

# Applied Fertility Research Highlights: Nitrogen, Phosphorus, & Beyond

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# Where will we go today?

## Nitrogen

- Highlights from 4R N Management Trials at Indian Head (ADOPT/Fertilizer Canada)
- Canola & wheat response to side-banded enhanced efficiency N fertilizer products (SaskOilseeds/ADOPT/SFP)
- Fine-tuning Nitrogen Management with Split-Applications in Spring Wheat (ADOPT/SaskWheat)

## Phosphorus

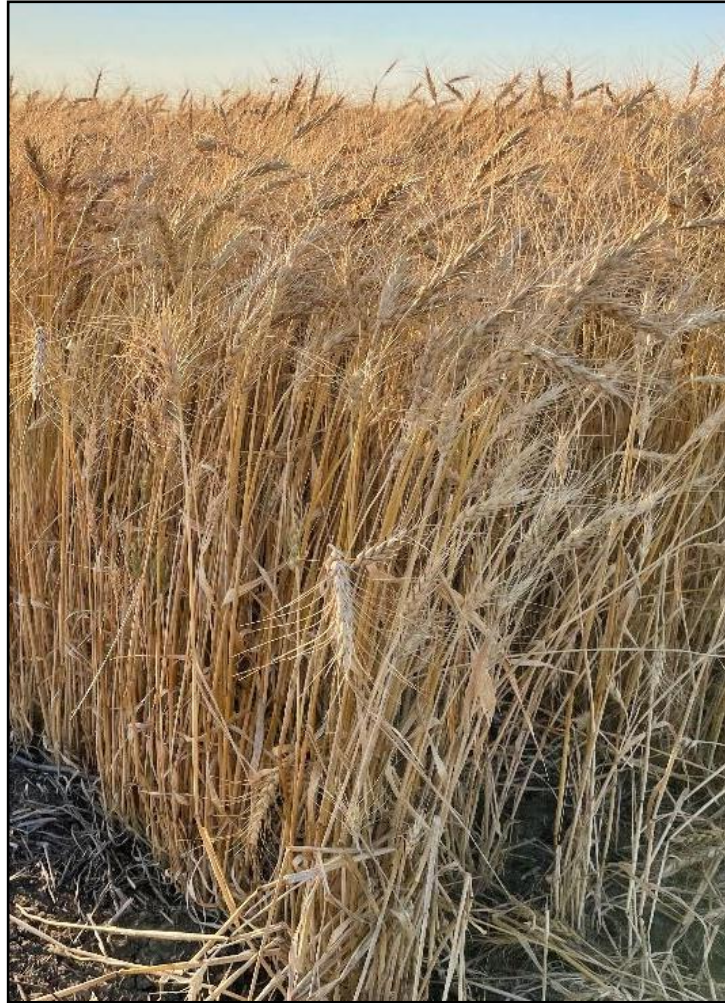
- Side-band versus in-furrow P research highlights for canola (SaskOilseeds)
- Novel P forms for improved seed-safety and efficacy in canola (ADOPT)
- Field pea P response and comparing forms/placement options (SaskPulse/ADOPT)

## Beyond

- Elemental versus sulfate sulfur, reducing Cd uptake in flax with nutrition, in-furrow versus foliar micro-nutrient applications in canola (various funding sources)



# Nitrogen Fertility Trials & Demos



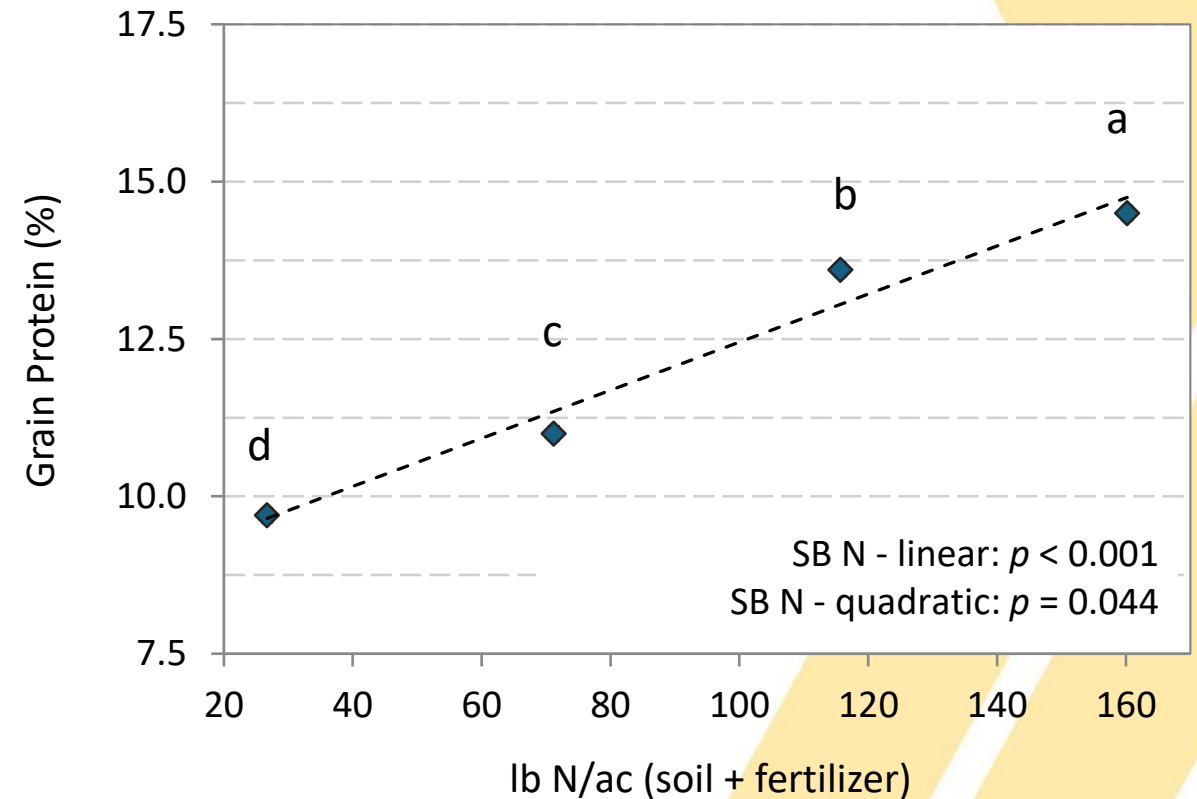
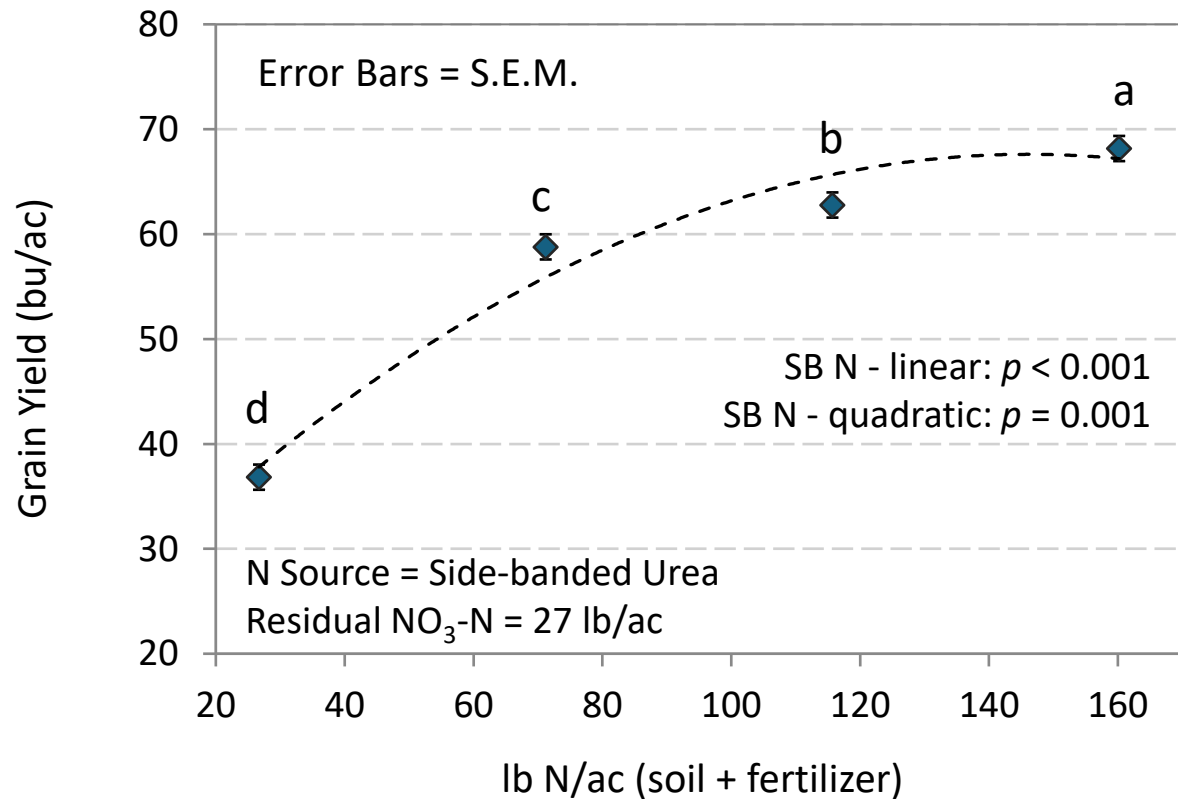
# 4R Nitrogen Management Demos (IH-2017)

#	Nitrogen Form	Timing / Placement	Rate *
1	Urea (untreated)	Side-band (~1.5-2" depth)	1.0x <span style="border: 1px solid black; padding: 2px;">May 5</span>
2	Urea	Spring Surface Broadcast	1.0x
3	UAN (Urea Ammonium-Nitrate)	Spring Surface Dribble-band	1.0x <span style="border: 1px solid black; padding: 2px;">May-4</span>
4	Urease Inhibitor (Agrotain®)	Spring Surface Broadcast	1.0x
5	Dual Inhibitor (SUPERU®)	Spring Surface Broadcast	1.0x
6	Urea	50:50 Split (side-band : in-crop)	1.0x
7	UAN (Urea Ammonium-Nitrate)	50:50 Split	1.0x <span style="border: 1px solid black; padding: 2px;">May-5/ Jun-20</span>
8	Urease Inhibitor (Agrotain®)	50:50 Split	1.0x
9	Dual Inhibitor (SUPERU®)	50:50 Split	1.0x

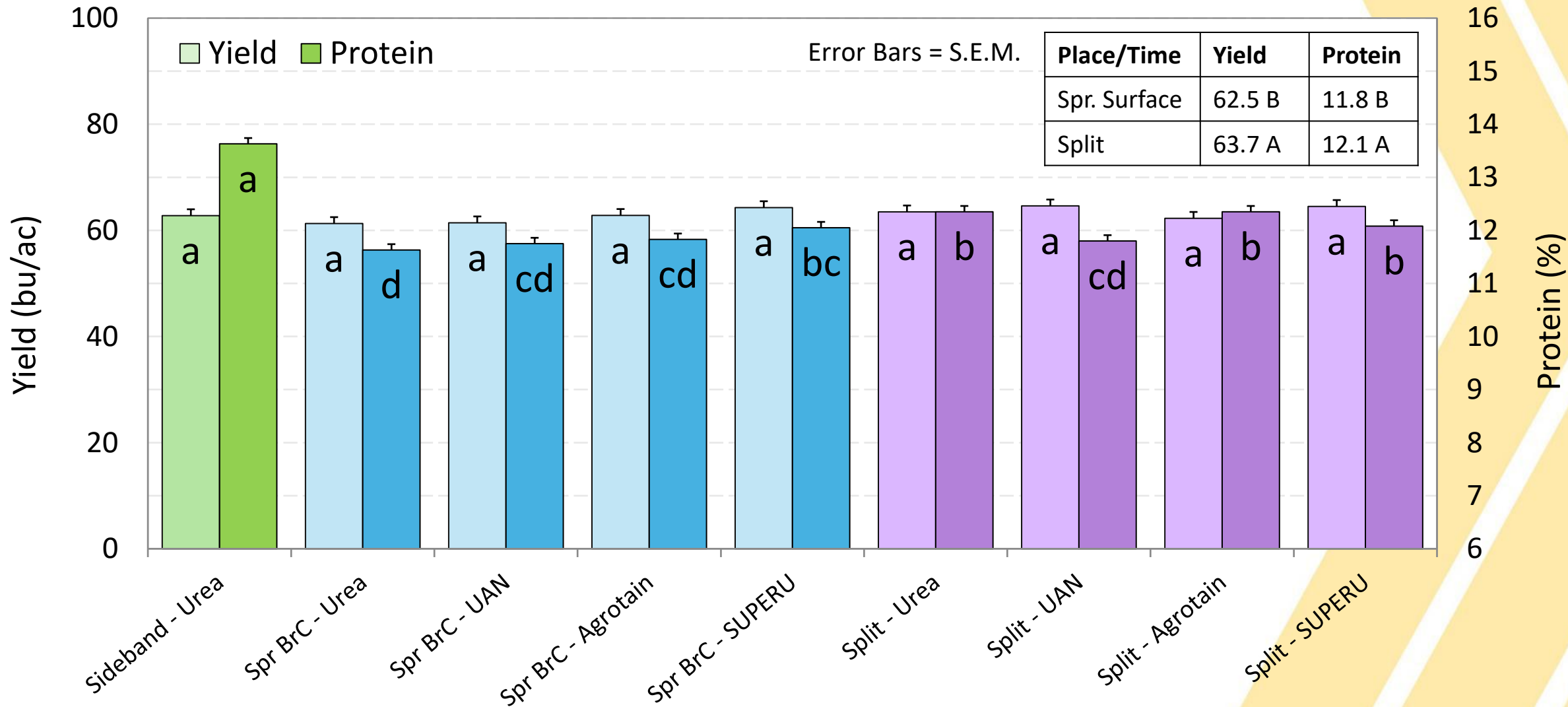
\* 1x = 116 lb N/ac for **wheat** & 129 lb N/ac for **canola** (soil + fertilizer)

# Wheat Response to N Fertilizer Rate (IH-2017)

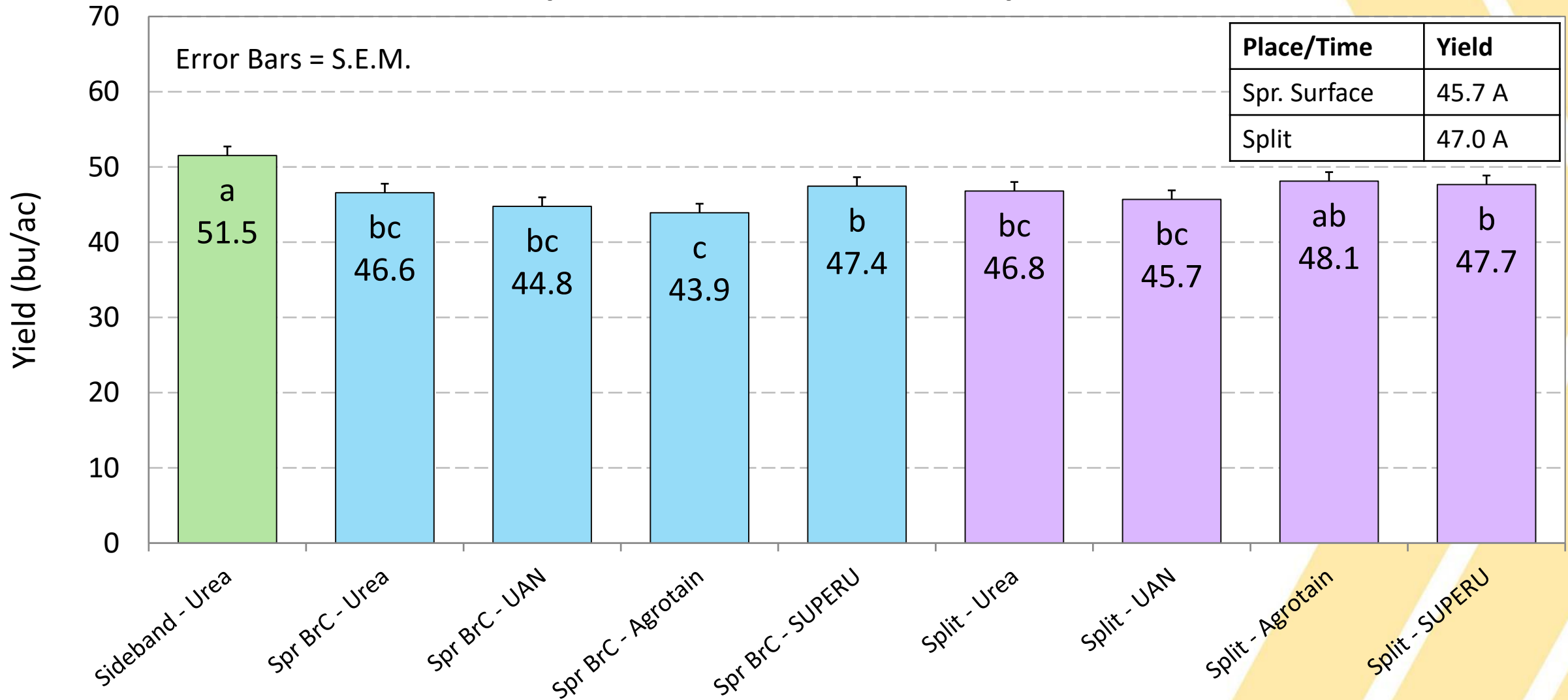
- These trials always included an N rate component to generate basic response curves
- N rates were adjusted for soil test N and intended to be slightly below the optimum rate required to achieve maximum yield to better demonstrate treatment differences



# Nitrogen Management Effects on Spring Wheat Grain Yield & Protein (Indian Head 2017)



# Nitrogen Management Effects on Canola Yield (Indian Head 2017)

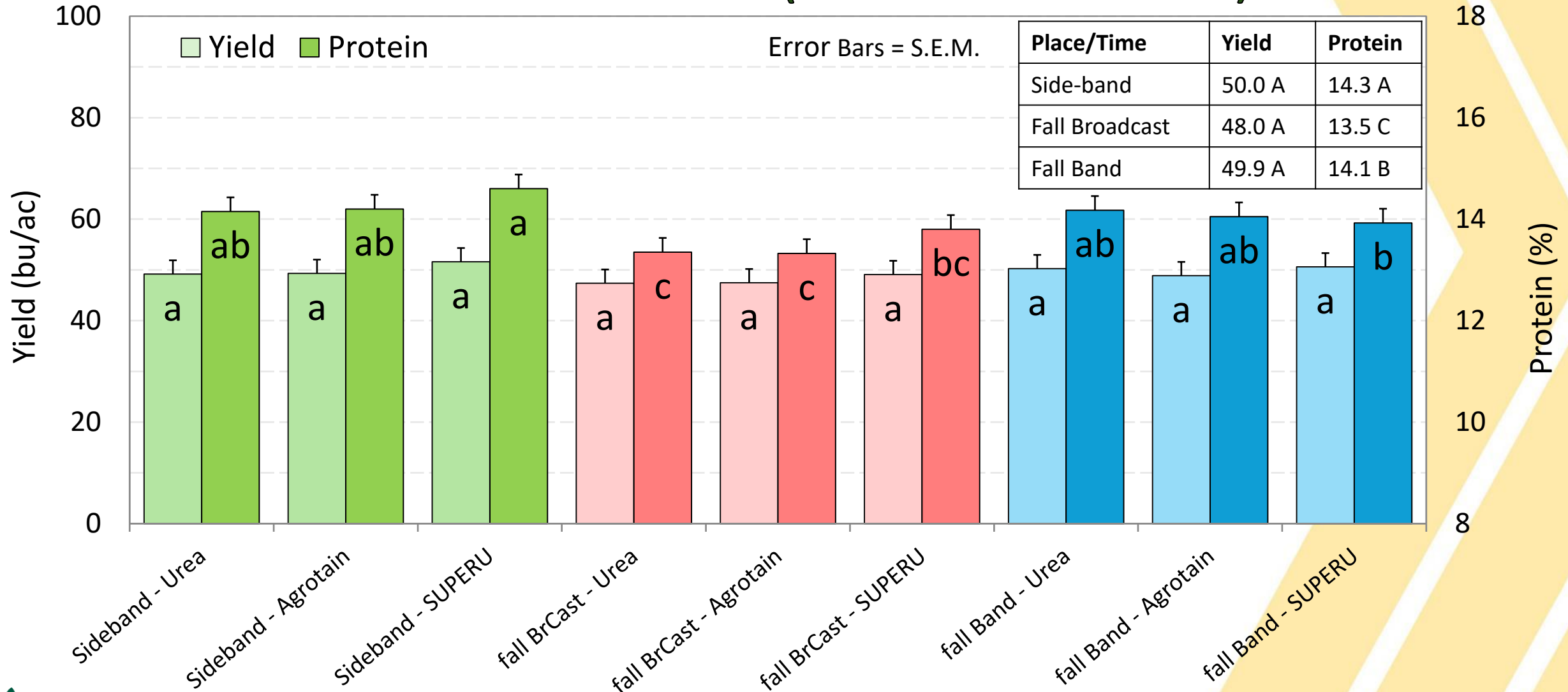


# 4R Nitrogen Management Demos (IH-2018)

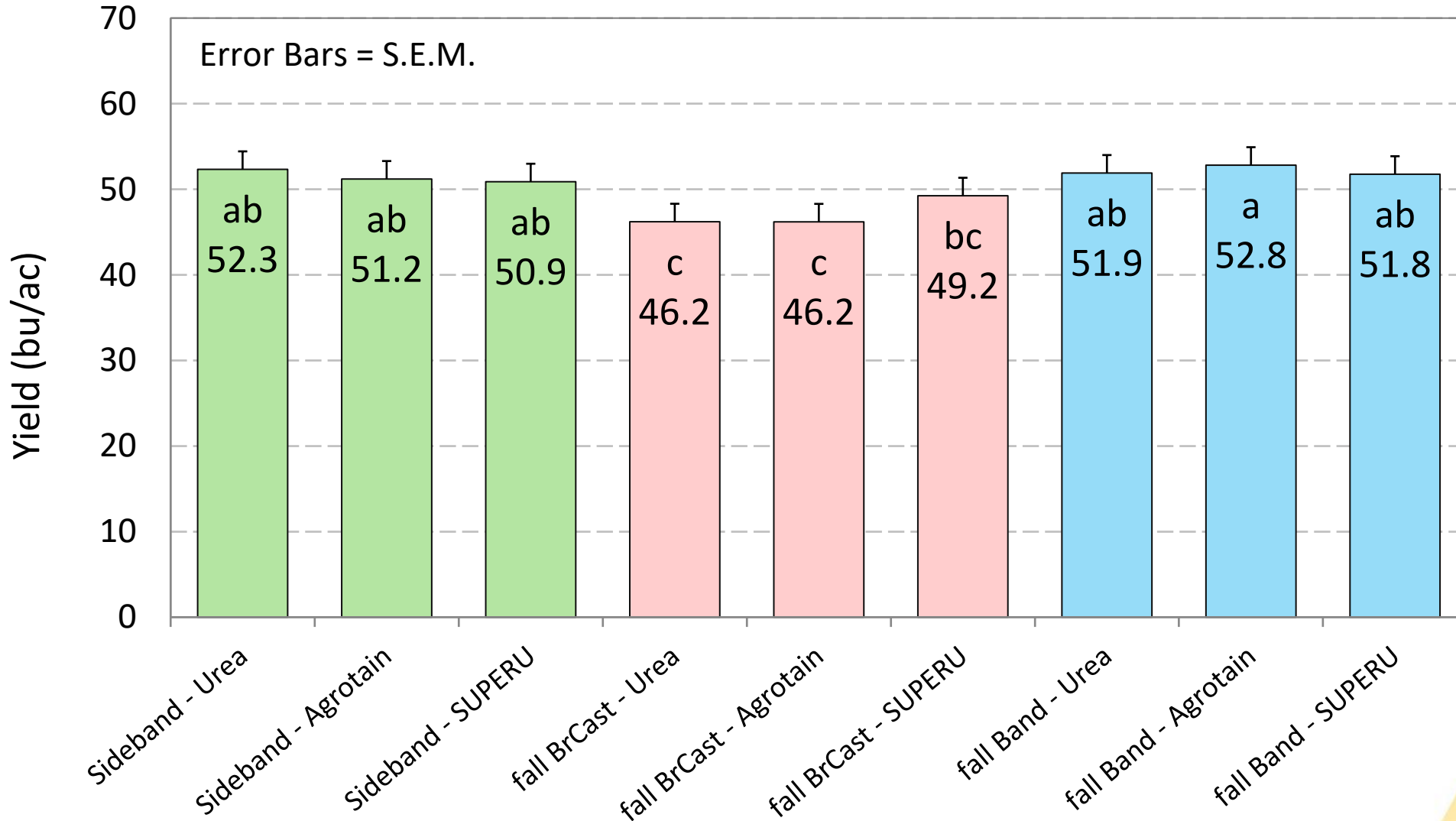
#	Form	Timing / Placement	Rate *	
1	Urea (untreated)	Side-band	1.0x	May 16
2	Urease Inhibitor (Agrotain®)	Side-band	1.0x	
3	Dual Inhibitor (SUPERU®)	Side-band	1.0x	
4	Urea	Fall Surface Broadcast	1.0x	Oct 17
5	Urease Inhibitor (Agrotain®)	Fall Surface Broadcast	1.0x	
6	Dual Inhibitor (SUPERU®)	Fall Surface Broadcast	1.0x	
7	Urea	Fall In-Soil Band	1.0x	Oct 17
8	Urease Inhibitor (Agrotain®)	Fall In-Soil Band	1.0x	
9	Dual Inhibitor (SUPERU®)	Fall In-Soil Band	1.0x	

