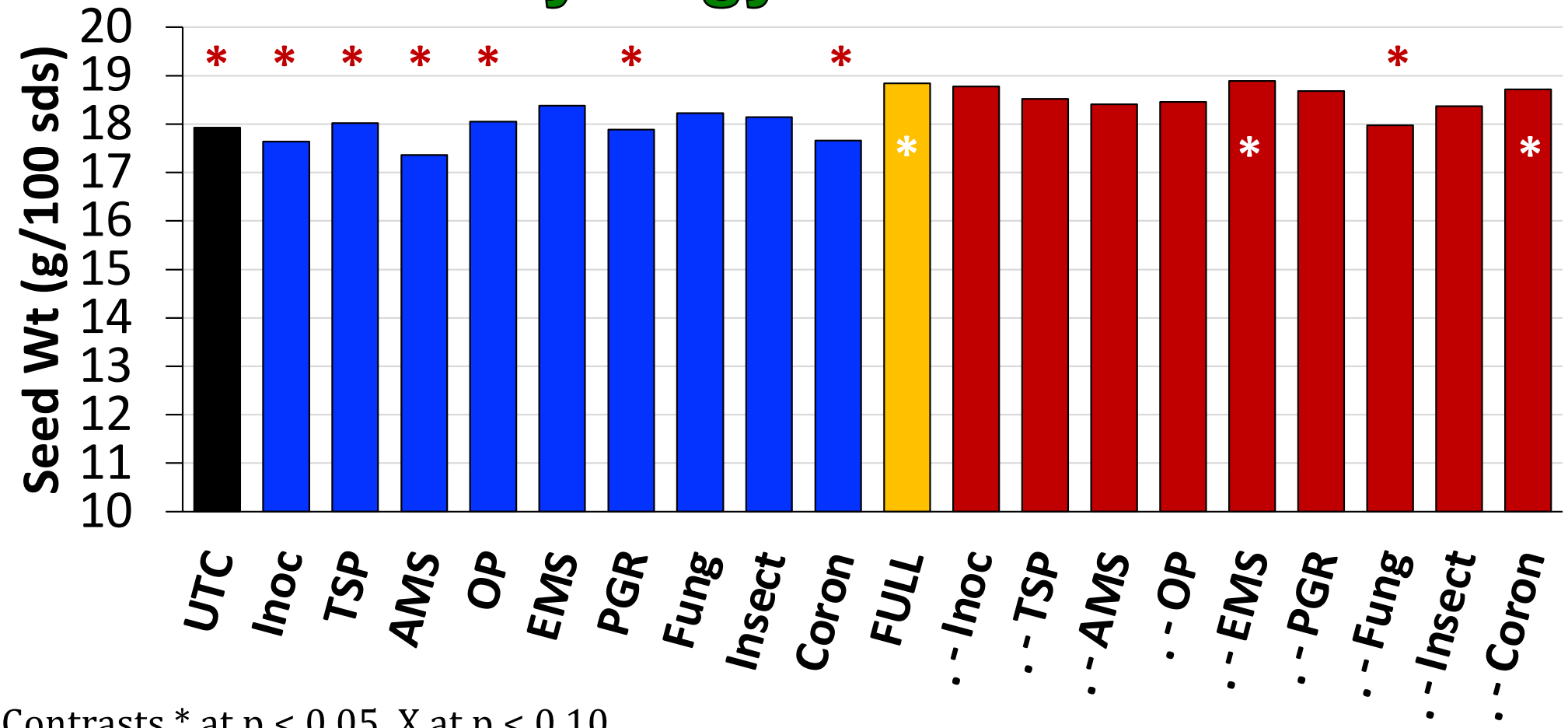


Contrasts * at p ≤ 0.05, X at p ≤ 0.10

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 73

18 Synergy: Seed Size

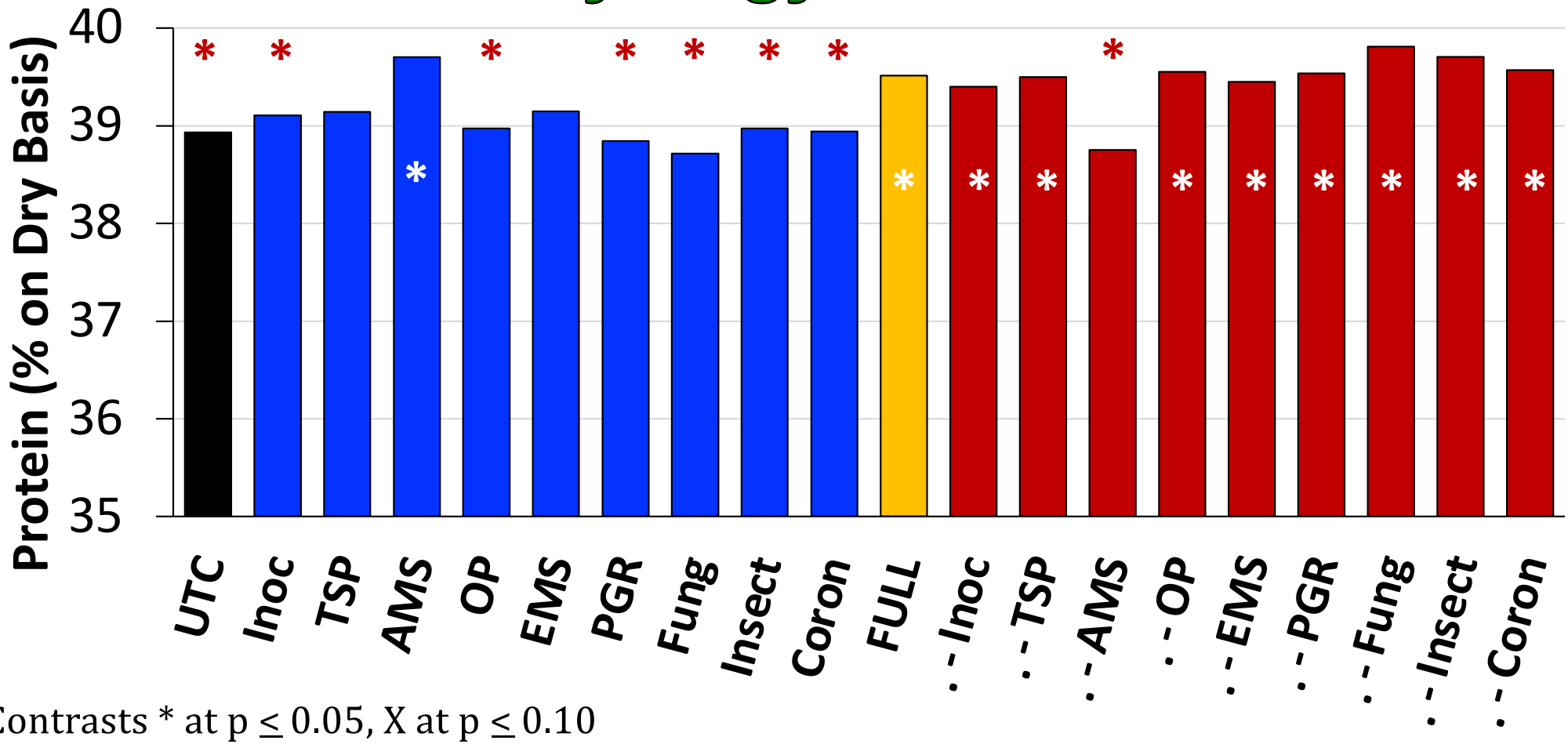


Contrasts * at $p \leq 0.05$, X at $p \leq 0.10$

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 74

18 Synergy: Protein

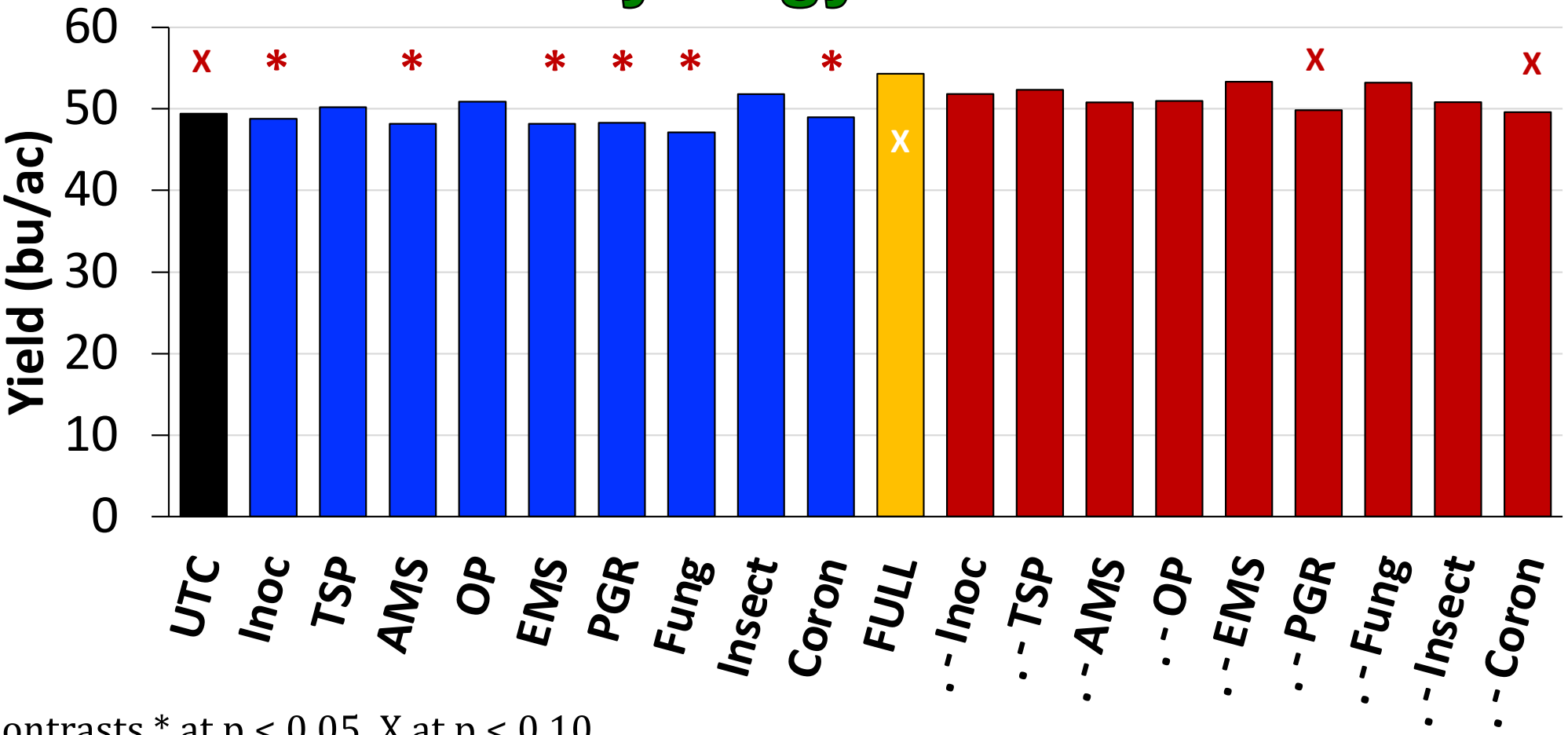


Contrasts * at p ≤ 0.05, X at p ≤ 0.10

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 75

19 Synergy: Yield



Contrasts * at p ≤ 0.05, X at p ≤ 0.10

Pooled over Wanatah, W. Laf

©2021 Casteel, Purdue University - 77

How Much S Does Soybean Need?

Grain	lb/bu	50 bu	75 bu	100 bu
Nitrogen	3.30	165	248	330
P_2O_5	0.73	37	55	73
K_2O	1.20	60	90	120
Sulfur	**0.18**	**9**	**14**	**18**
Total S	**0.35**	**18**	**26**	**35**

©2021 Casteel, Purdue University - 78

Doing the Math: Sulfur Needs (lb S/ac)
(Rough Mass Balance)

			Soil Organic Matter			
Yield	Need	Sky	1%	2%	3%	4%
bu	lb S/ac		~4	~8	~12	~16
50	18	~5	9	5	1	+3
75	26	~5	17	13	9	5
100	35	~5	26	23	18	14

©2021 Casteel, Purdue University - 79

No Sulfur



20 lb S/acre



©2021 Casteel, Purdue University - 80