\* 1x = 116 lb N/ac for **wheat** & 129 lb N/ac for **canola** (soil + fertilizer)

# Nitrogen Management Effects on Spring Wheat Yield & Protein (Indian Head 2018)



# Nitrogen Management Effects on Canola Yield (Indian Head 2018)



Place/Time	Yield
Side-band	51.5 A
Fall Broadcast	47.2 B
Fall Band	52.2 A

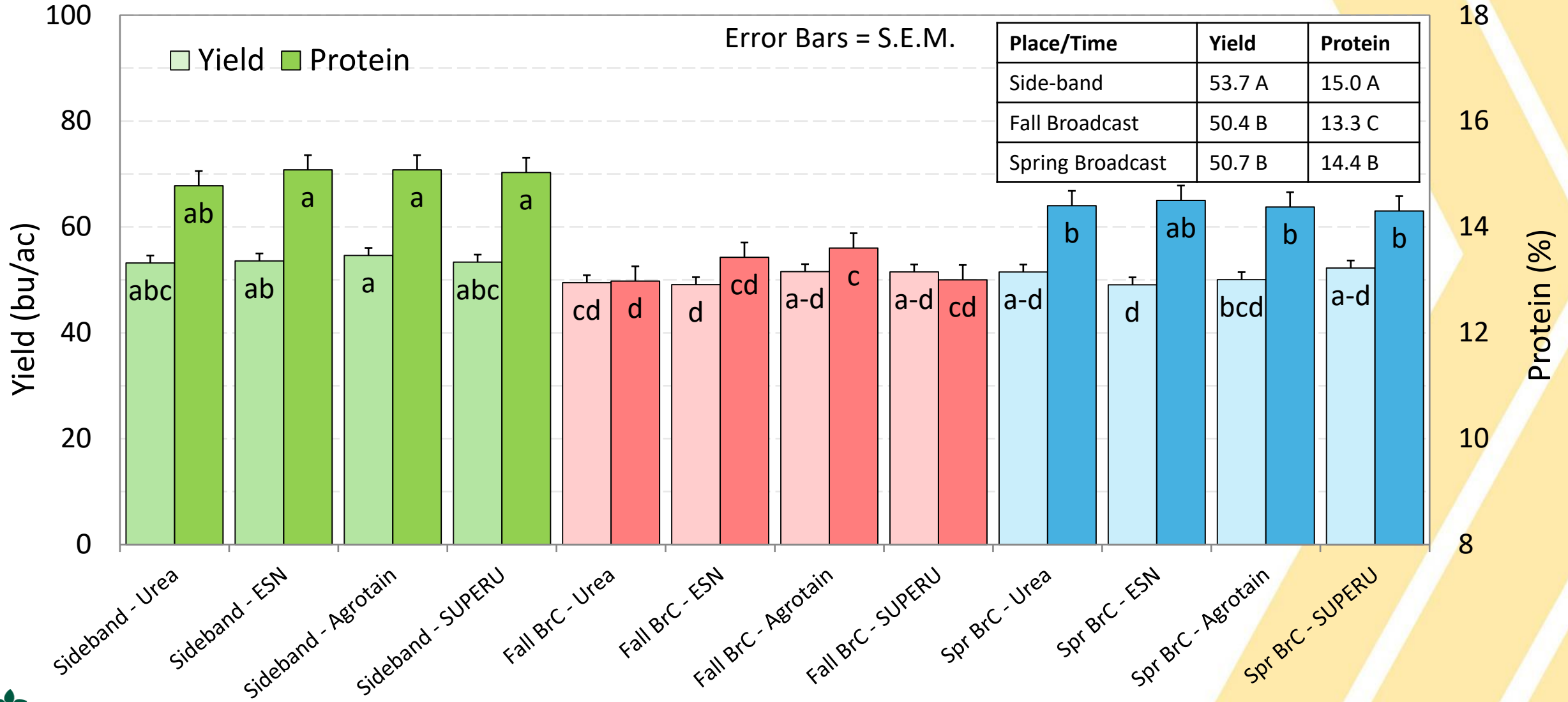


# 4R Nitrogen Management Demos (IH-2019)

#	Form	Timing / Placement	Rate *	
1	Urea (untreated)	Side-band	1.0x	
2	ESN® (polymer coated)	Side-band	1.0x	May 6
3	Urease Inhibitor (Agrotain®)	Side-band	1.0x	
4	Dual Inhibitor (SUPERU®)	Side-band	1.0x	
5	Urea	Fall Surface Broadcast	1.0x	
6	ESN®	Fall Surface Broadcast	1.0x	Oct 9
7	Agrotain®	Fall Surface Broadcast	1.0x	
8	SUPERU®	Fall Surface Broadcast	1.0x	
9	Urea	Spring Surface Broadcast	1.0x	
10	ESN®	Spring Surface Broadcast	1.0x	May 4
11	Agrotain®	Spring Surface Broadcast	1.0x	
12	SUPERU®	Spring Surface Broadcast	1.0x	

\* 1x = 111 lb/ac for wheat (soil + fertilizer); No canola trials in 2019

# Nitrogen Management Effects on Spring Wheat Yield & Protein (Indian Head 2019)

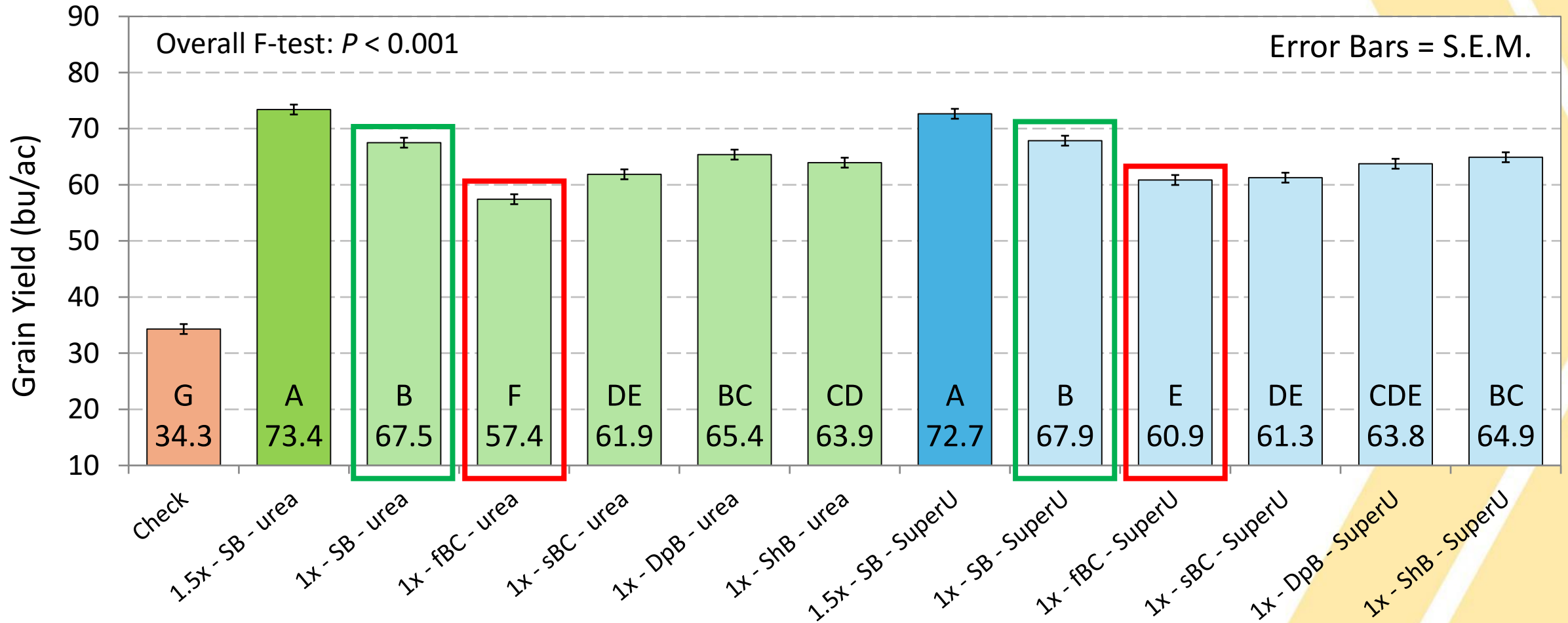


# N Banding Depth & Broadcast Timing (IH 2020-22)

#	Form	Timing / Placement	Rate (soil + fertilizer)
1	N/A	N/A	6 lb N/ac (from MAP) + Residual†
2	Untreated Urea	Side-Band (≈1.5" depth)	147 lb N/ac (High N – 1.5x rate)
3	Untreated Urea	Side-Band (≈1.5" depth)	98 lb N/ac (1.0x rate)
4	Untreated Urea	Fall Surface Broadcast	98 lb N/ac (1.0x rate)
5	Untreated Urea	Spring Surface Broadcast	98 lb N/ac (1.0x rate)
6	Untreated Urea	Fall Deep Band (≈2.3")	98 lb N/ac (1.0x rate)
7	Untreated Urea	Fall Shallow Band (≈1")	98 lb N/ac (1.0x rate)
8	SUPERU® (Dual Inhibitor)	Side-Band (≈1.5" depth)	147 lb N/ac (High N – 1.5x rate)
9	SUPERU®	Side-Band (≈1.5" depth)	98 lb N/ac (1.0x rate)
10	SUPERU®	Fall Surface Broadcast	98 lb N/ac (1.0x rate)
11	SUPERU®	Spring Surface Broadcast	98 lb N/ac (1.0x rate)
12	SUPERU®	Fall Deep Band (≈2.3")	98 lb N/ac (1.0x rate)
13	SUPERU®	Fall Shallow Band (≈1")	98 lb N/ac (1.0x rate)

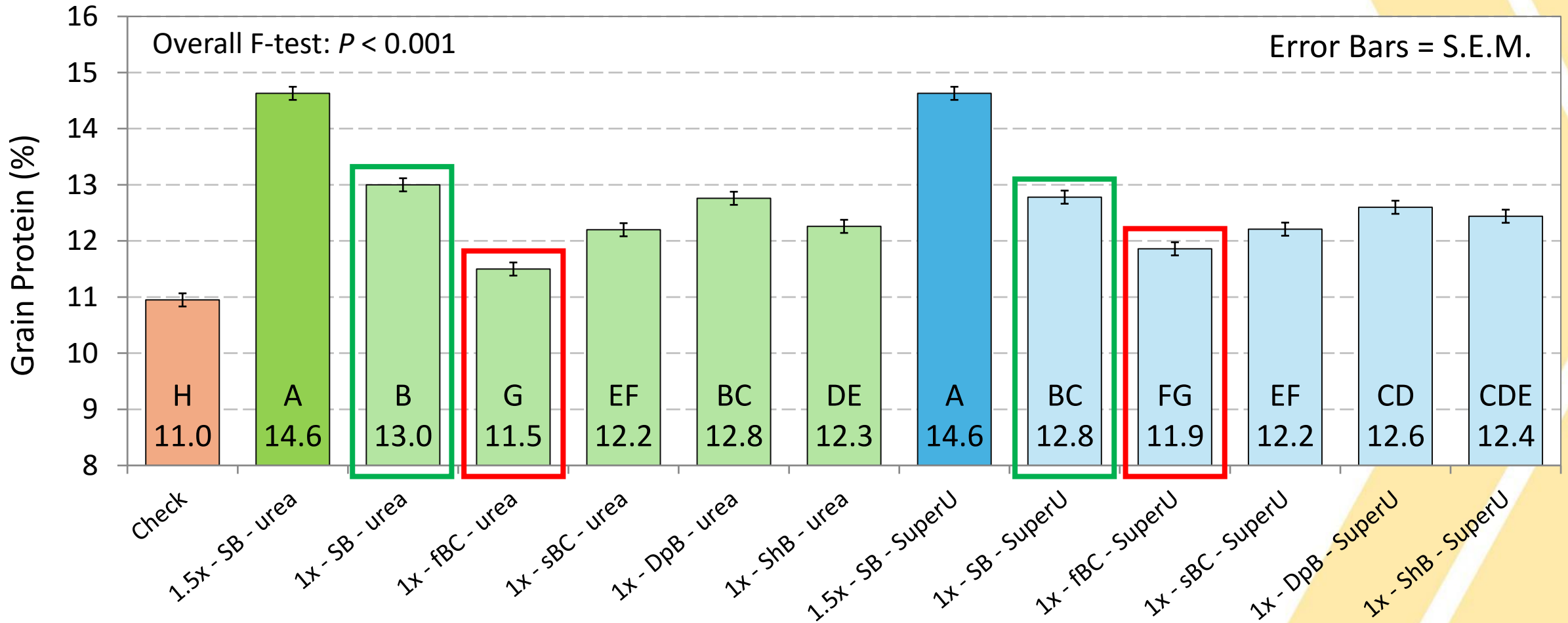
†Residual NO<sub>3</sub>-N (0-24"): 8 lb/ac in 2020, 14 lb/ac in 2021, and 15 lb/ac in 2022

# Averaged Nitrogen Management Effects on Spring Wheat Yield (Indian Head 2020-22)



SB – Side Band    fBC – fall Broadcast    sBC – spring Broadcast    DpB – fall Deep Band    ShB – fall shallow band

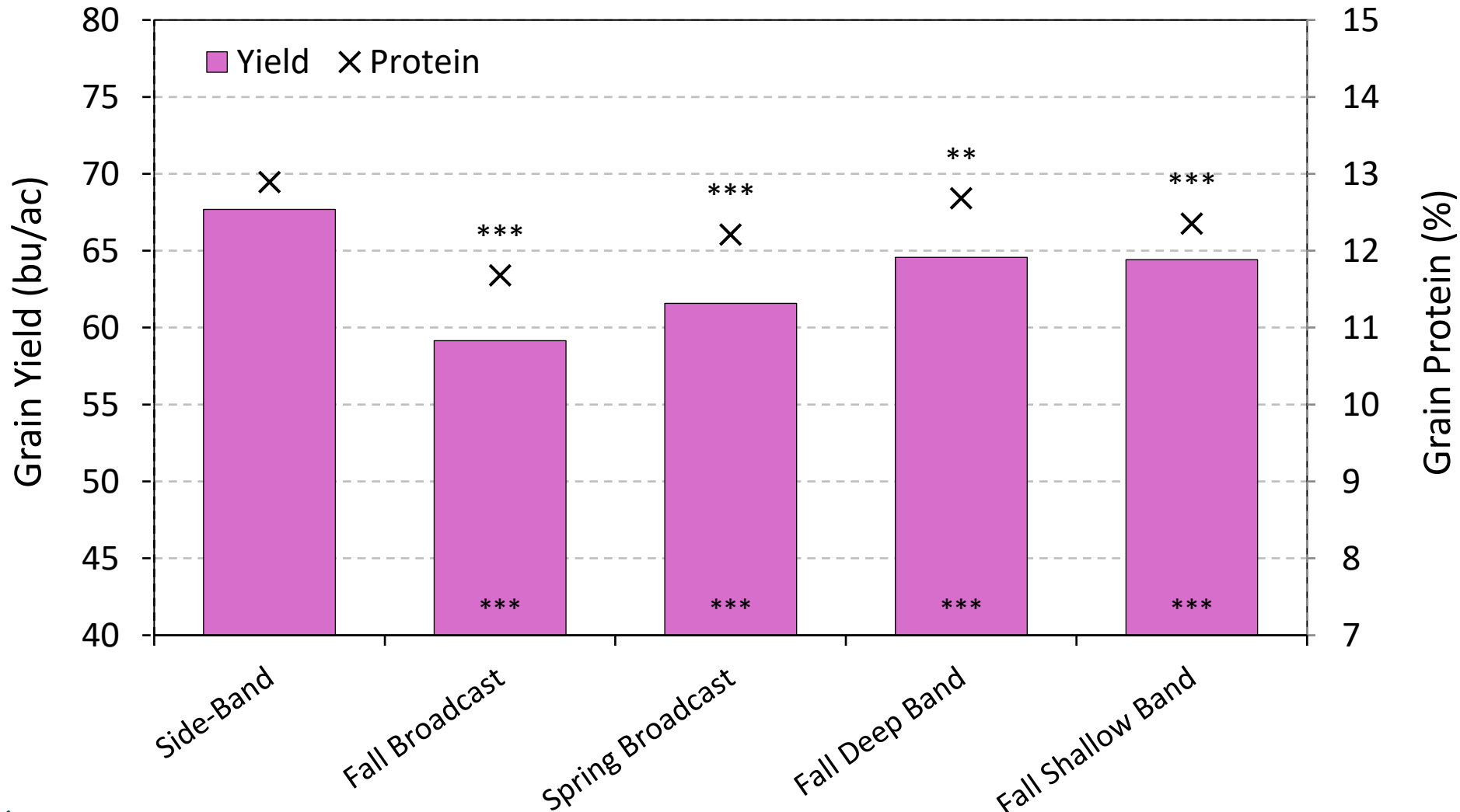
# Averaged Nitrogen Management Effects on Spring Wheat Protein (Indian Head 2020-22)



SB – Side Band    fBC – fall Broadcast    sBC – spring Broadcast    DpB – fall Deep Band    ShB – fall shallow band

# Pre-Determined Contrast Comparisons

## Two-Pass Seeding/Fertilization vs. Sideband (3-Year Average)



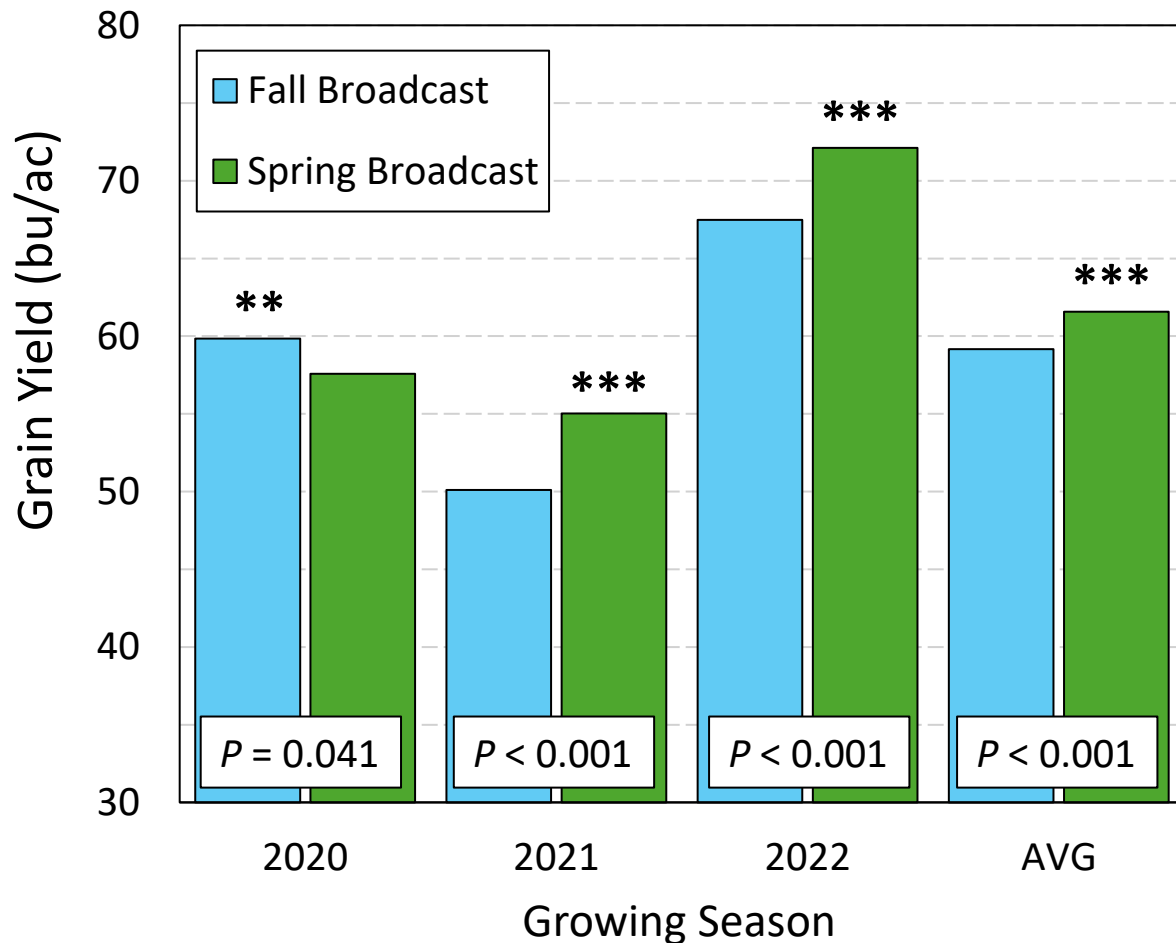
Notation	Pr > F
ns	> 0.100
*	0.05 ≤ 0.100
**	0.01 ≤ 0.05
***	< 0.01



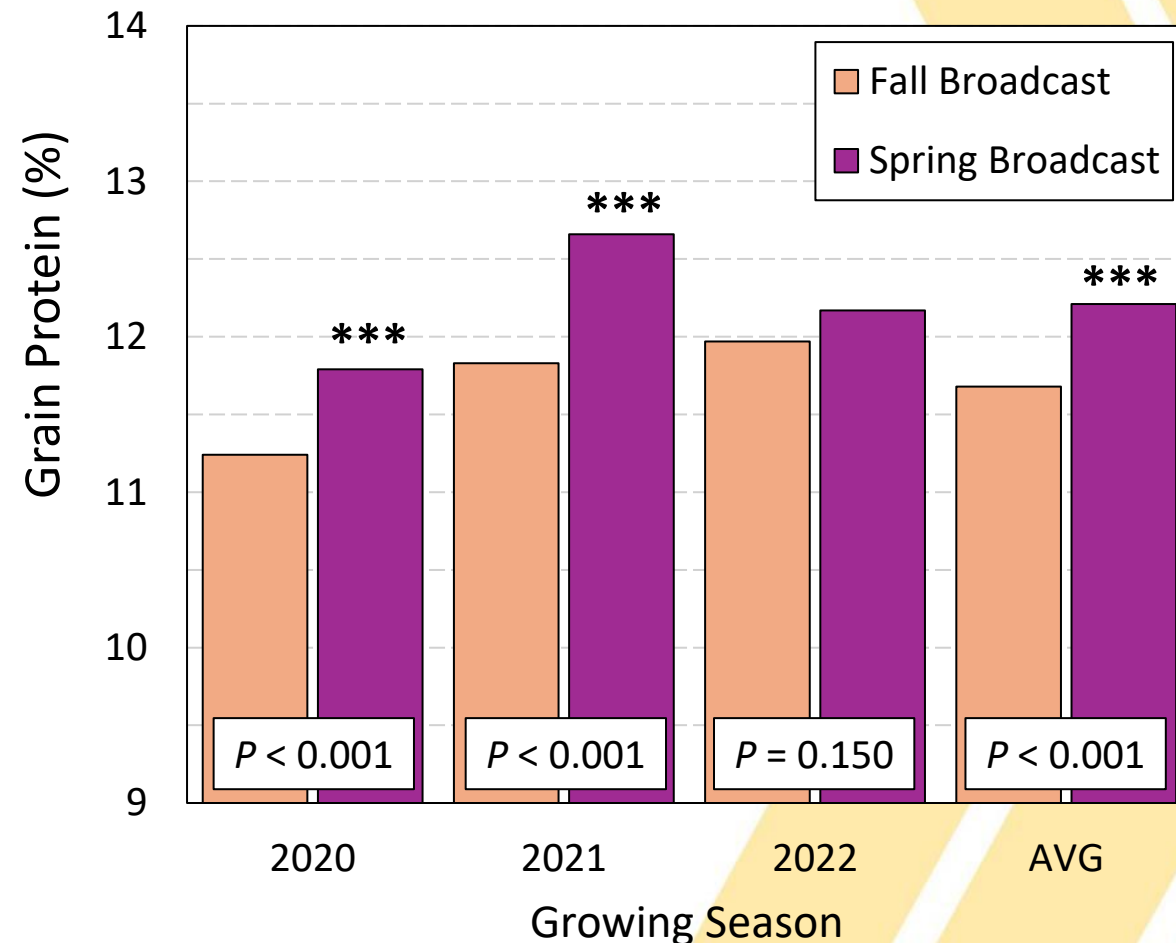
# Pre-Determined Contrast Comparisons

## Fall vs. Spring Broadcast Timing of N Fertilizer

### Grain Yield



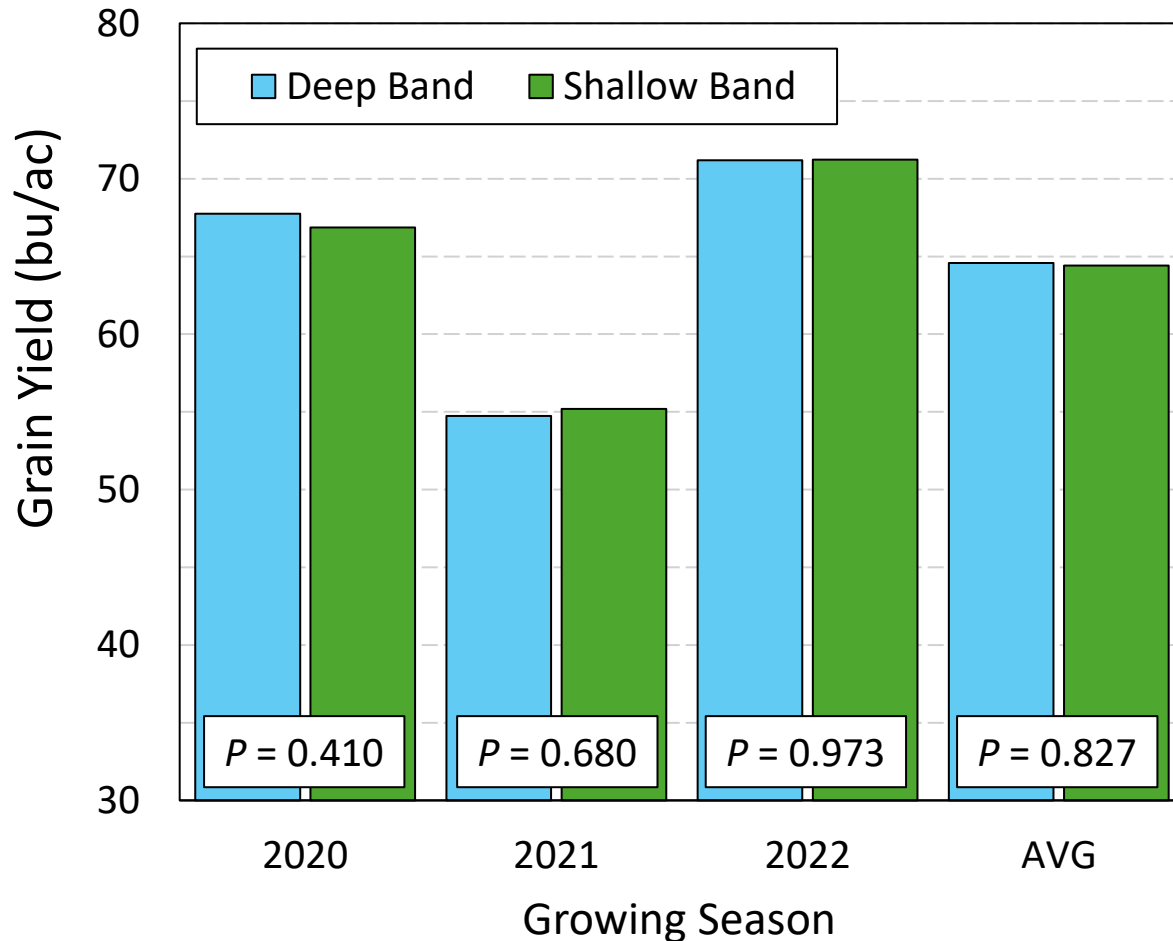
### Grain Protein



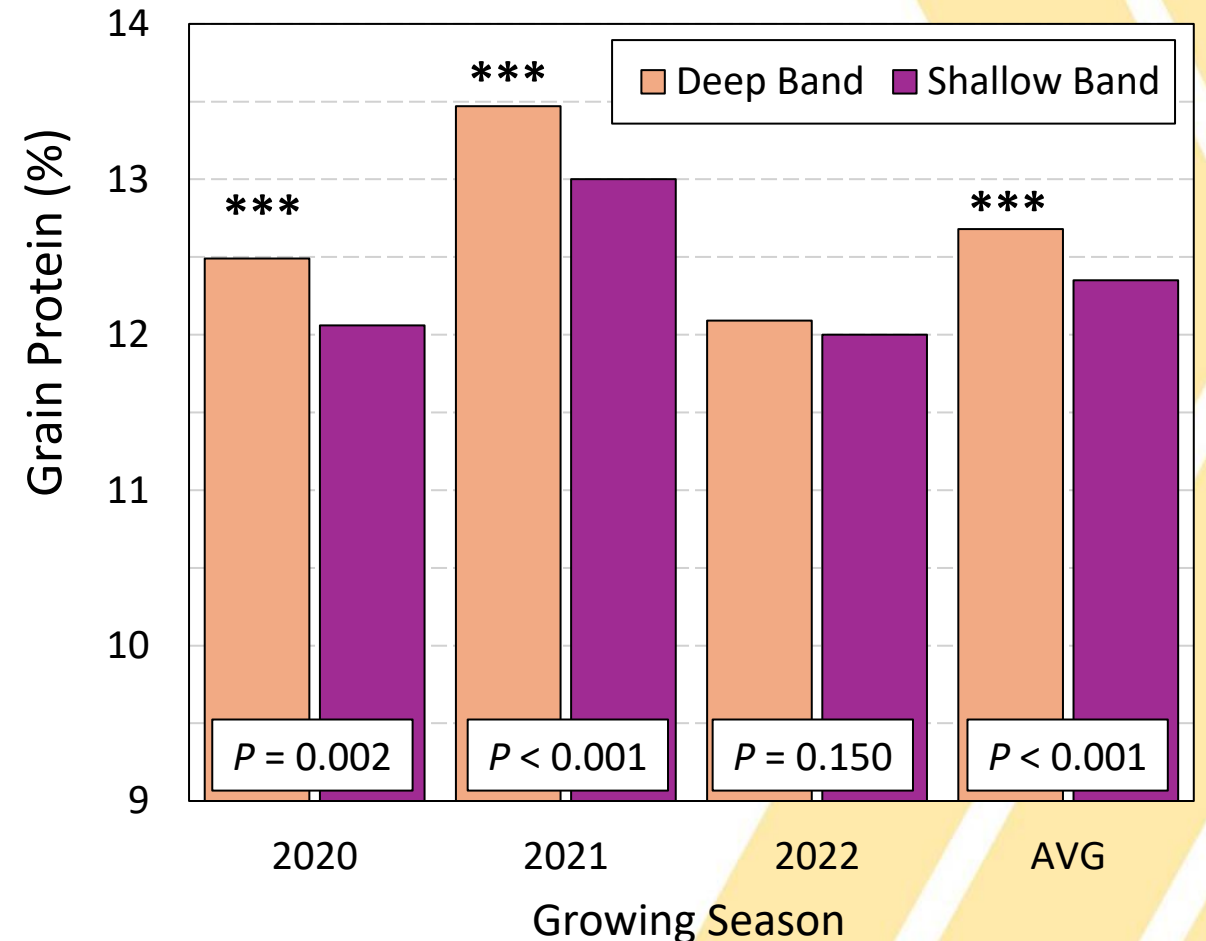
# Pre-Determined Contrast Comparisons

## Deep (>2") vs. Shallow (~1") Banding of N Fertilizer

### Grain Yield



### Grain Protein



# Efficacy of Enhanced Efficiency Nitrogen Fertilizers for Side-Band Applications in Spring Wheat (SFP)

**Objectives:** To determine if the use of certain enhanced efficiency nitrogen fertilizer products can improve the nitrogen use-efficiency over untreated urea for spring banded applications in CWRS wheat.

**Years:** 2024 and 2025 **Locations:** Yorkton (lead), Indian Head, Scott, Melfort, & Prince Albert

**Treatments (10):** 3 N Rates x 3 N Forms, plus a 0N Control

## N Rates<sup>z</sup>

- 1) 80 lb N/ac
- 2) 120 lb N/ac
- 3) 160 lb N/ac

## N Forms

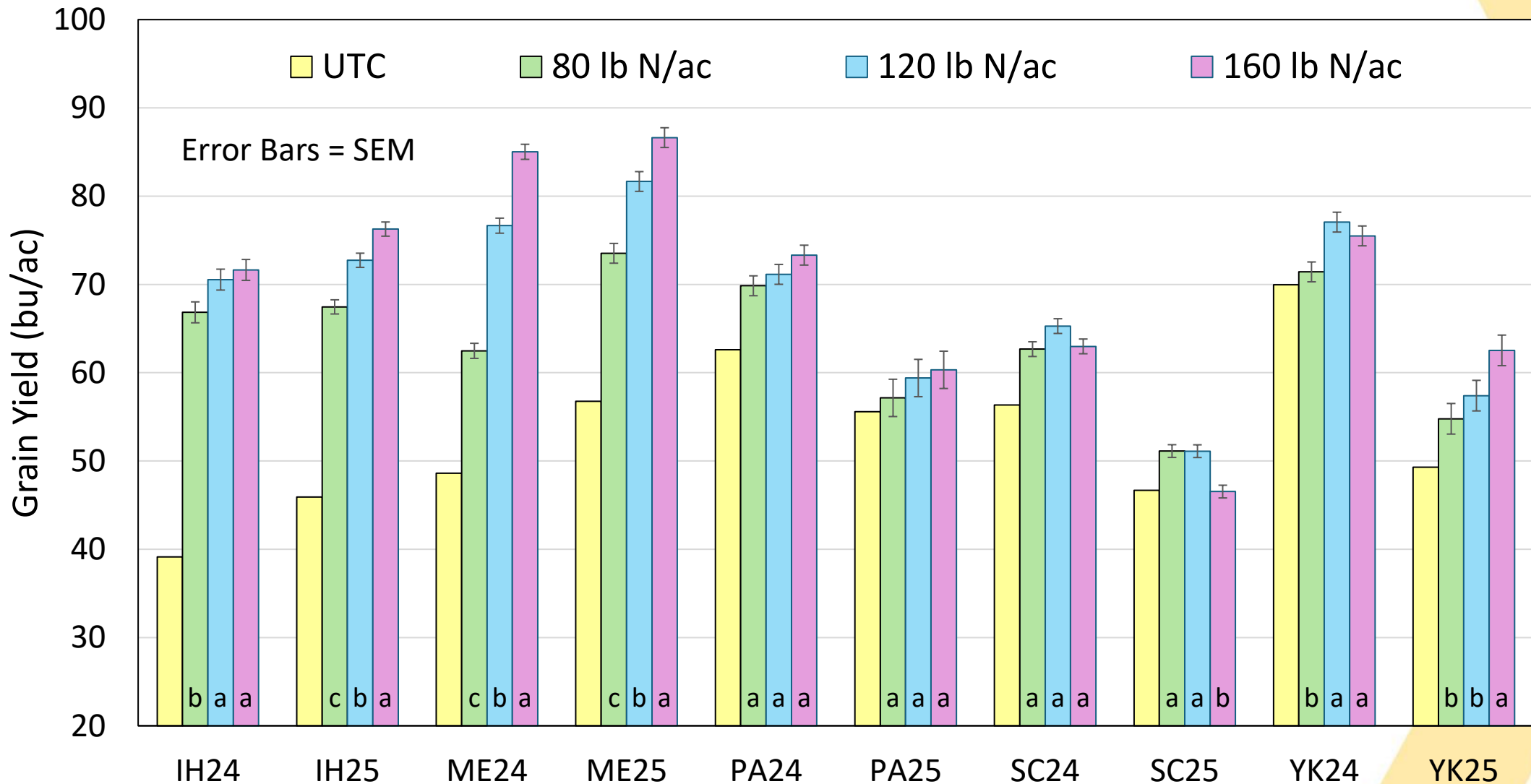
- 1) Untreated Urea
- 2) eNtrench NXTGEN (nitrification inhibitor)
- 3) SUPERU (dual urease/nitrification inhibitor)

<sup>z</sup> N rates include soil NO<sub>3</sub>-N plus N from PKS products

## **Data Collection:**

- 1) Emergence (plants/m<sup>2</sup>)
- 2) Maturity (days)
- 3) Grain Yield (bu/ac)
- 4) Grain Protein (%)
- 5) Tissue N (%)
- 6) N Uptake (lb N/ac)

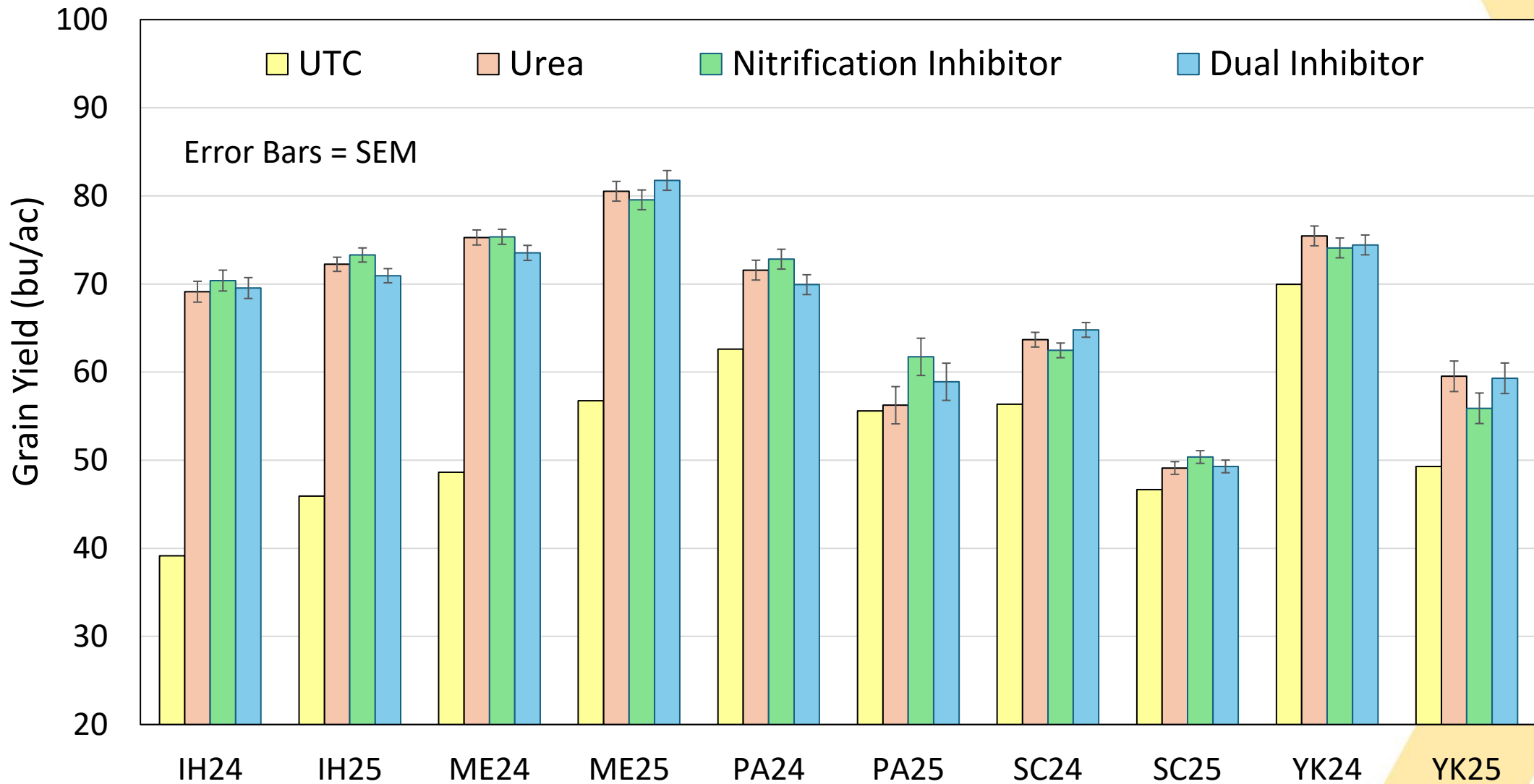
# Nitrogen Rate x Site Effects on Wheat Yield



Effect	Pr > F
Rate (R)	<0.001
Form (F)	0.880
Site (S)	<0.001
R x F	0.975
R x S	<0.001
F x S	0.773
R x F x S	0.997



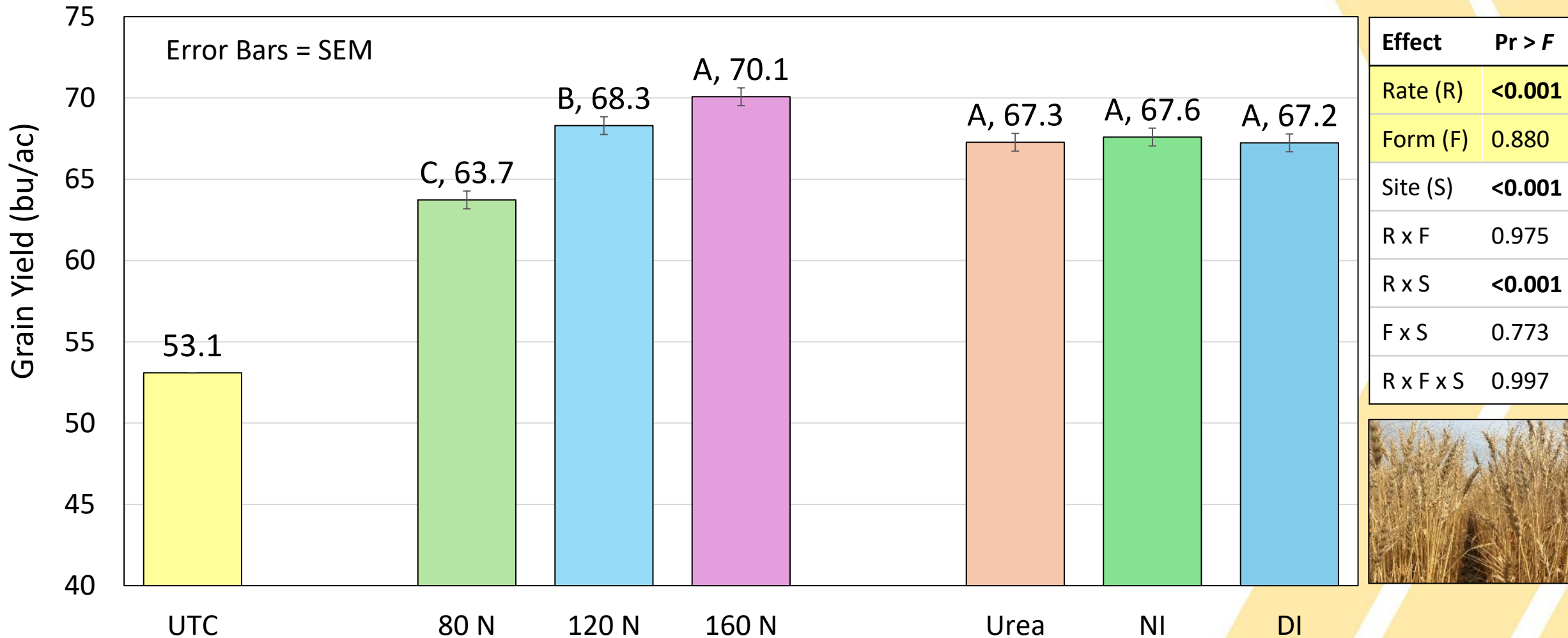
# Nitrogen Form x Site Effects on Wheat Yield



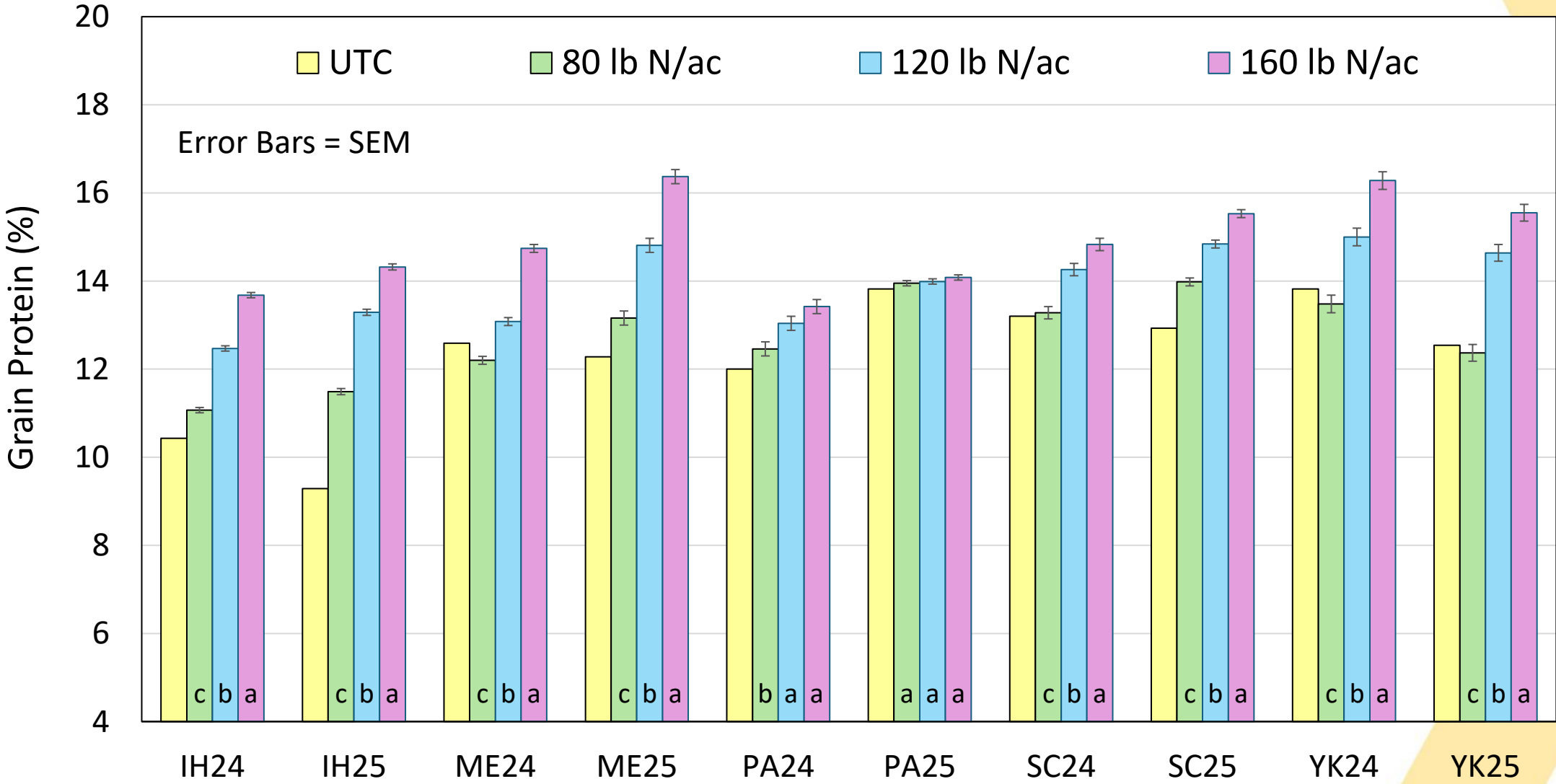
Effect	Pr > F
Rate (R)	<0.001
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Site (S)	<0.001
R x F	0.975
R x S	<0.001
F x S	0.773
R x F x S	0.997



# Nitrogen Rate & Form Effects on Wheat Yield (10 Site Average)



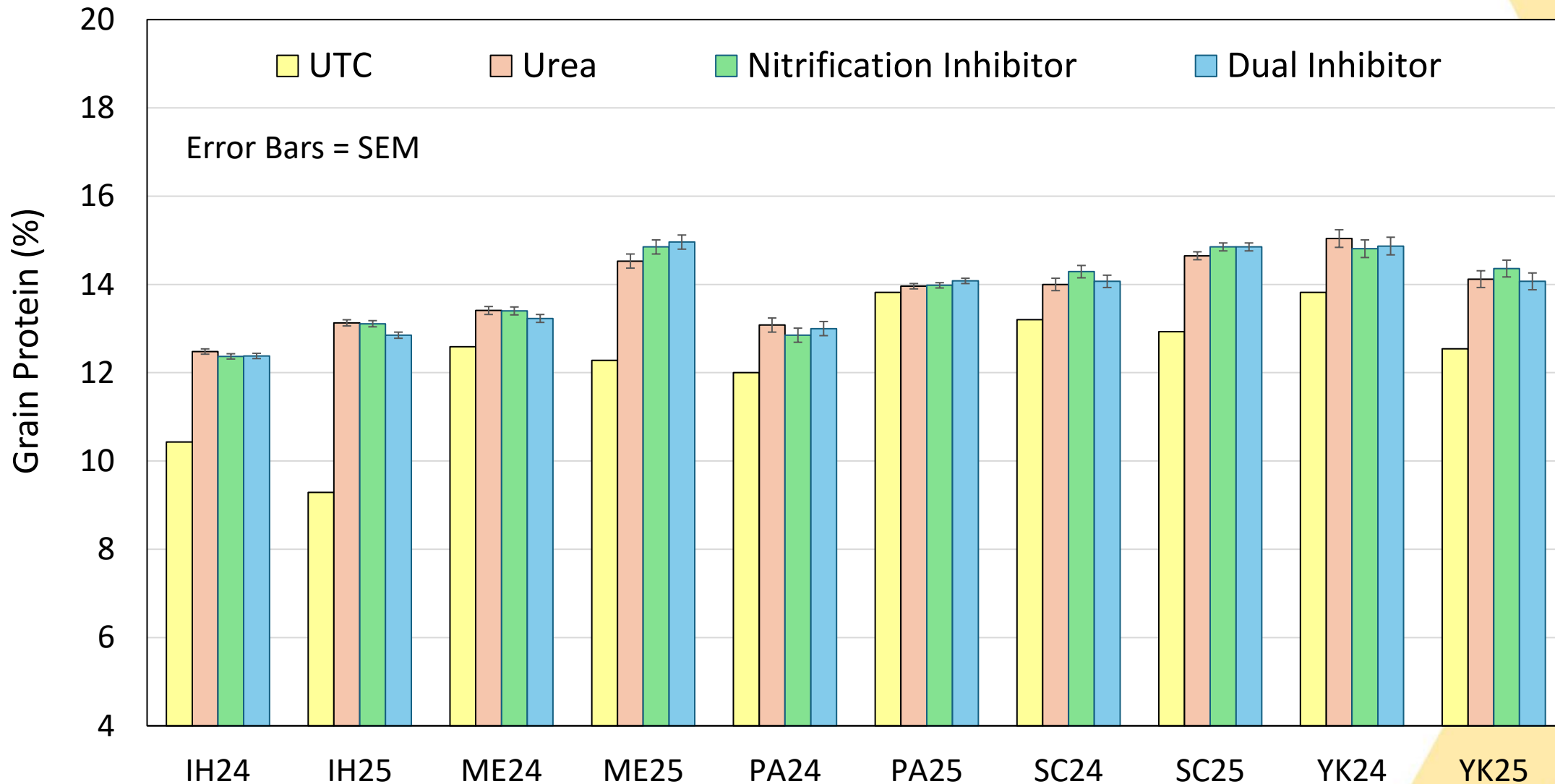
# Nitrogen Rate x Site Effects on Wheat Protein



Effect	Pr > F
Rate (R)	<0.001
Form (F)	0.774
Site (S)	<0.001
R x F	0.331
R x S	<0.001
F x S	0.902
R x F x S	0.996



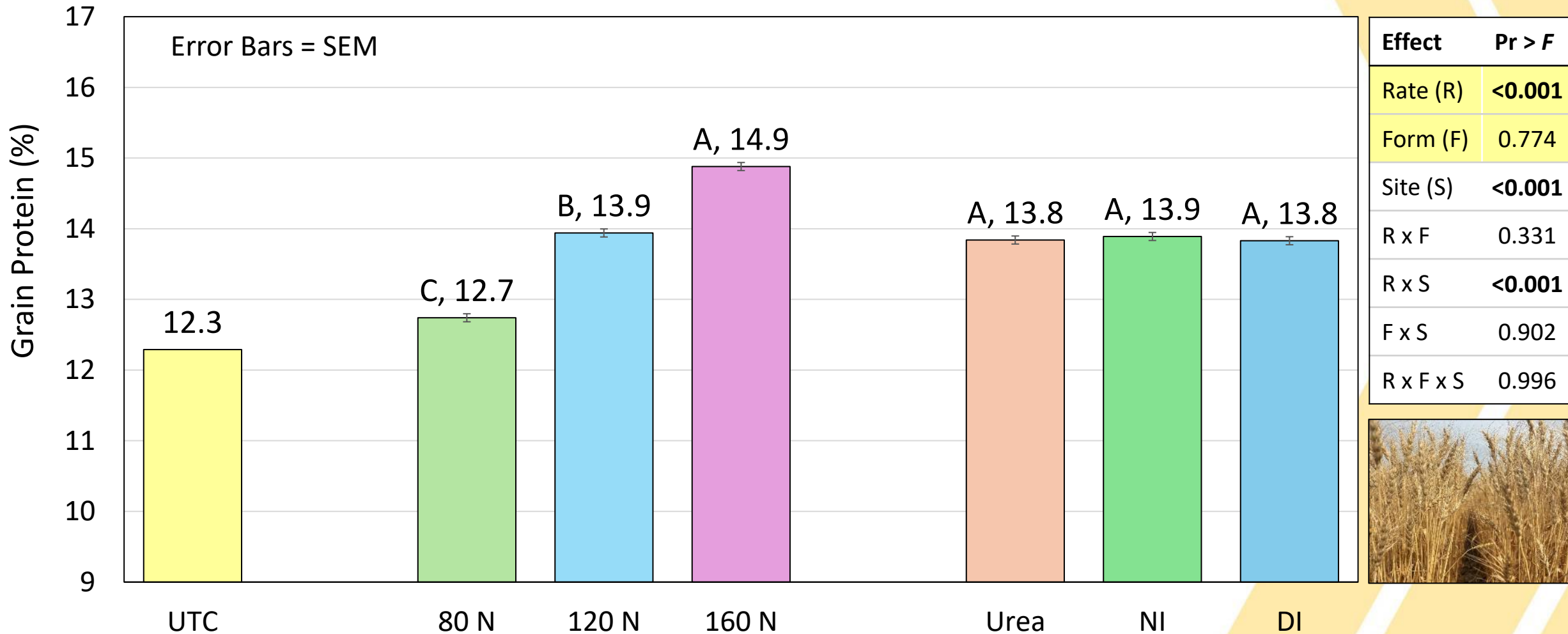
# Nitrogen Form x Site Effects on Wheat Protein



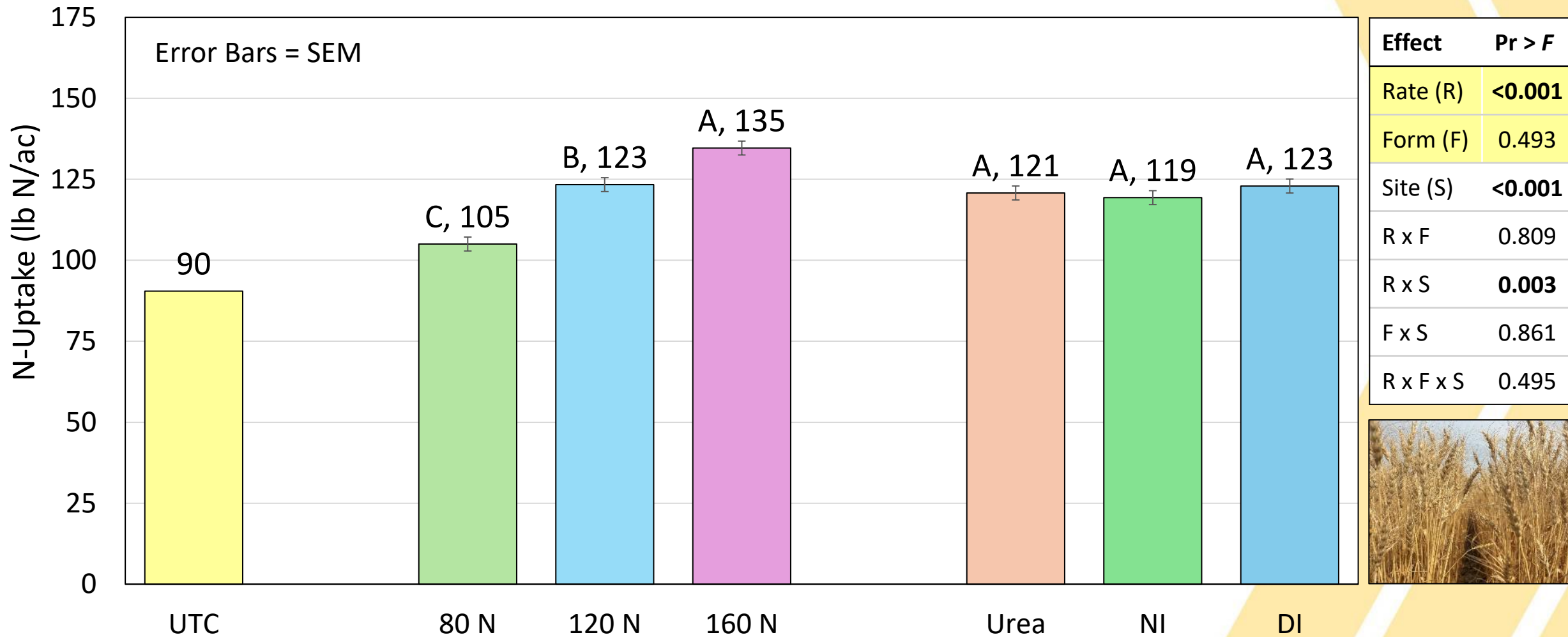
Effect	Pr > F
Rate (R)	<0.001
Form (F)	0.774
Site (S)	<0.001
R x F	0.331
R x S	<0.001
F x S	0.902
R x F x S	0.996



# Nitrogen Rate & Form Effects on Wheat Protein (10 Site Overall Average)



# Nitrogen Rate & Form Effects on Wheat N-Uptake (10 Site Overall Average)



# Canola Response to Side-Banded Enhanced Efficiency Nitrogen Formulations & Blends

**Objectives:** To demonstrate canola response & the agronomic N-use efficiency of contrasting N fertilizer forms and blends, relative to untreated urea, with side-banding

## Treatments:

- |                              |   |   |
|------------------------------|---|---|
| 1) Control (soil N plus PKS) | 5) Med N – 25% ESN <sup>®</sup> (polymer) | 9) Med N – 25% SUPERU <sup>®</sup> (dual)         |
| 2) Low N – urea (67 N)       | 6) Med N – 50% ESN <sup>®</sup>           | 10) Med N – 50% SUPERU <sup>®</sup>               |
| 3) Med N – urea (111 N)      | 7) Med N – 75% ESN <sup>®</sup>           | 11) Med N – 75% SUPERU <sup>®</sup>               |
| 4) High N – urea (156 N)     | 8) Med N – 100% ESN <sup>®</sup>          | 12) Med N – 100% SUPERU <sup>®</sup>              |
|                              |   | 13) Med N – ANVOL <sup>®</sup> (urease)           |
|                              |   | 14) Med N – eNtrench <sup>™</sup> (nitrification) |

**Note:** Nitrogen rates include residual soil NO<sub>3</sub>-N plus N from PKS products

## Data Collection:

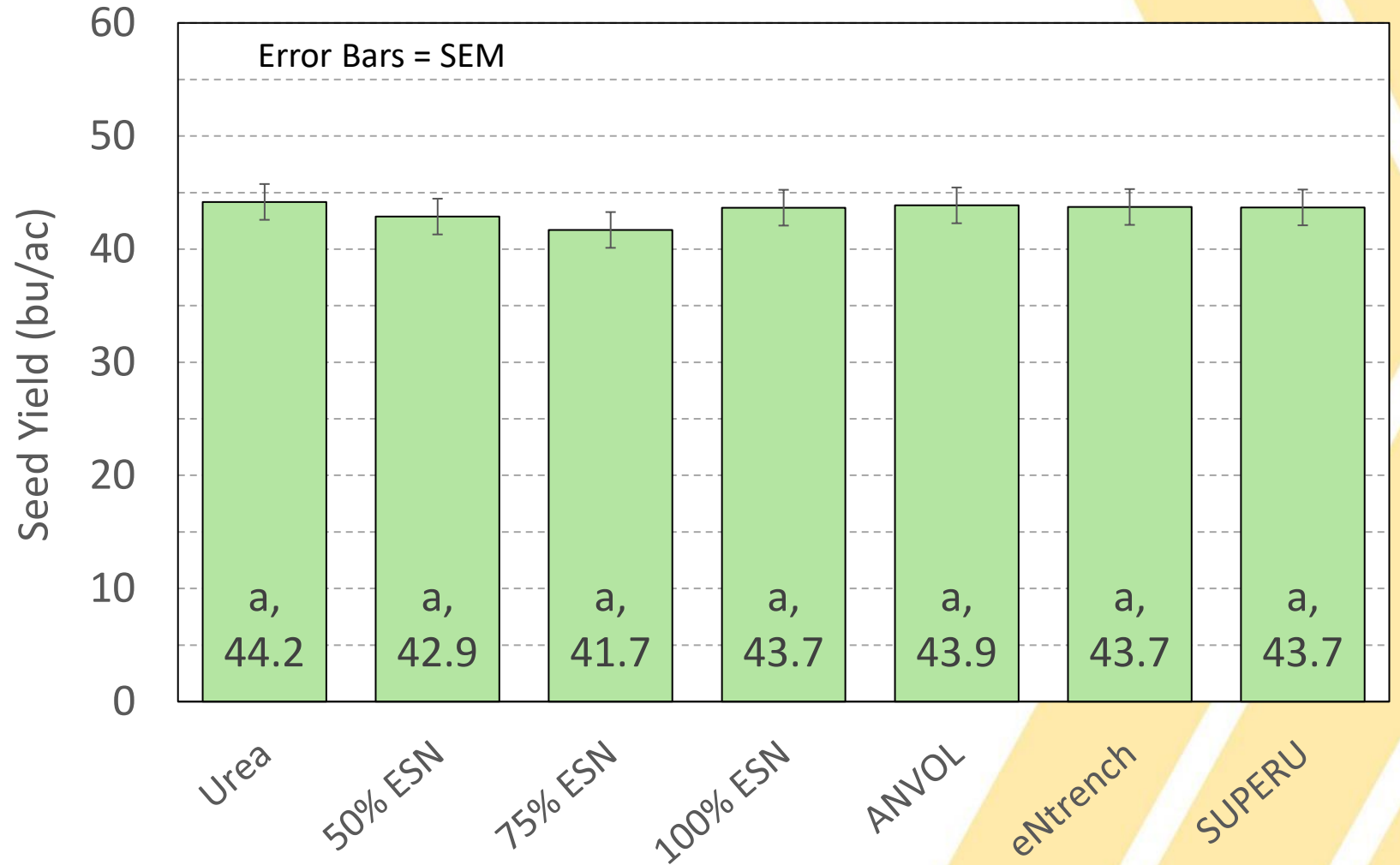
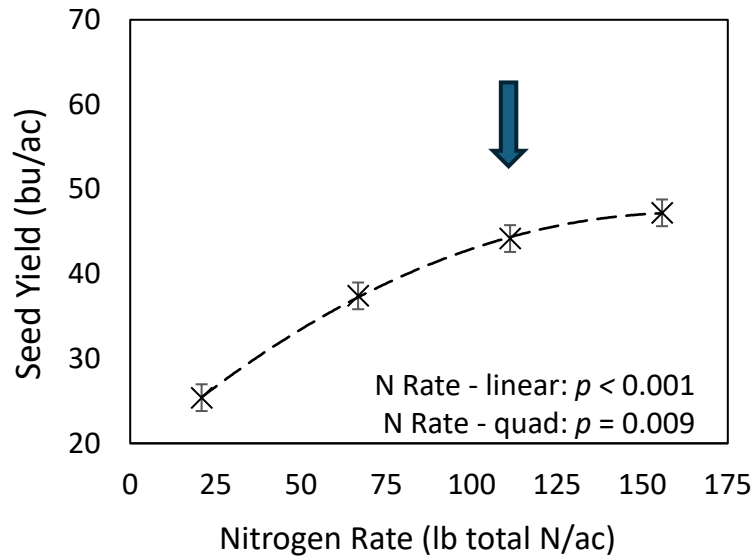
- 1) Emergence
- 2) Seed Yield
- 3) Seed Protein/Oil
- 4) Agronomic NUE

## Locations (2024 and 2025):

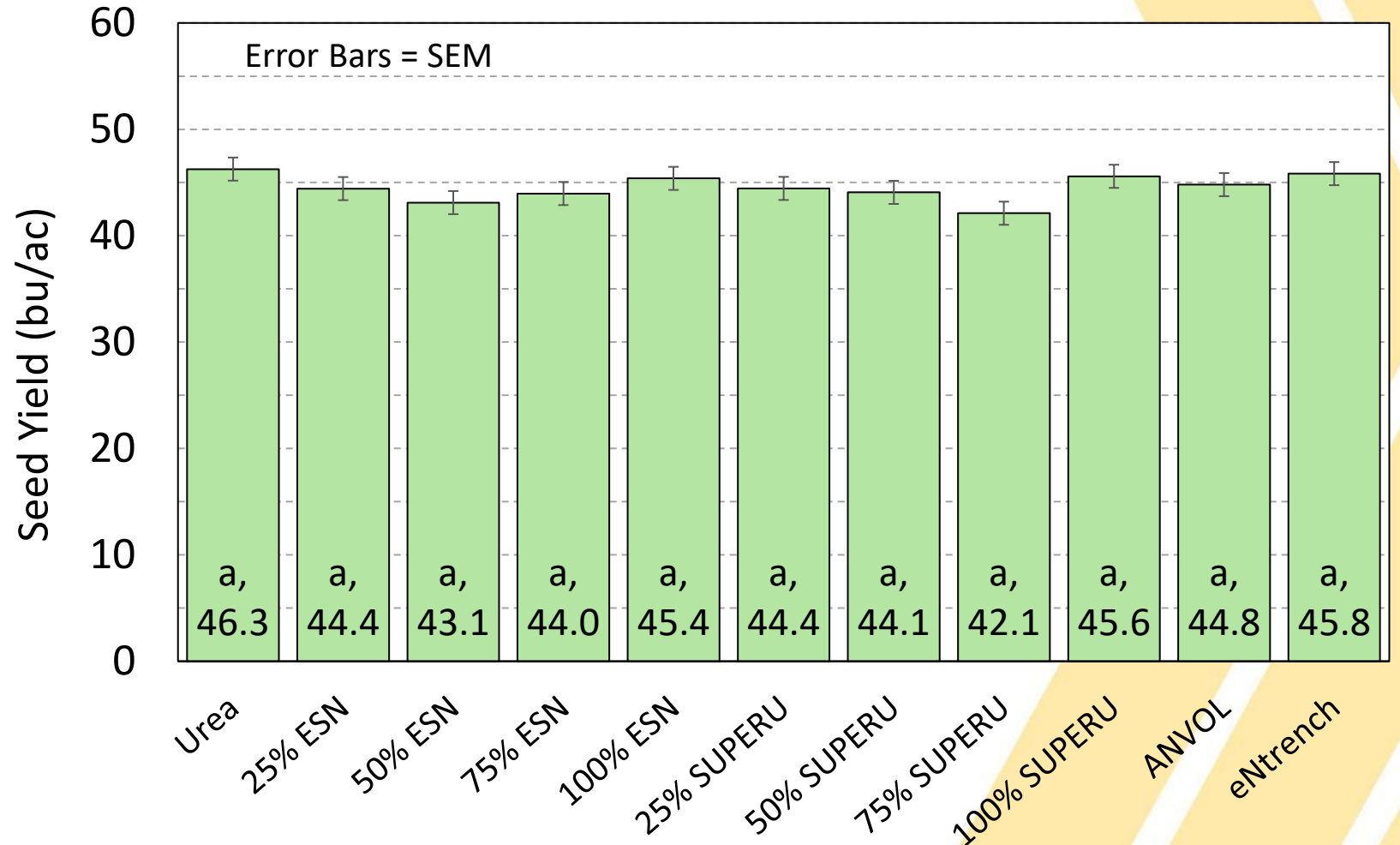
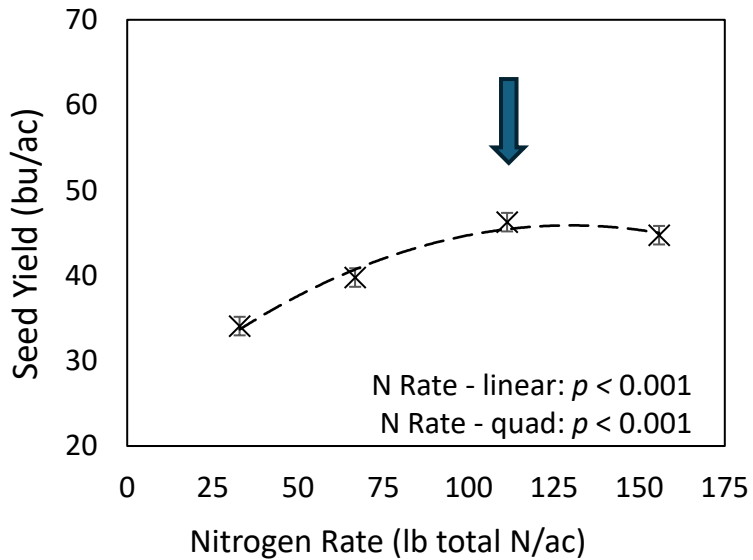
Indian Head (lead)<sup>z</sup>, Melfort, Prince Albert, Scott, Swift Current, and Yorkton

<sup>z</sup> Similar project completed at Indian Head in 2023

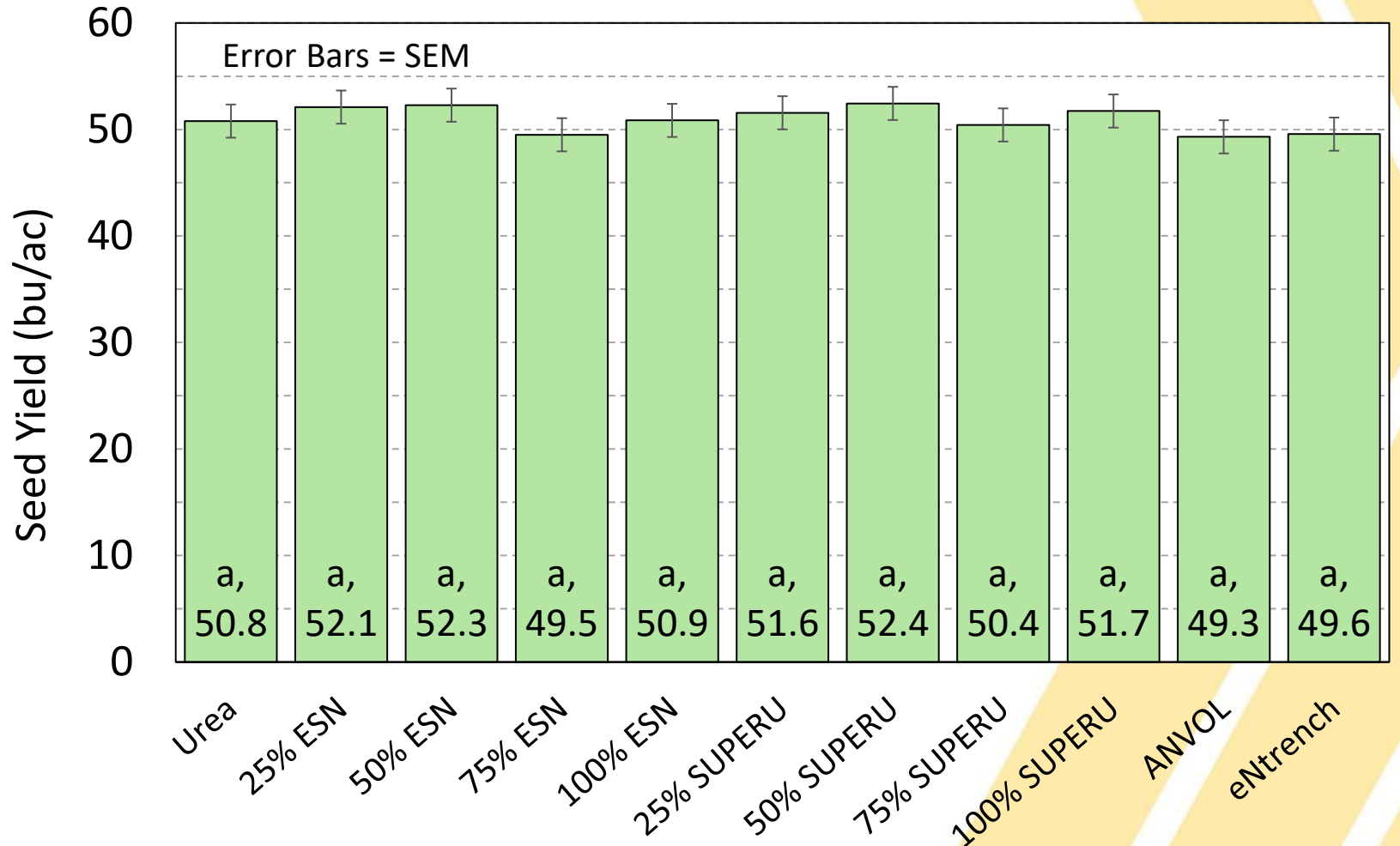
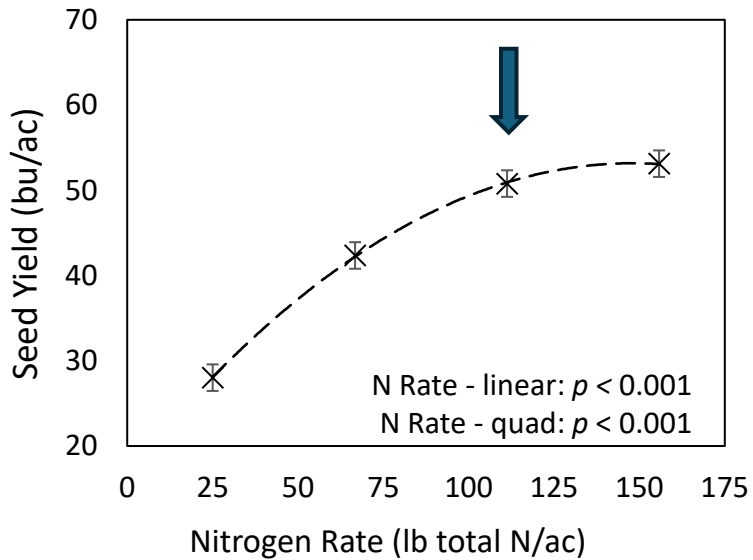
# Side-banded Nitrogen Rate & Formulation Effects on Canola Seed Yield (IH-23)



# Side-banded Nitrogen Rate & Formulation Effects on Canola Seed Yield (IH-24)



# Side-banded Nitrogen Rate & Formulation Effects on Canola Seed Yield (IH-25)



# Managing Drought Risk in Spring Wheat with Split Applications of Nitrogen (2022)

**Objectives:** To demonstrate the efficacy of various rates and timings of split-applied N relative to simply side-banding all the N at seeding

**Locations:** Yorkton (lead), Indian Head, Melfort, Outlook, Scott, & Swift Current

## Treatments:

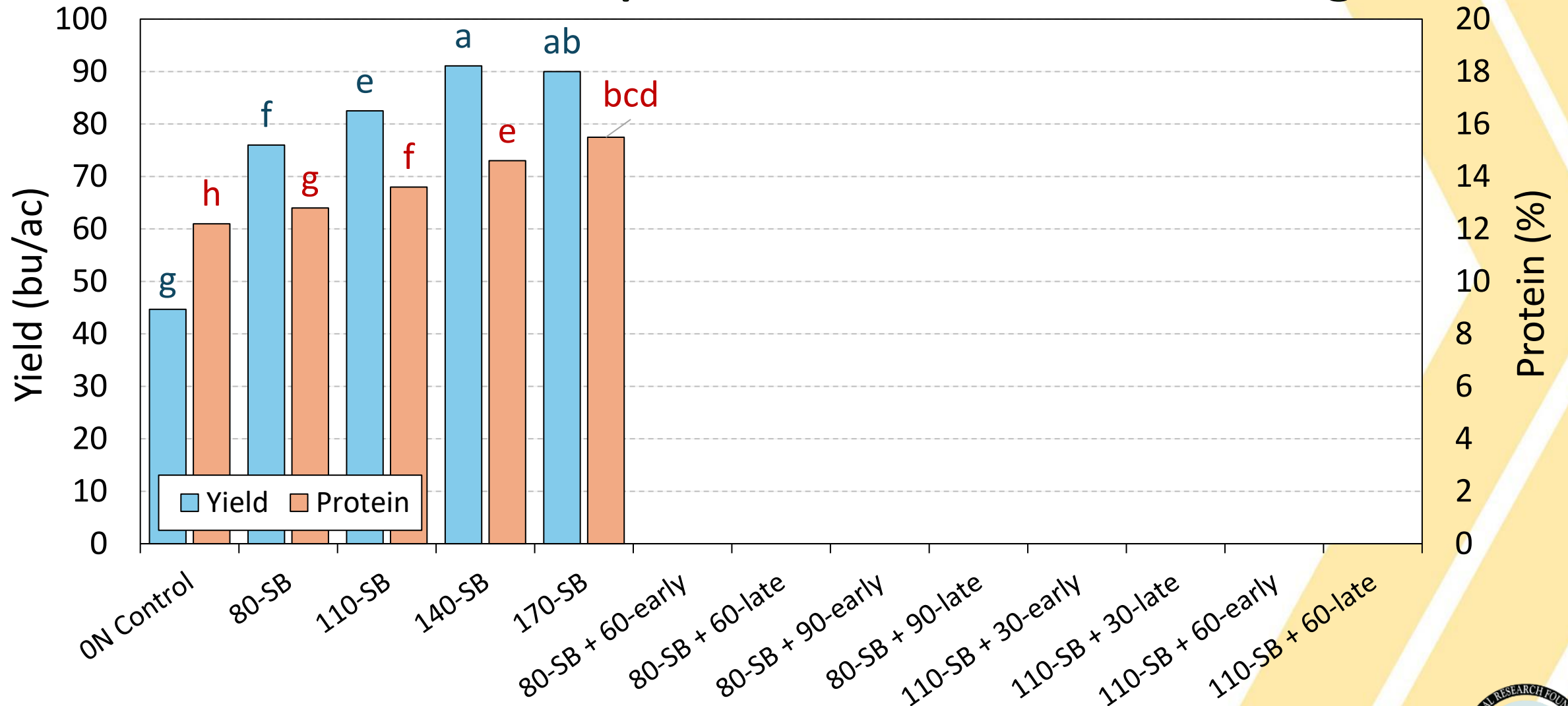
100% at Seeding	Split Applications	
1) Control (0 N)	(early – 3-5 leaf stage; late – early flag leaf stage)	
2) 80 lb N/ac	6) 80 N + 60 N early (140)	10) 110 N + 30 N early (140)
3) 110 lb N/ac	7) 80 N + 60 N late (140)	11) 110 N + 30 N late (140)
4) 140 lb N/ac	8) 80 N + 90 N early (170)	12) 110 N + 60 N early (170)
5) 170 lb N/ac	9) 80 N + 90 N late (170)	13) 110 N + 60 N late (170)



- N applied at seeding was side-banded urea, in-crop N was dribbled-banded UAN

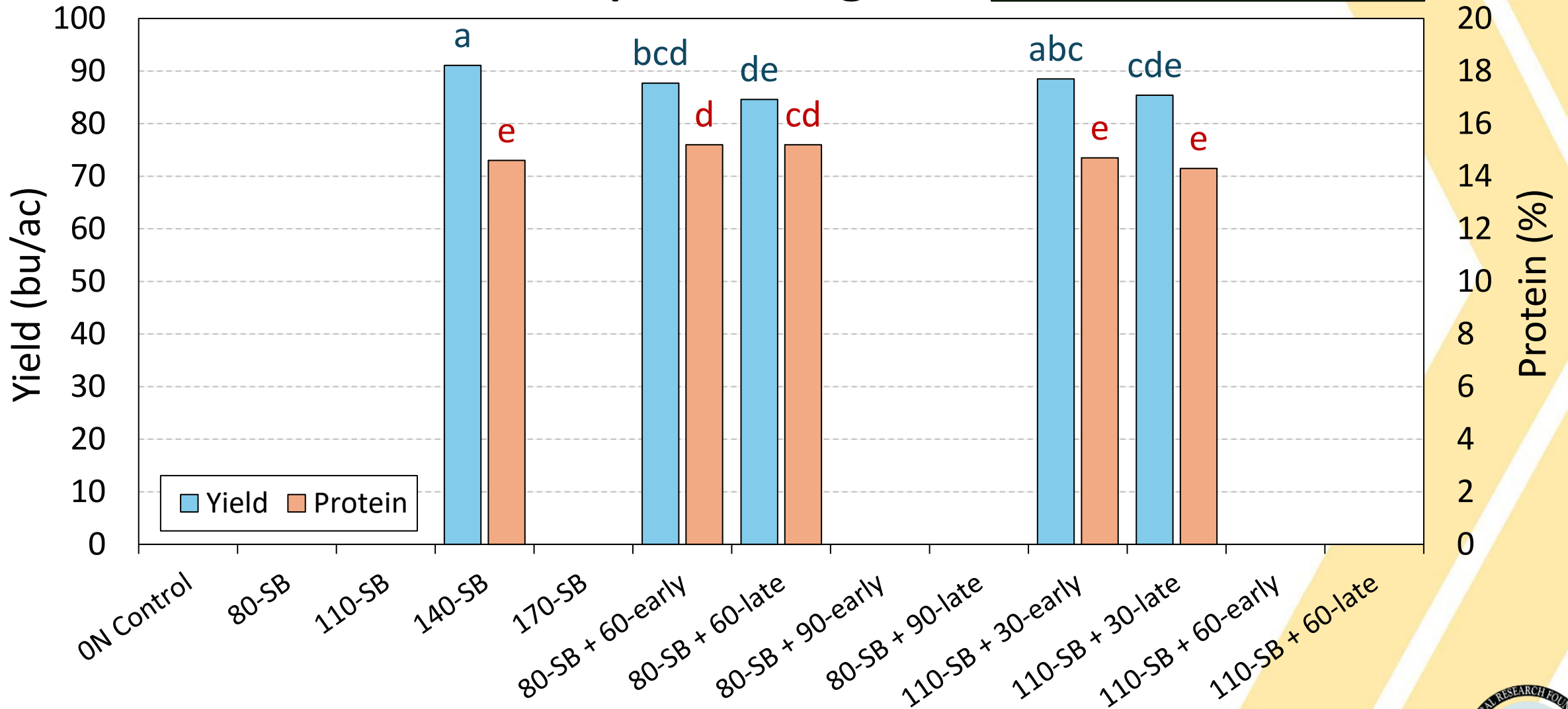
# Indian Head 2022

## Yield & Protein Response to Side-banded Nitrogen



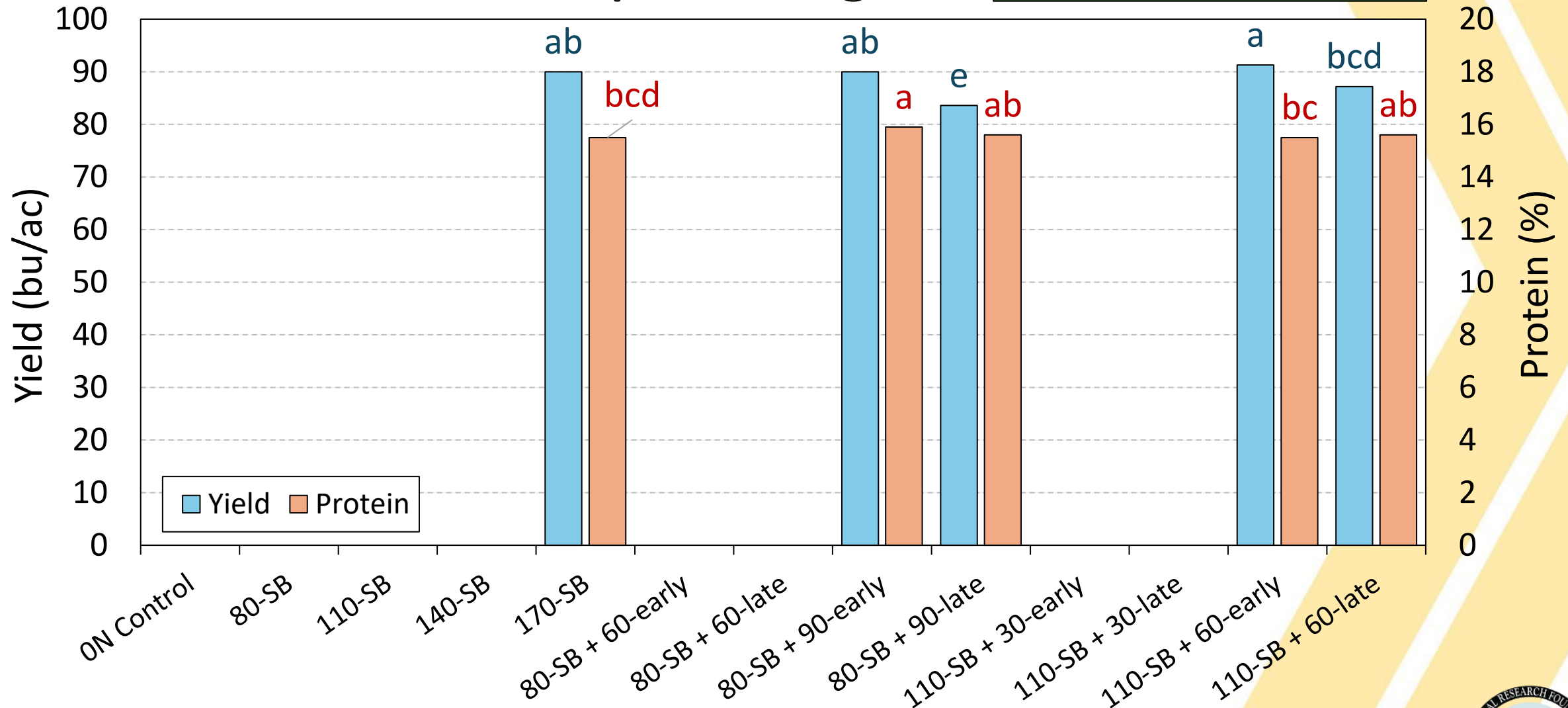
# Indian Head 2022

## Side-Band versus Split Nitrogen – 140 lb Total N/ac



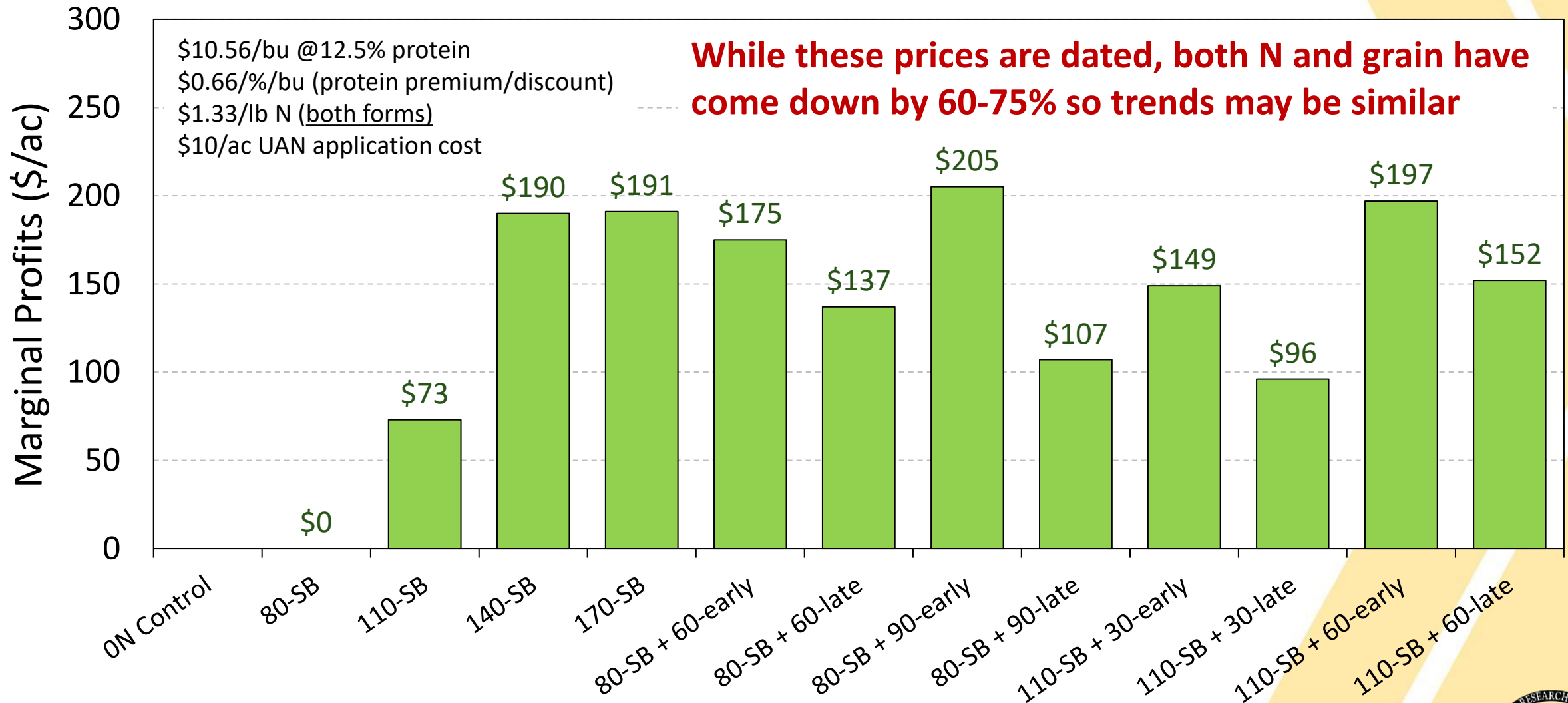
# Indian Head 2022

## Side-Band versus Split Nitrogen – 170 lb Total N/ac



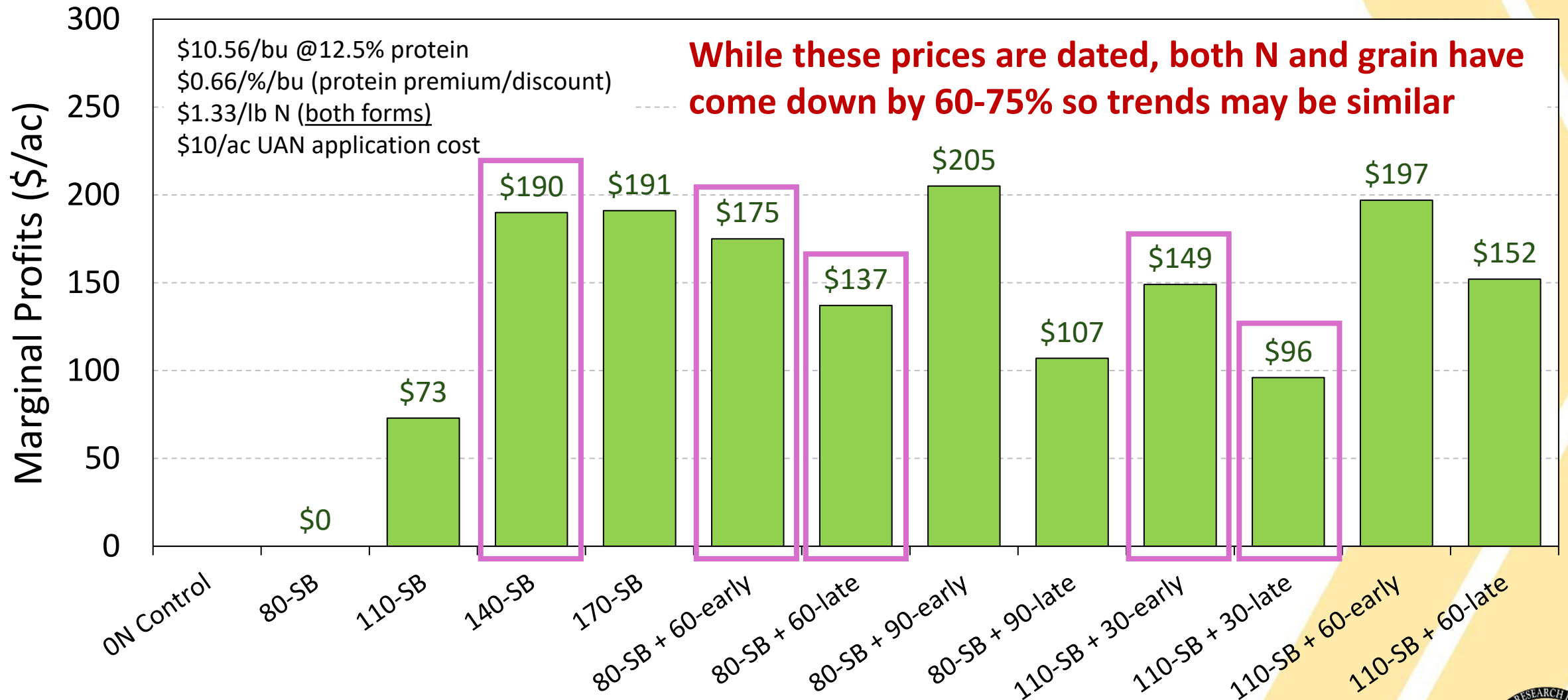
# Indian Head 2022 (all treatments)

## Marginal Profits (relative to 80 lb total N/ac at seeding)



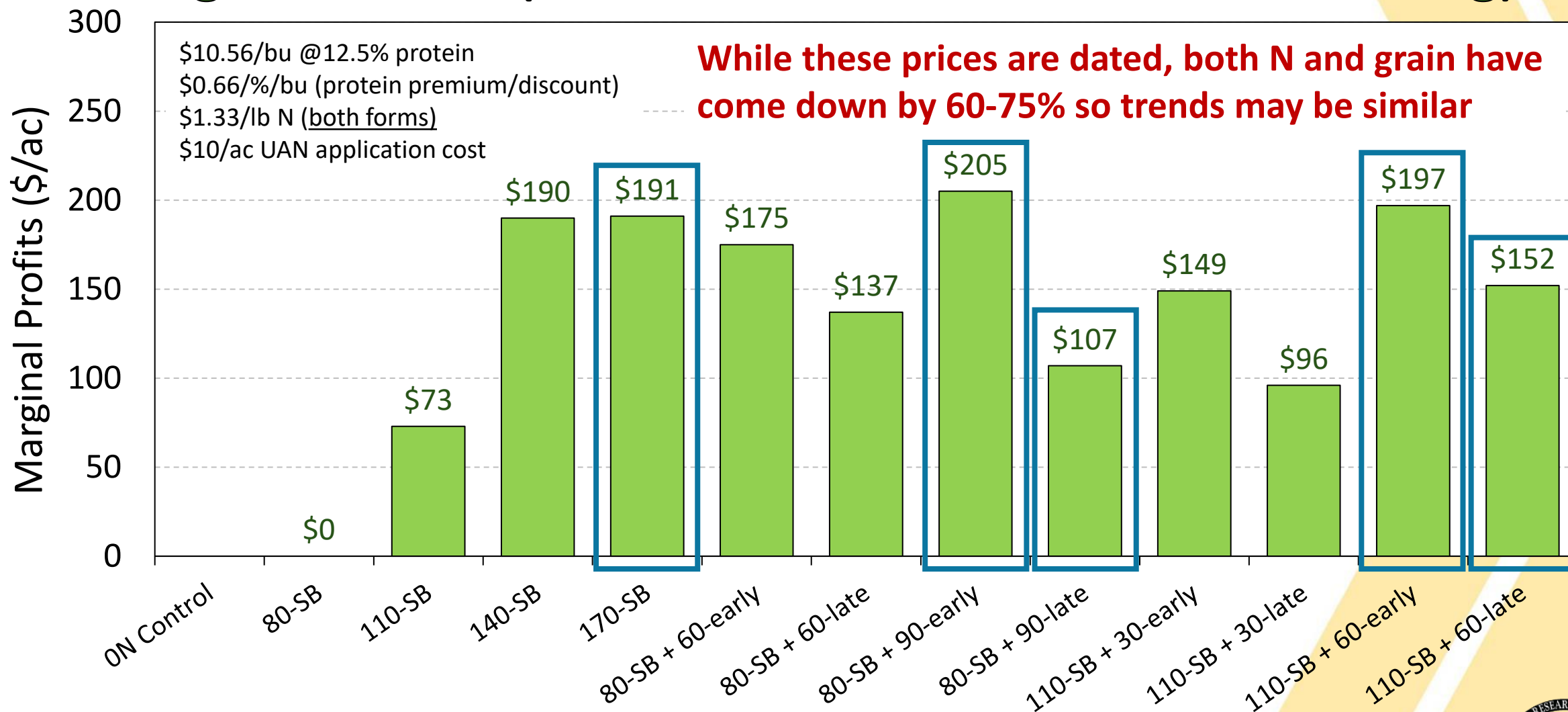
# Indian Head 2022 (all treatments)

## Marginal Profits (relative to 80 lb total N/ac at seeding)



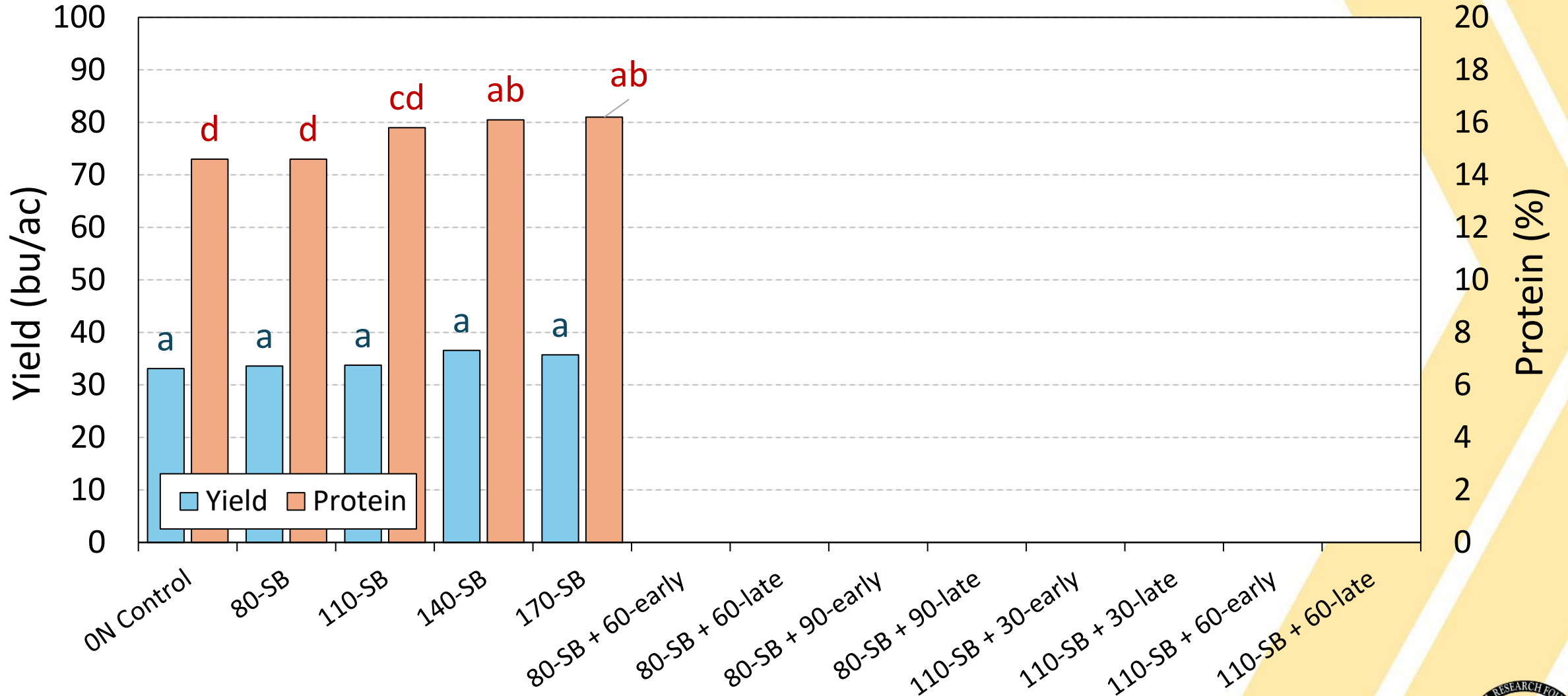
# Indian Head 2022 (all treatments)

## Marginal Profits (relative to 80 lb total N/ac at seeding)



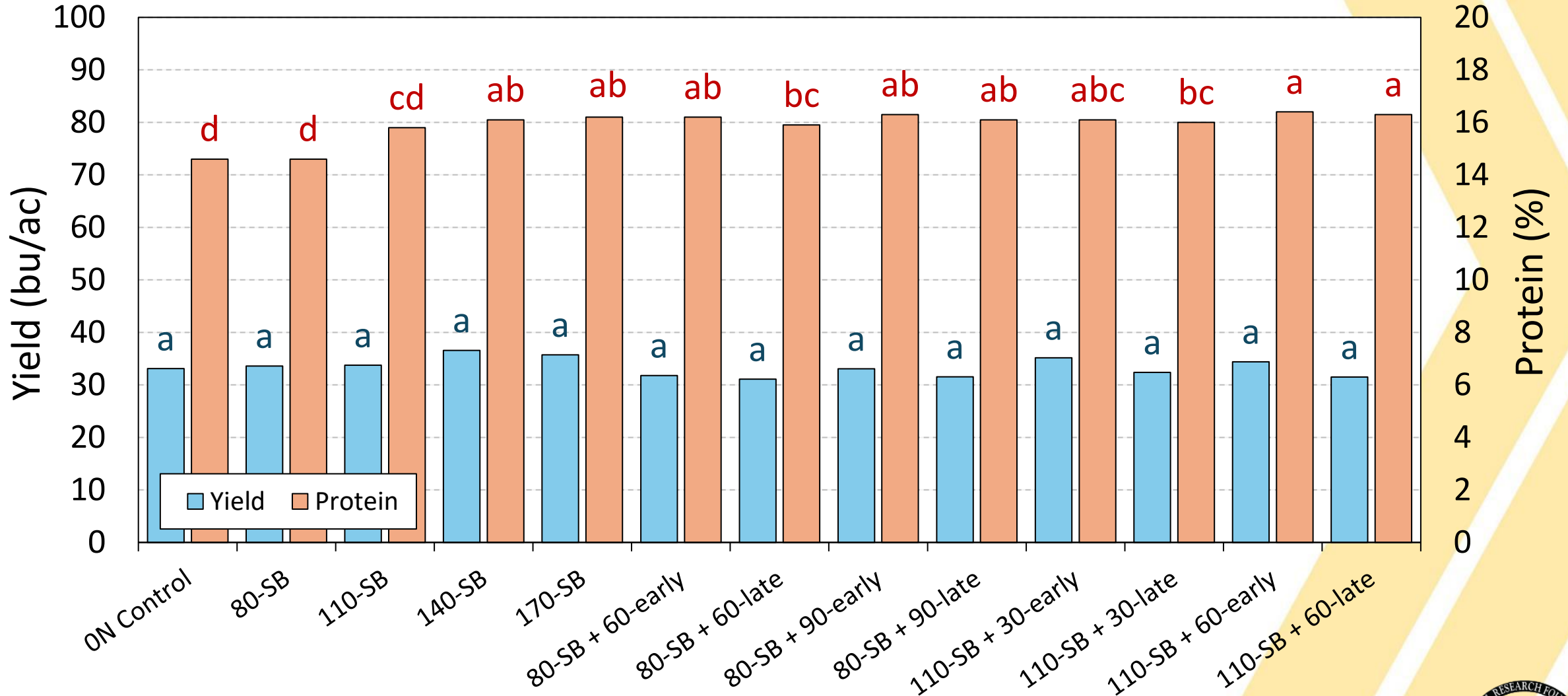
# Swift Current 2022

## Yield & Protein Response to Side-banded Nitrogen



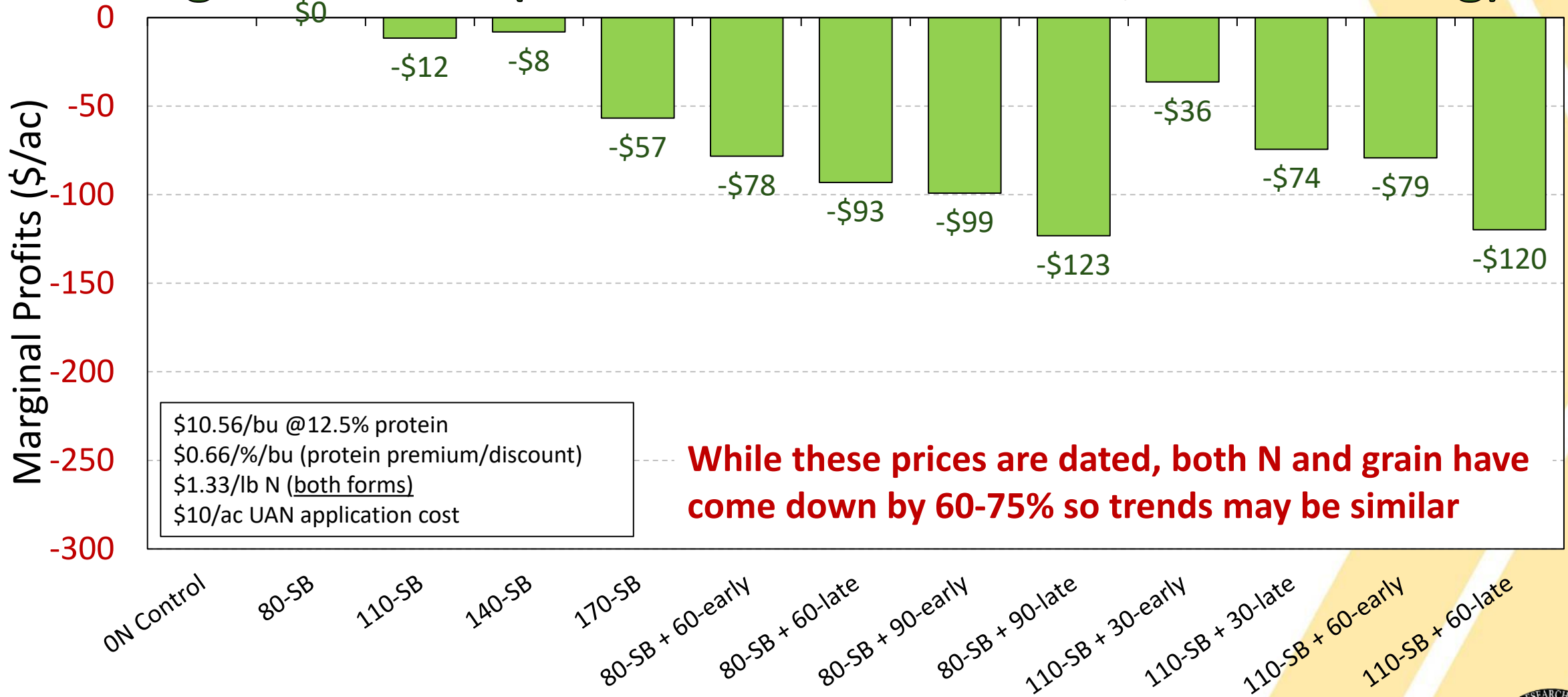
# Swift Current 2022

## Yield & Protein Response to Nitrogen Management Treatments



# Swift Current 2022 (all treatments)

## Marginal Profits (relative to 80 lb total N/ac at seeding)



# Managing Lodging, Yield & Quality in CWRS Wheat with PGR & Intensive N Management (SaskWheat)

**Objectives:** To demonstrate the ability of PGR combined with intensive N management strategies to achieve the highest possible wheat yields without compromising grain quality.

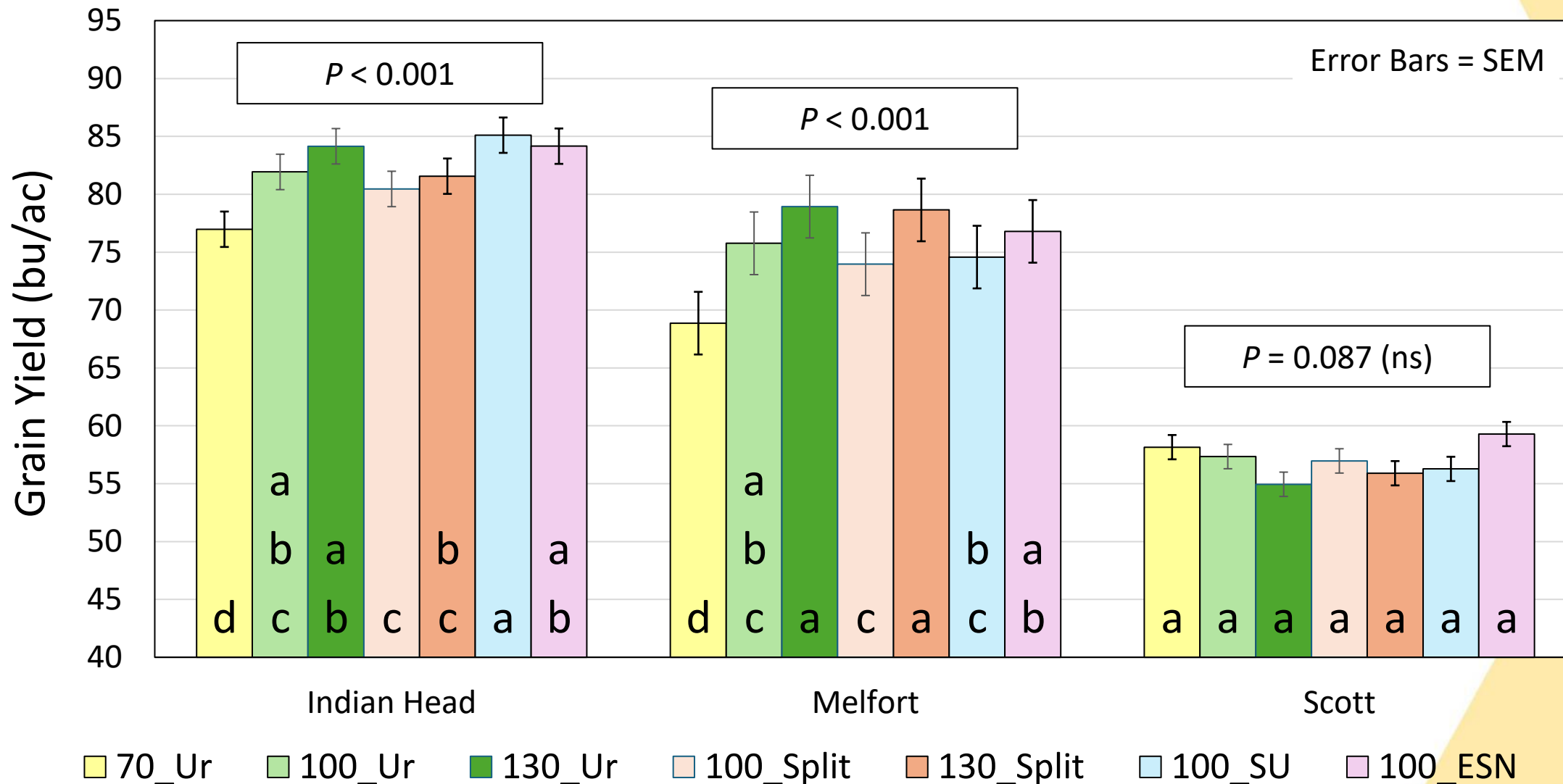
**Locations:** Indian Head (lead), Melfort & Scott      **Years:** 2025 and 2026

**Treatments:** 2 PGR (UTC vs Manipulator) x 7 N Management Strategies

#	Side-banded Nitrogen	In-Crop N (3-5 leaf)
1	70% as urea	Nil
2	100% as urea (134 lb total N/ac)	Nil
3	130% as urea	Nil
4	70% as urea	30% dribble banded UAN
5	100% as urea	30% dribble banded UAN
6	100% as SUPERU® (Dual Inhibitor)	Nil
7	100% as 75% ESN® (Polymer)	Nil



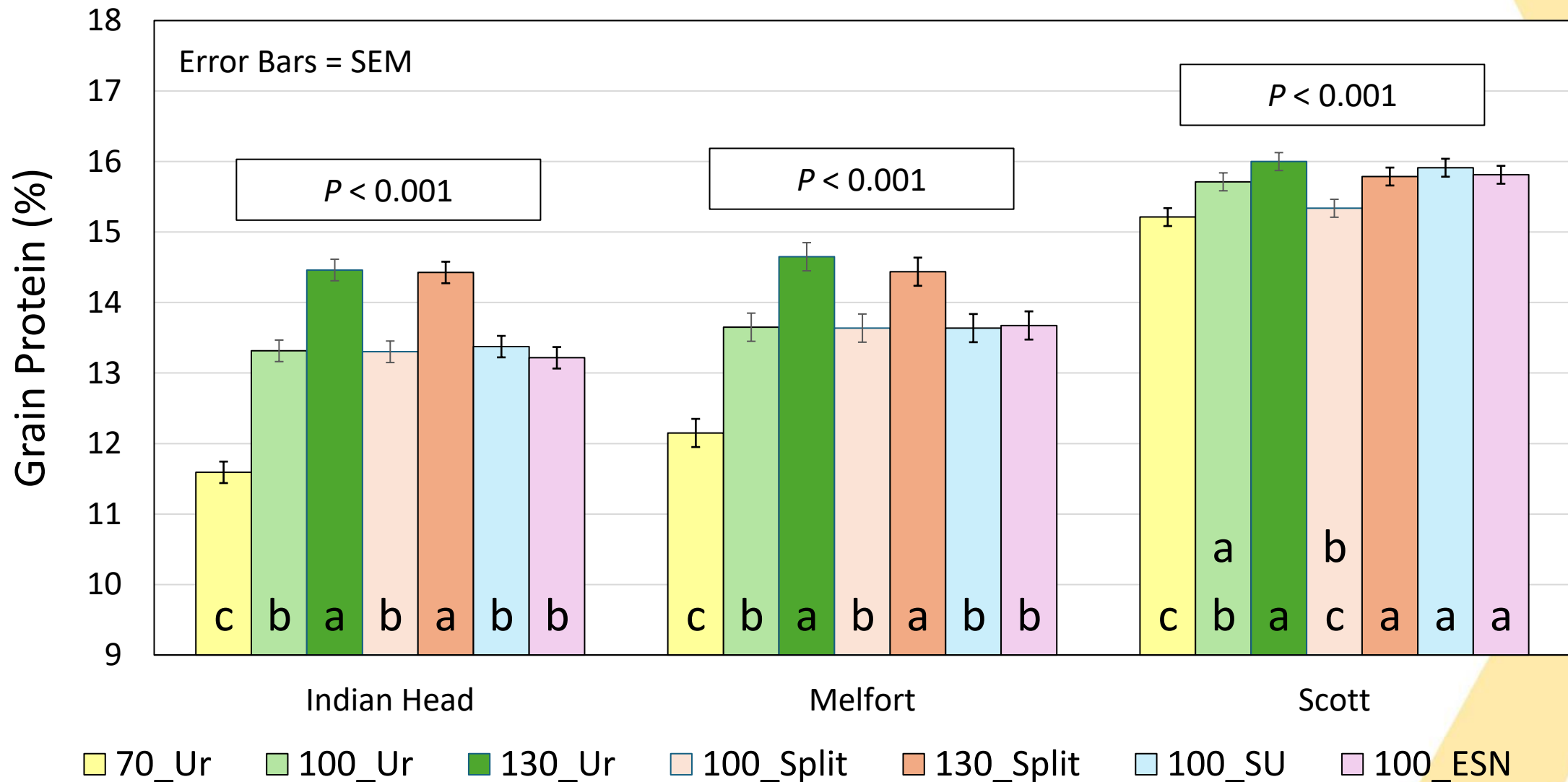
# Site x Nitrogen Treatment Effects on Wheat Yield



Effect	Pr > F
Site (S)	<0.001
PGR	0.596
S x PGR	0.577
N	<0.001
S x N	<0.001
PGR x N	0.229
S x P x N	0.274



# Site x N Treatment Effects on Wheat Protein

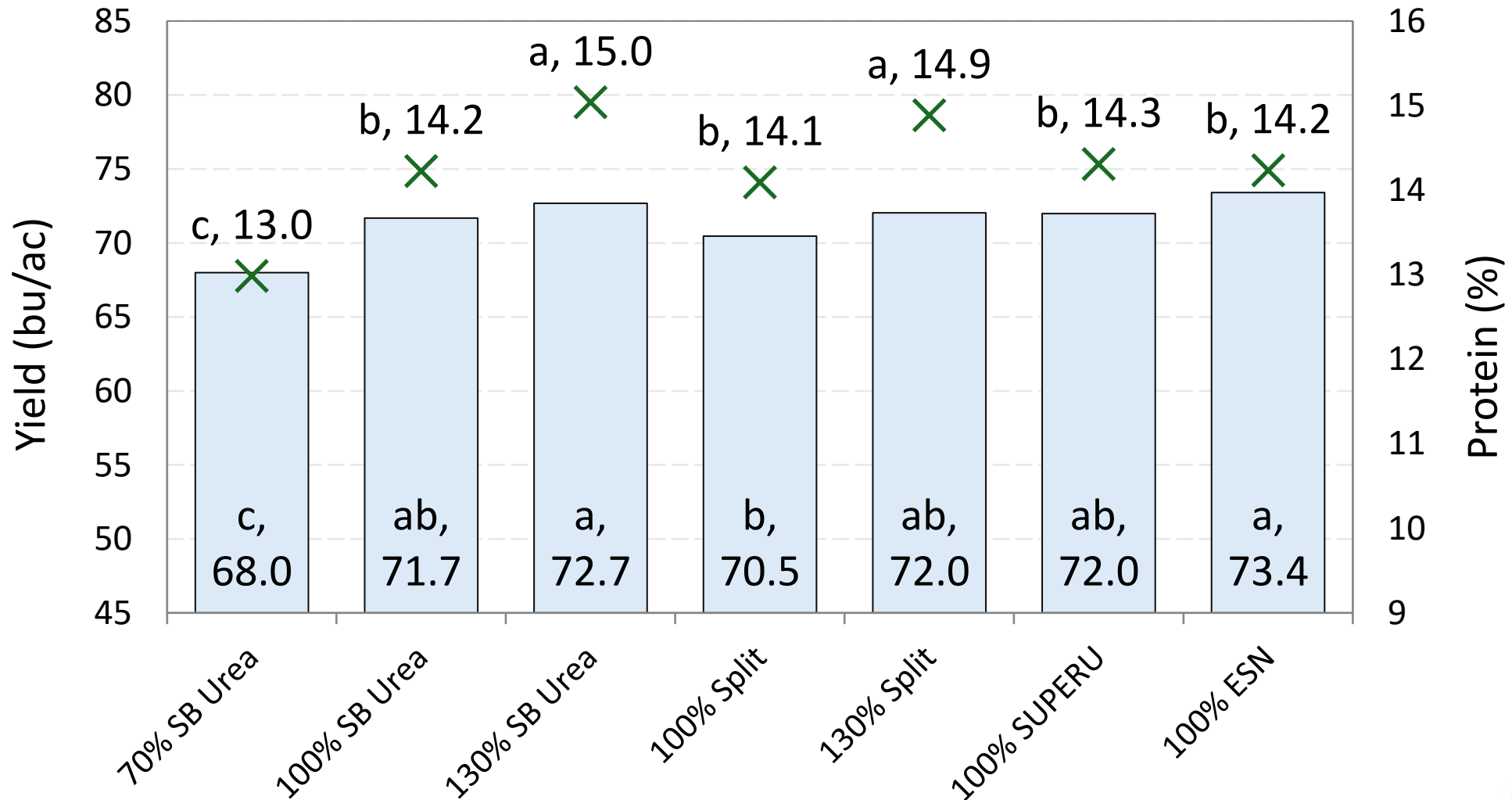


Effect	Pr > F
Site (S)	<0.001
PGR	0.030
S x PGR	0.217
N	<0.001
S x N	<0.001
PGR x N	0.836
S x P x N	0.398



# N Treatment Effects on Wheat Yield and Protein

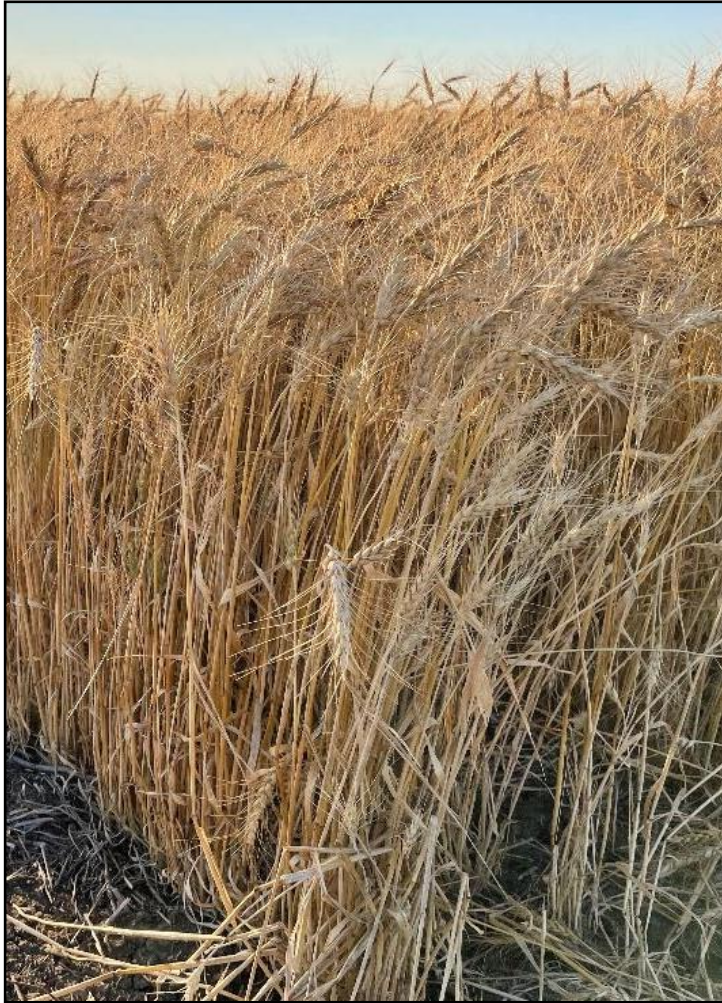
## Three Site Average: Indian Head, Melfort, & Scott (2025)



	Yield	Prot
Effect	----- Pr > F-----	
Site (S)	<b>&lt;0.001</b>	<b>&lt;0.001</b>
PGR	0.596	<b>0.030</b>
S x PGR	0.577	0.217
<b>N</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>
S x N	<b>&lt;0.001</b>	<b>&lt;0.001</b>
PGR x N	0.229	0.836
S x P x N	0.274	0.398



# Phosphorus Management Trials & Demos



# Enhancing Canola Production with Improved Phosphorus Fertilizer Management (Brandt et al. 2018)

## 3 Locations (2016-18)

Scott, Indian Head, and Melfort

## Five P Rates

0, 18, 36, 53, 71 lb P<sub>2</sub>O<sub>5</sub>/ac  
(0, 20, 40, 60, 80 kg P<sub>2</sub>O<sub>5</sub>/ac)

## Three Fertilizer 'Placement' Options

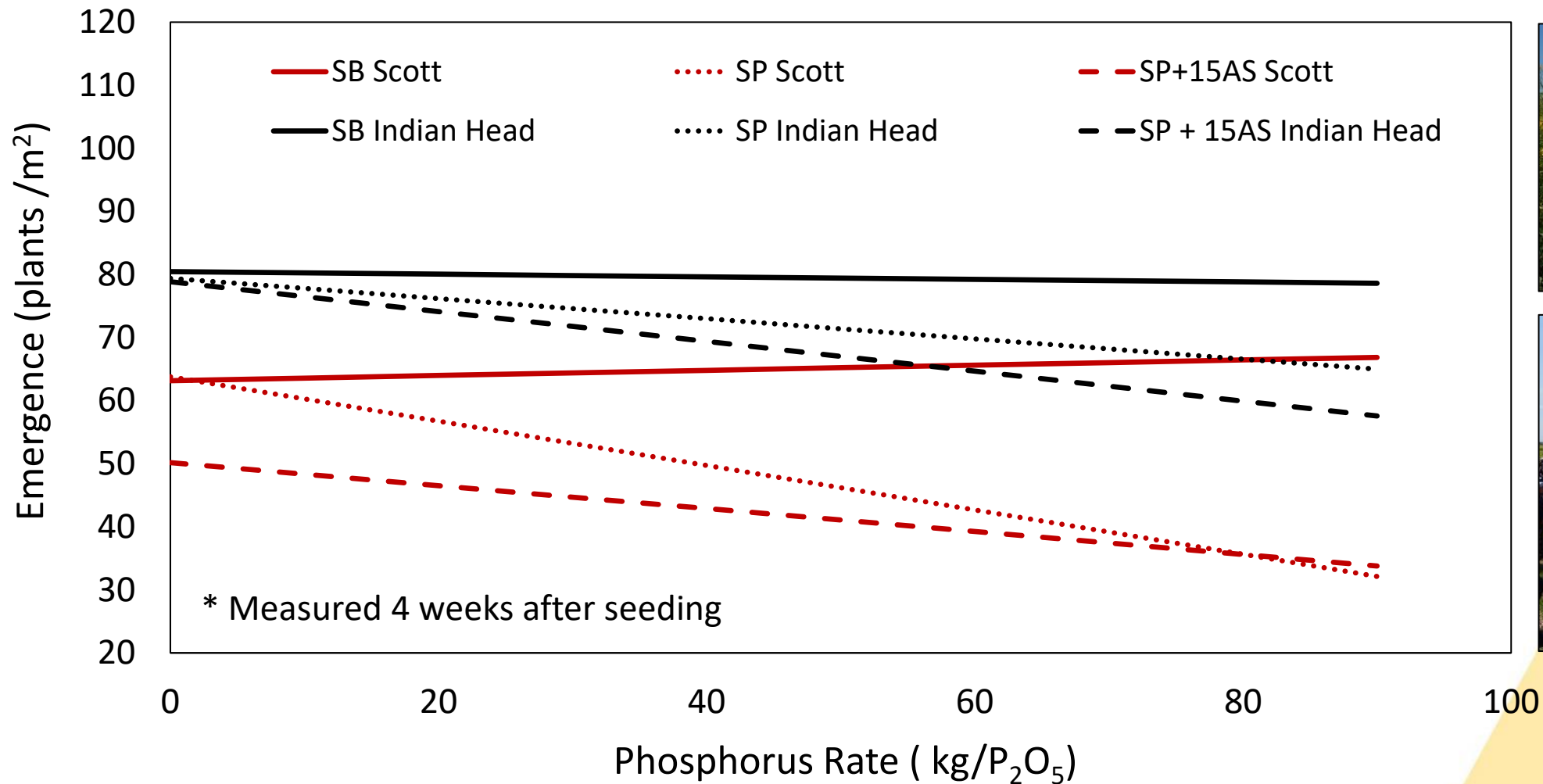
- 1) Side-band all fertilizer
- 2) Seed-place all MAP (11-52-0)
- 3) Seed-place all MAP + 56 lb/ac ammonium sulfate (21-0-0-24)

\* All sites used drills equipped with hoe type openers

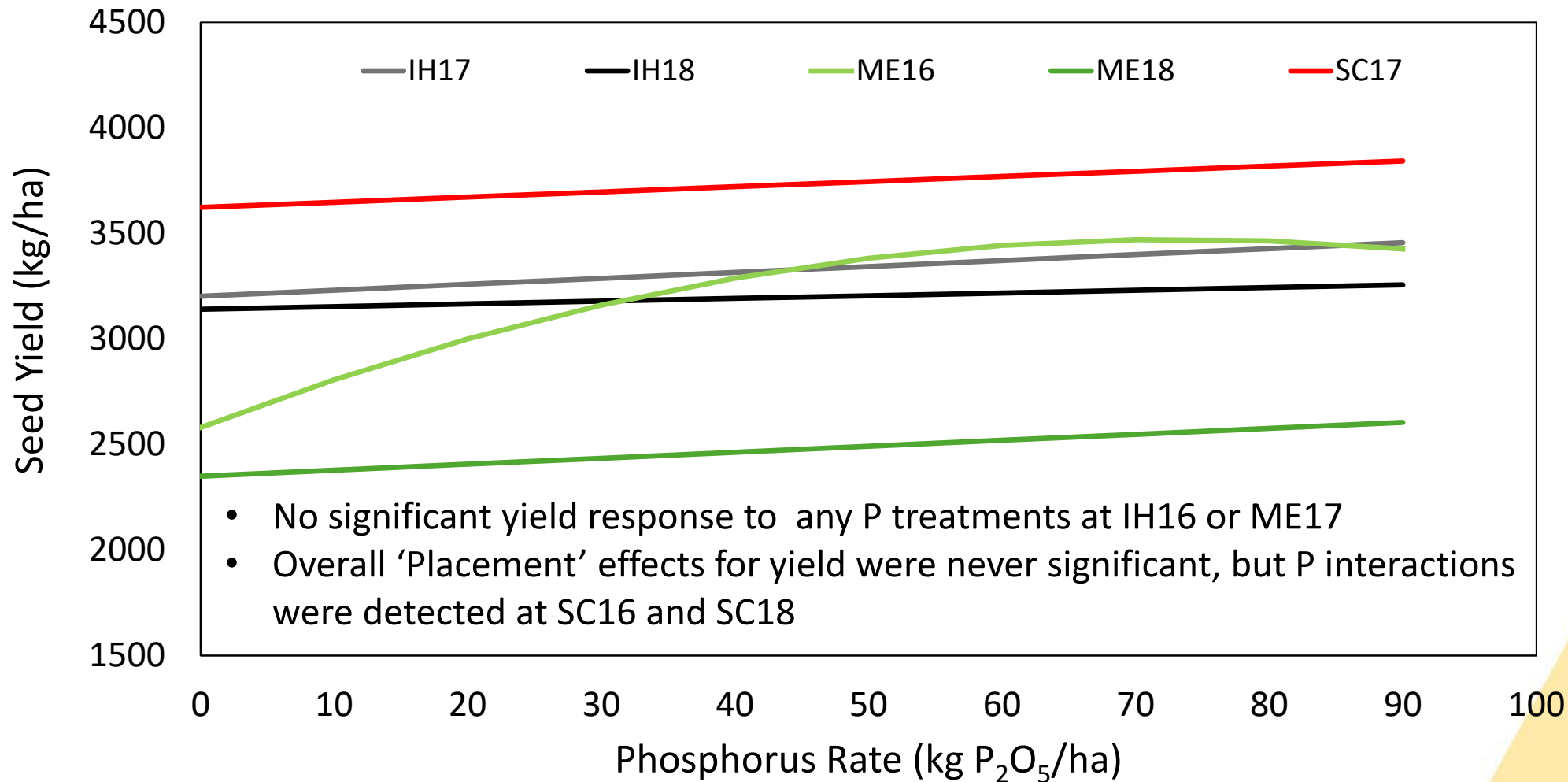
	Indian Head			Melfort			Scott		
	16	17	18	16	17	18	16	17	18
<b>Soil Zone</b>	Thin Black			Thick Black			Dark Brown		
<b>Texture</b>	Clay Loam			Clay Loam			Loam		
<b>pH (0-6")</b>	7.9	8.0	7.2	6.2	6.1	6.2	5.2	5.6	5.8
<b>OM (% , 0-6")</b>	2.7	4.8	5.5	12.3	11.5	9.5	4.1	3.5	4.4
<b>Olsen-P (ppm, 0-6")</b>	6	7	9	11	43	12	18	9	18



# Phosphorus Rate by Placement Effects on Canola Establishment (Scott vs Indian Head; 3-yr average)

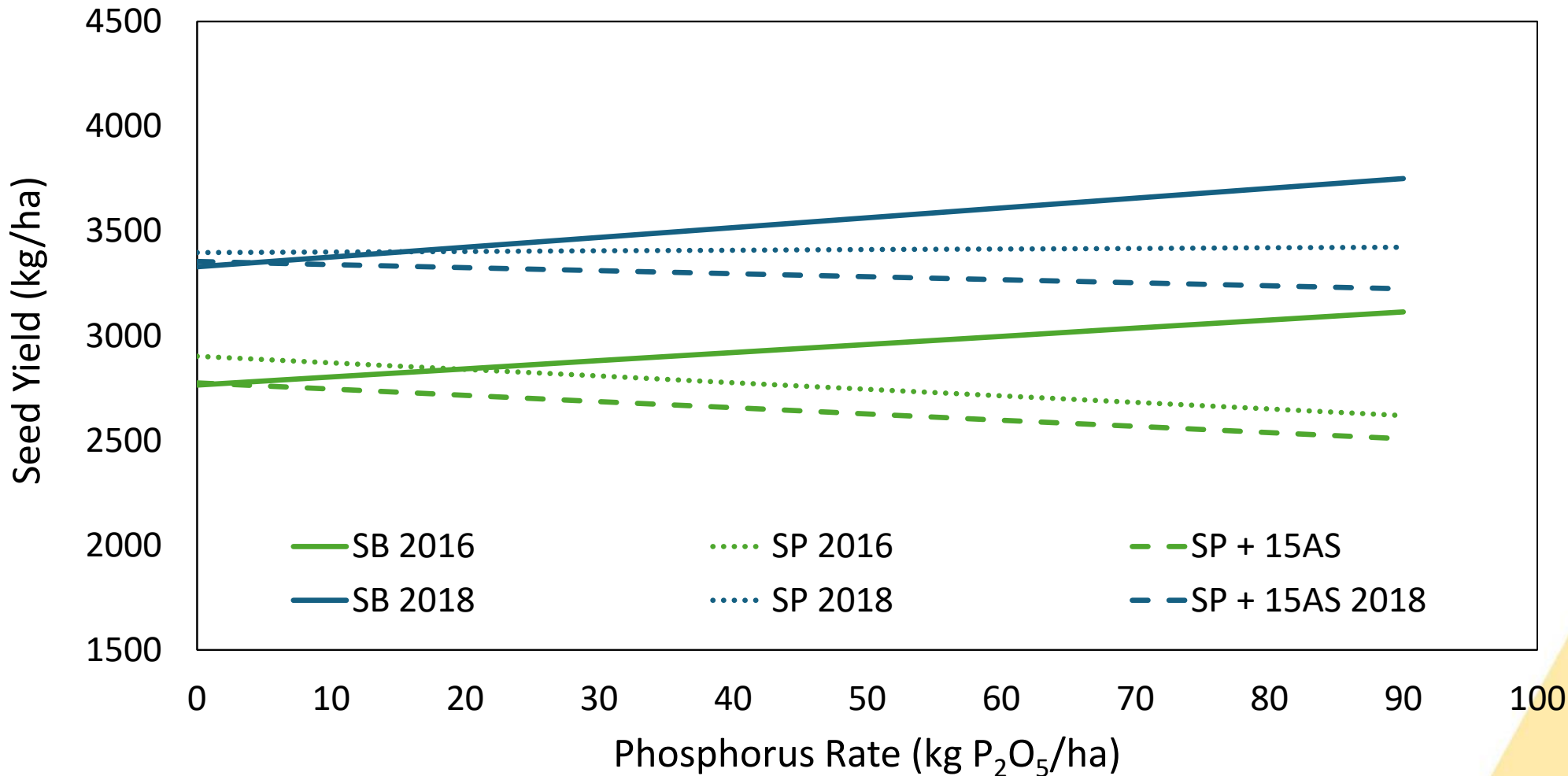


# Phosphorus Fertilizer Rate Effects on Canola Seed Yield at Responsive Sites



P Rate Main Effect	
Site	Pr > F
IH16	0.379
IH17	<0.001
IH18	<0.001
ME16	<0.001
ME17	0.501
ME18	<b>0.023</b>
SC16	0.282
SC17	<0.001
SC18	0.189

# Phosphorus Rate by Placement Interactions for Seed Yield at Scott (2016 and 2018)



P Rate x Placement	
Site	Pr > F
IH16	0.934
IH17	0.740
IH18	0.406
ME16	0.869
ME17	0.134
ME18	0.520
SC16	<0.001
SC17	0.224
SC18	<0.001

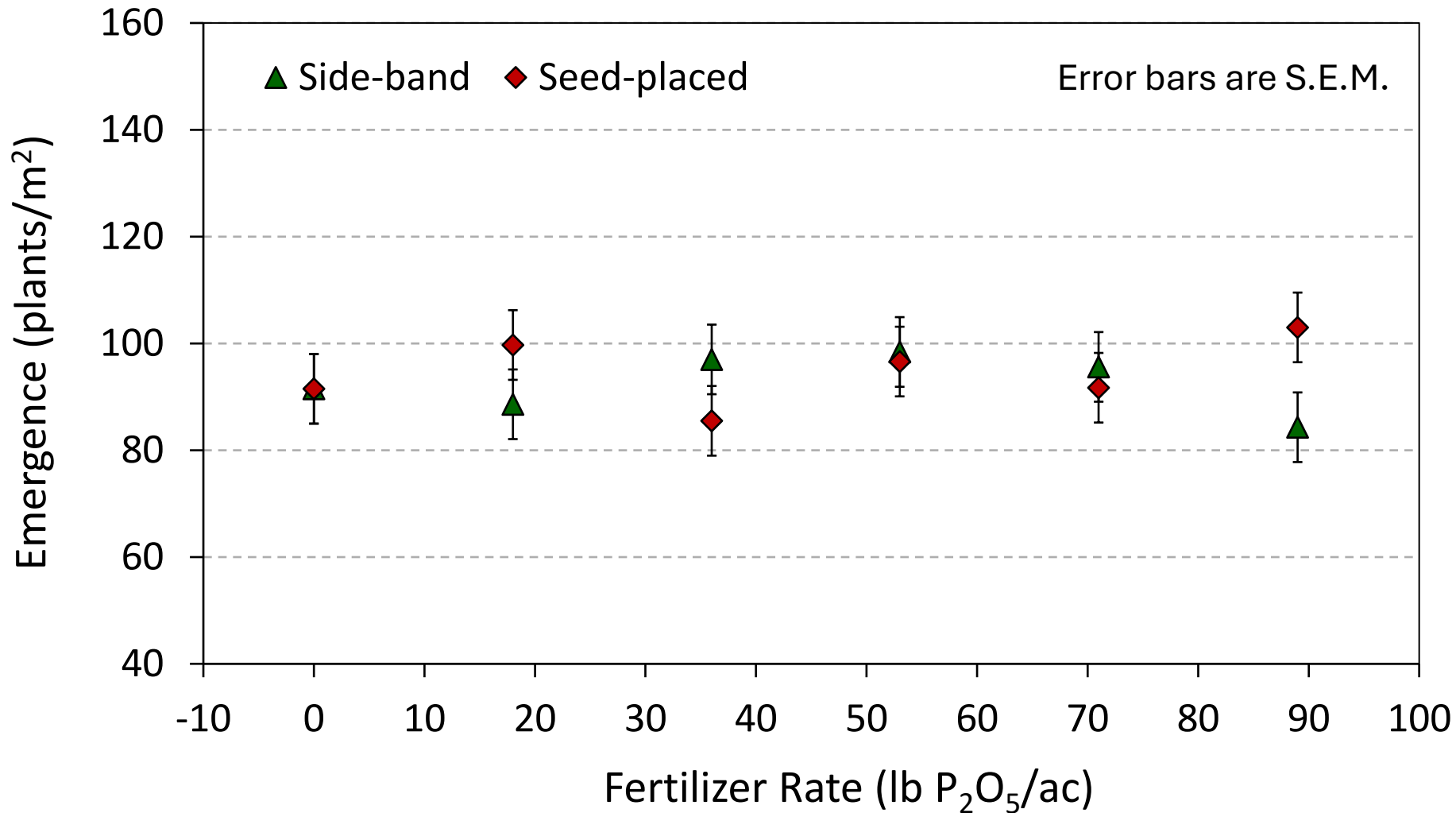
# Canola Seed-Placed vs Side-band Phosphorus ADOPT Demo – Indian Head 2015



- Five MAP Rates (18, 36, 53, 71, 89 lb P<sub>2</sub>O<sub>5</sub>/ac) by two placement options (side-band vs in-furrow), & a 0P control
  - Side-banded P dual banded with urea to bring total N up to 116 lb N/ac. K<sub>2</sub>SO<sub>4</sub> broadcast before seeding.
  - Low residual P (~5 ppm Olsen-P)
  - Seeded into moisture, but no major post-seeding rainfall events until 3<sup>rd</sup> week in June when canola was close to bolting; abundant moisture for the latter half of the season.

**Data Collected:** Emergence at 14-, 21-, and 28-days past seeding, Biomass yield at 28 days past seeding, Maturity, Seed Yield, and Quality

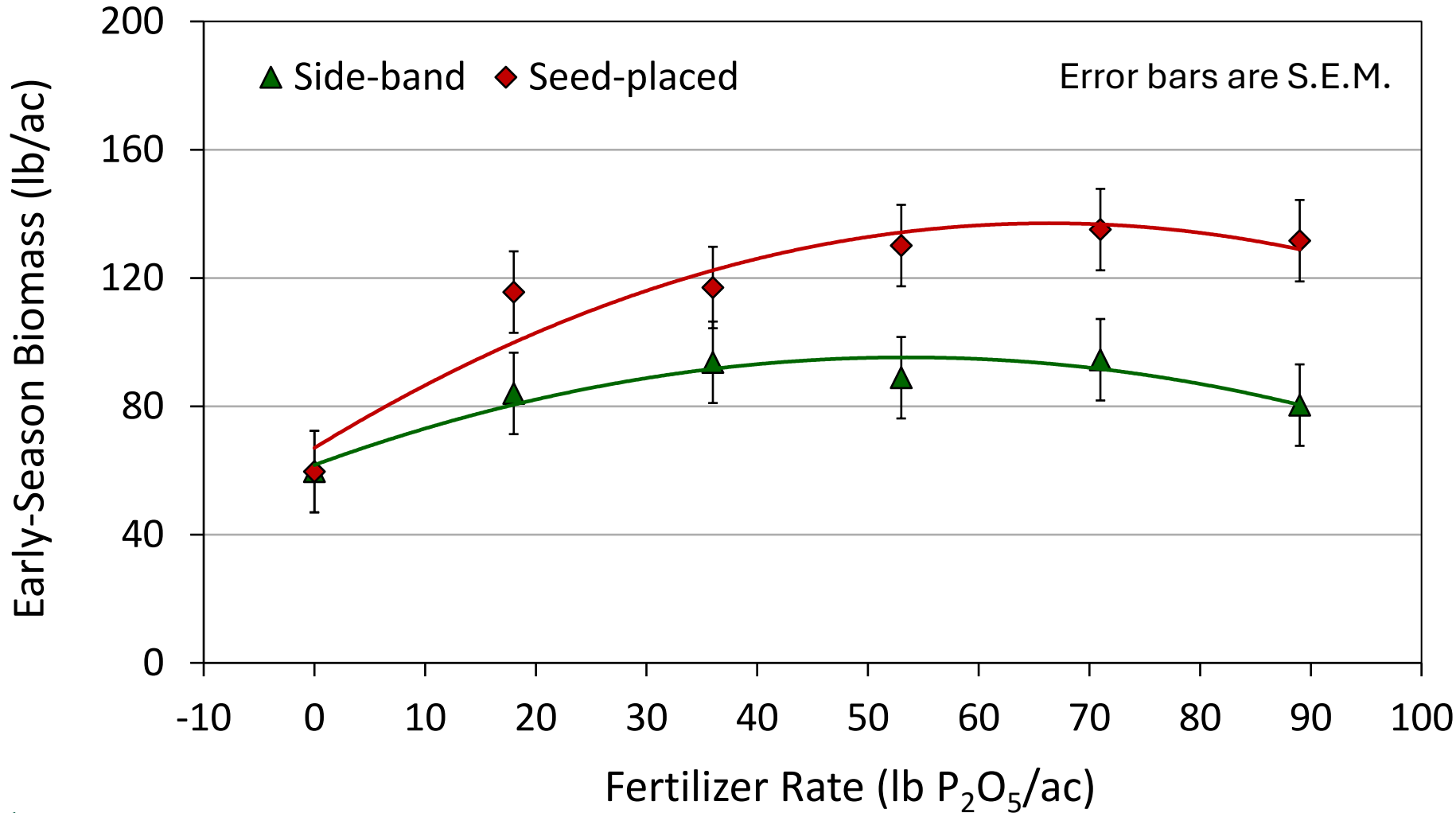
# Phosphorus Rate by Placement Effects on Spring Emergence in Canola (Indian Head 2015)



Effect / Contrast	Side-Band	Seed-Row
Pr. > F	0.596	
Lin	0.804	0.422
Quad	0.156	0.387
0 P vs P	0.713	
SB vs SR	0.549	



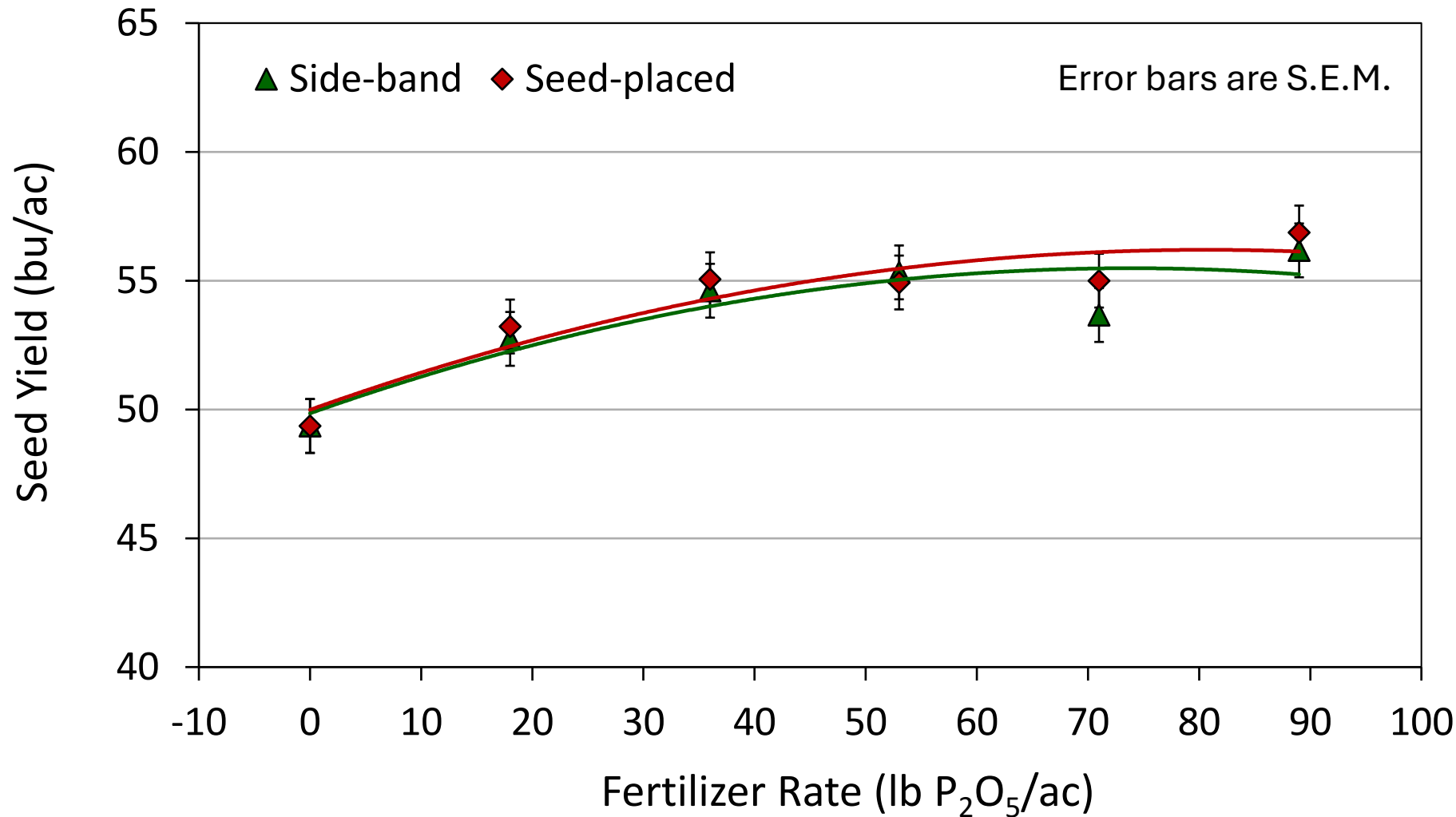
# Phosphorus Rate by Placement Effects on Early Season Biomass Yields in Canola (Indian Head 2015)



Effect / Contrast	Side-Band	Seed-Row
Pr. > F	0.002	
Lin	0.228	< 0.001
Quad	0.081	0.021
0 P vs P	0.001	
SB vs SR	< 0.001	



# Phosphorus Rate by Placement Effects on Seed Yields in Canola (Indian Head 2015)



Effect / Contrast	Side-Band	Seed-Row
Pr. > F	<0.001	
Lin	<0.001	<0.001
Quad	0.010	0.017
0 P vs P	<0.001	
SB vs SR	0.275	



# Canola Seed Safety and Yield Response to Novel Phosphorus Sources (ADOPT 2020-22)



## 14 sites over a three-year period

- Swift Current, Outlook, Scott, Redvers, Indian Head, Yorkton, and Melfort, SK

## Four Phosphorus Rates (all seed-placed)

0, 22, 40, and 58 lb P<sub>2</sub>O<sub>5</sub>/ha

## Four Phosphorus Forms

- 1) MAP (11-52-0)
- 2) MES15 (13-33-0-15)
- 3) Struvite (5-28-0 + 10% Mg)
- 4) 50:50 MAP:Struvite (8-40-0 + 5% Mg)



Site	pH	SOM (%)	Olsen-P (ppm)
IH-20	7.9	5.2	7
IH-21	7.8	4.8	8
IH-22	8.0	5.2	6
ME-21	5.9	12.1	8
ME-22	5.7	9.3	10
OL-21	7.9	2.7	11
RV-21	8.0	3.6	6
SC-20	6.4	4.0	12
SC-21	5.5	4.4	6
SC-22	5.8	4.2	8
SW-20	6.6	2.8	10
SW-21	6.5	2.4	16
SW-22	6.4	2.4	10
YK-21	7.1	4.7	13

# Seed-Placed P Fertilizer Form x P Rate Treatment Effects on Canola Establishment

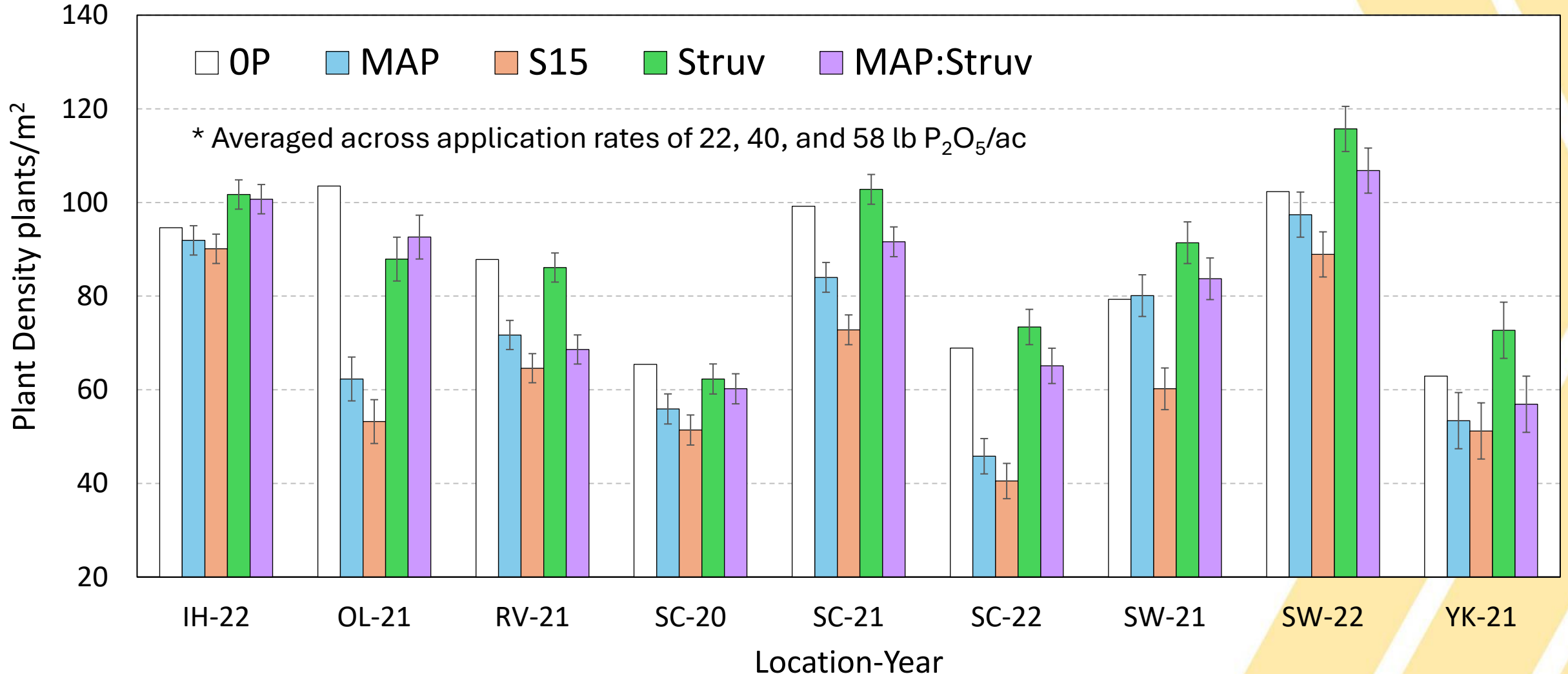
Source	Pr > F
<u>Simple Analyses</u>	
Site (S)	***
Entry (E)	***
S × E	***
<u>Factorial Analyses</u>	
Site (S)	***
Form (F)	***
Rate (R)	***
F × R	**
S × F	***
S × R	***
S × F × R	***

Site	Form (F)	Rate (R)	Entry
	----- Pr > F -----		
IH-20	ns	ns	ns
IH-21	ns	ns	ns
IH-22	*	ns	ns
ME-21	ns	ns	ns
ME-22	ns	ns	ns
OL-21	***	***	***
RV-21	**	ns	***
SC-20	**	ns	ns
SC-21	***	**	***
SC-22	***	*	***
SW-20	ns	ns	ns
SW-21	***	***	***
SW-22	*	***	***
YK-21	***	ns	***

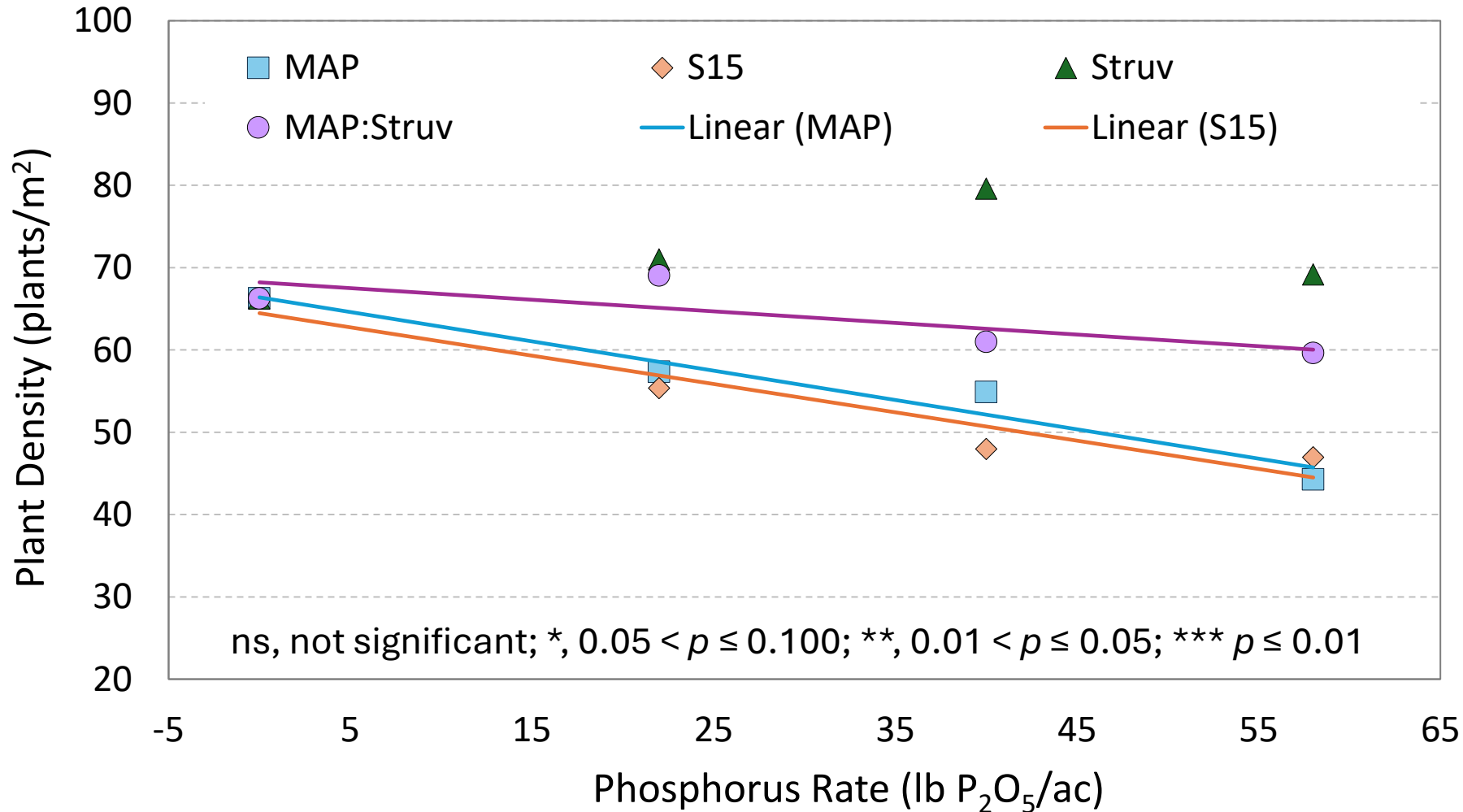
- All interactions were significant indicating that form & rate effects varied with environment and rate effects varied with P form.
- No significant treatment effects whatsoever at 36% of sites (5/14)
- Phosphorus form affected emergence 64% of the time (9/14 sites)
- Phosphorus rate affected emergence 36% of the time (5/14 sites)

ns, not significant;  
 \*, 0.05 < p ≤ 0.100;  
 \*\*, 0.01 < p ≤ 0.05;  
 \*\*\* p ≤ 0.01

# Seed-Placed P Form Effects on Canola Emergence at Responsive Sites (no P form effect at 36% of sites)

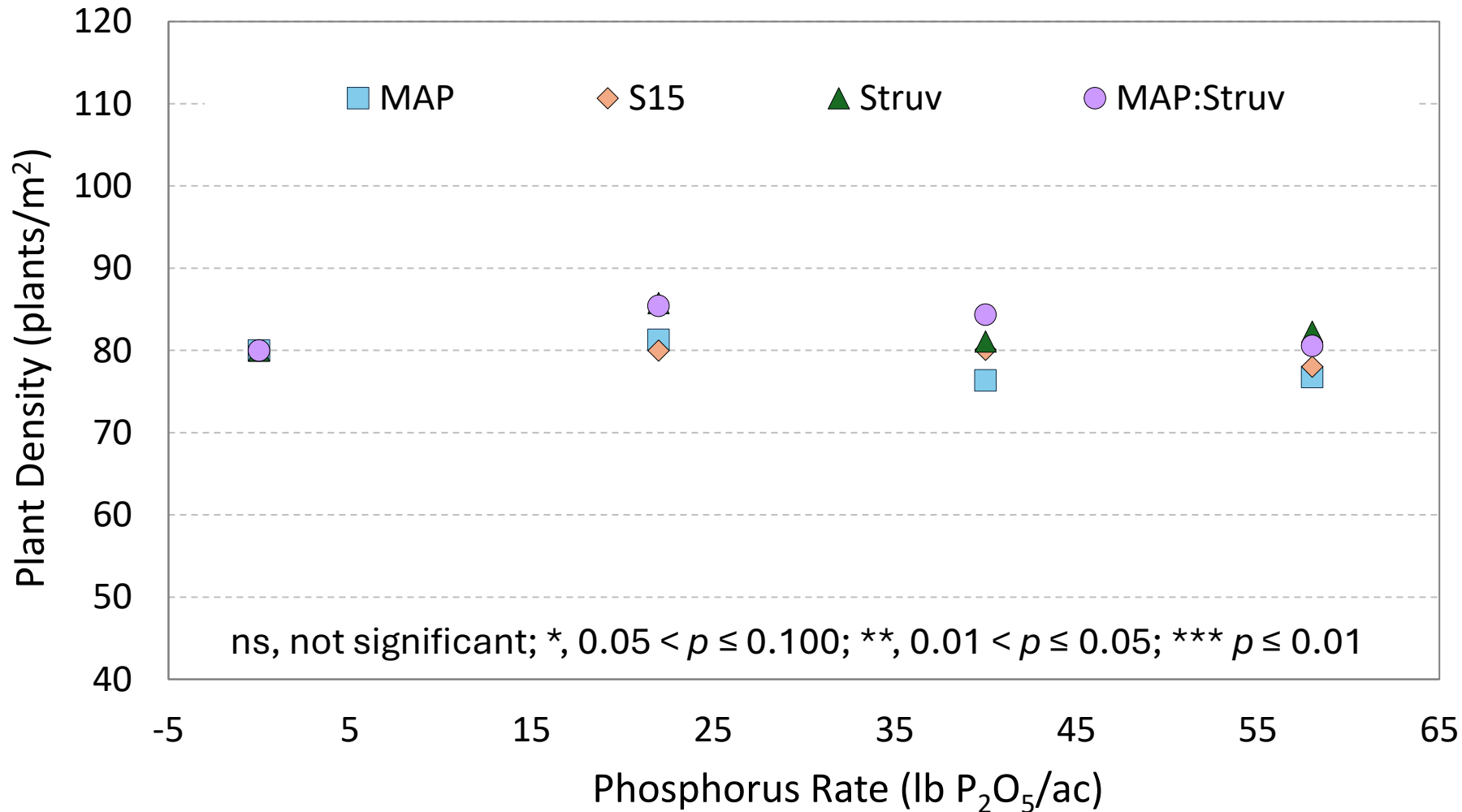


# Seed-Placed Phosphorus Form by Rate Effects on Canola Emergence at Scott, 3-year Average



	2020	2021	2022
Contrast	-----	Pr > F	-----
MAP-lin	*	***	***
MAP-quad	ns	ns	ns
S15-lin	**	***	***
S15-quad	ns	ns	ns
Str-lin	ns	ns	ns
Str-quad	ns	ns	**
Blend-lin	ns	*	ns
Blend-quad	ns	ns	ns

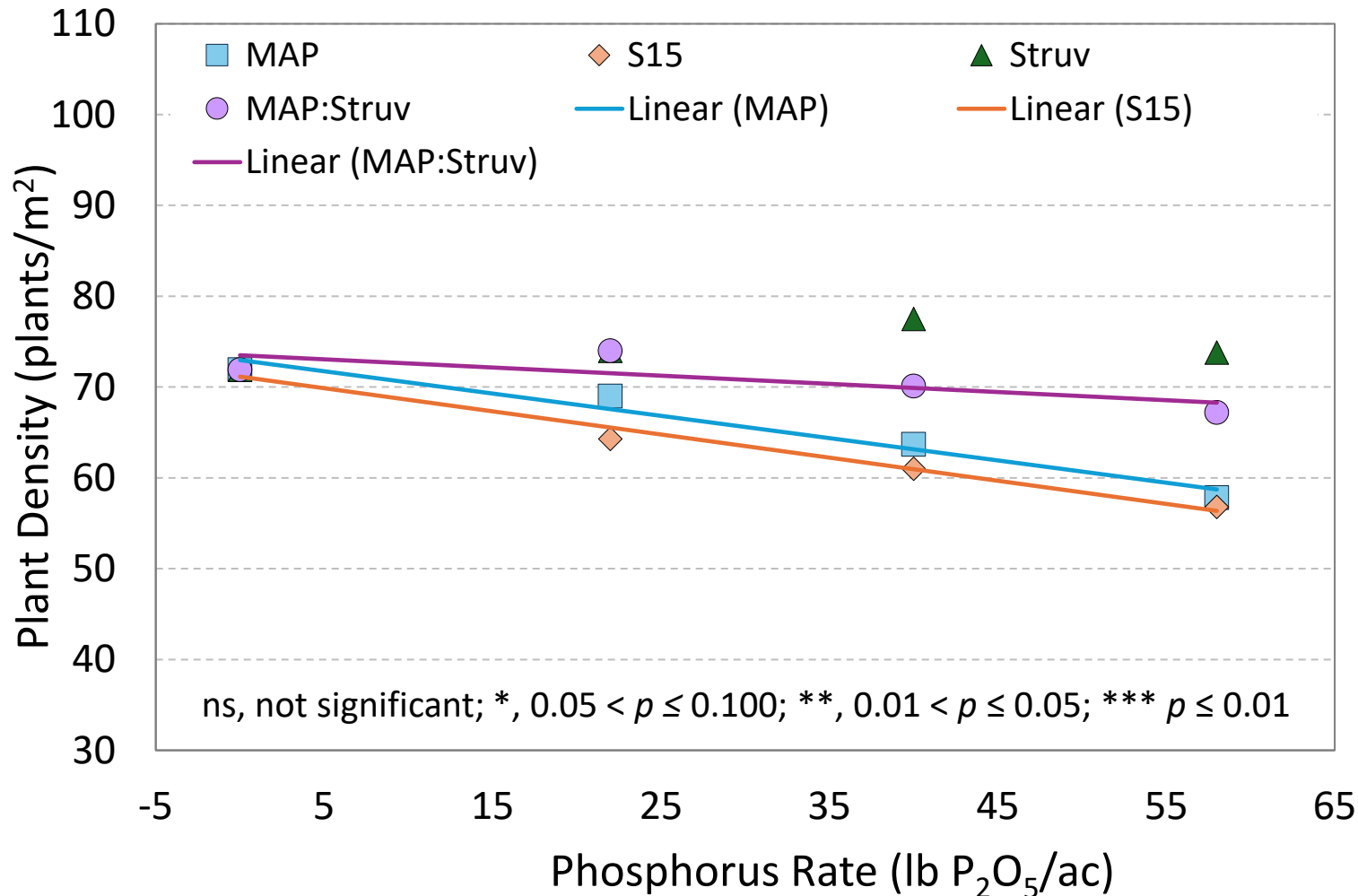
# Seed-Placed Phosphorus Form by Rate Effects on Canola Emergence at Indian Head, 3-year Average



	2020	2021	2022
Contrast	----- Pr > F -----		
MAP-lin	ns	ns	ns
MAP-quad	ns	ns	ns
S15-lin	ns	ns	ns
S15-quad	ns	ns	ns
Str-lin	ns	ns	ns
Str-quad	ns	ns	ns
Blend-lin	ns	ns	ns
Blend-quad	ns	ns	**



# Average Seed-Placed Phosphorus Form by Rate Effects on Canola Emergence (14-Sites)



Contrast	Pr > F
MAP-lin	***
MAP-quad	ns
S15-lin	***
S15-quad	ns
Str-lin	ns
Str-quad	*
Blend-lin	**
Blend-quad	ns

Fertilizer Form	Overall Mean
Control	72
MAP	64 C
S15	61 D
Struv	75 A
Blend	70 B



# Seed-Placed P Fertilizer Form x P Rate Treatment Effects on Canola Seed Yield

Source	Pr > F
<u>Simple Analyses</u>	
Site (S)	***
Entry (E)	***
S × E	***
<u>Factorial Analyses</u>	
Site (S)	***
Form (F)	***
Rate (R)	***
F × R	***
S × F	***
S × R	ns
S × F × R	ns

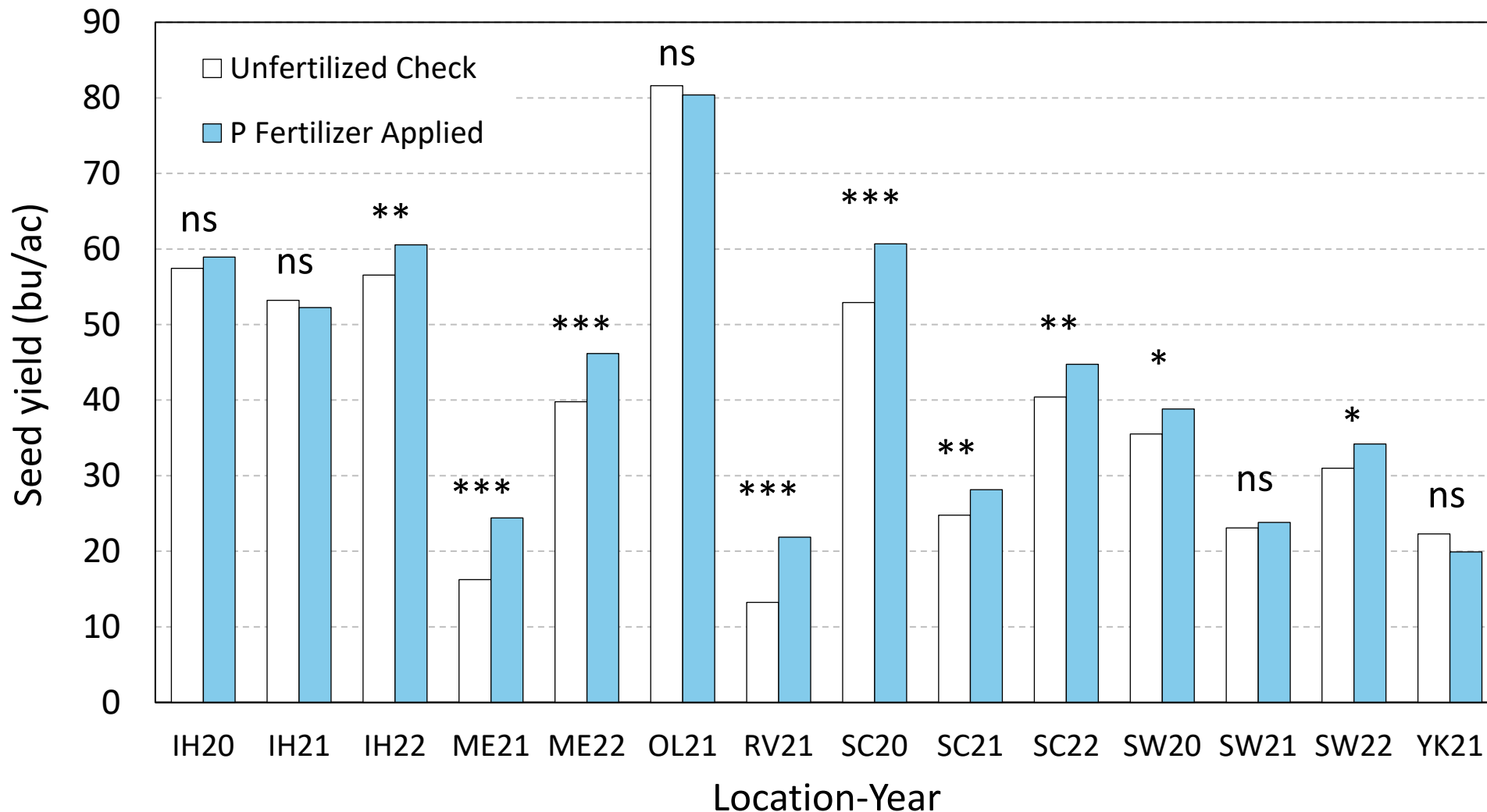
Site	Form (F)	Entry	OP vs Rest
----- Pr > F -----			
IH-20	ns	ns	ns
IH-21	ns	ns	ns
IH-22	ns	ns	**
ME-21	***	***	***
ME-22	***	***	***
OL-21	ns	***	ns
RV-21	ns	***	***
SC-20	ns	***	***
SC-21	ns	*	**
SC-22	ns	**	**
SW-20	ns	ns	*
SW-21	ns	ns	ns
SW-22	**	**	*
YK-21	ns	ns	ns

- No yield response to P fertilizer at 36% of sites (5/14) based on OP vs Rest (P applied) comparison
- Phosphorus fertilizer form only affected yield at 3/14 sites
- Significant R and F x R interactions detected, but no S x R or S x F x R interactions for yield

ns, not significant;  
 \*,  $0.05 < p \leq 0.100$ ;  
 \*\*,  $0.01 < p \leq 0.05$ ;  
 \*\*\*  $p \leq 0.01$

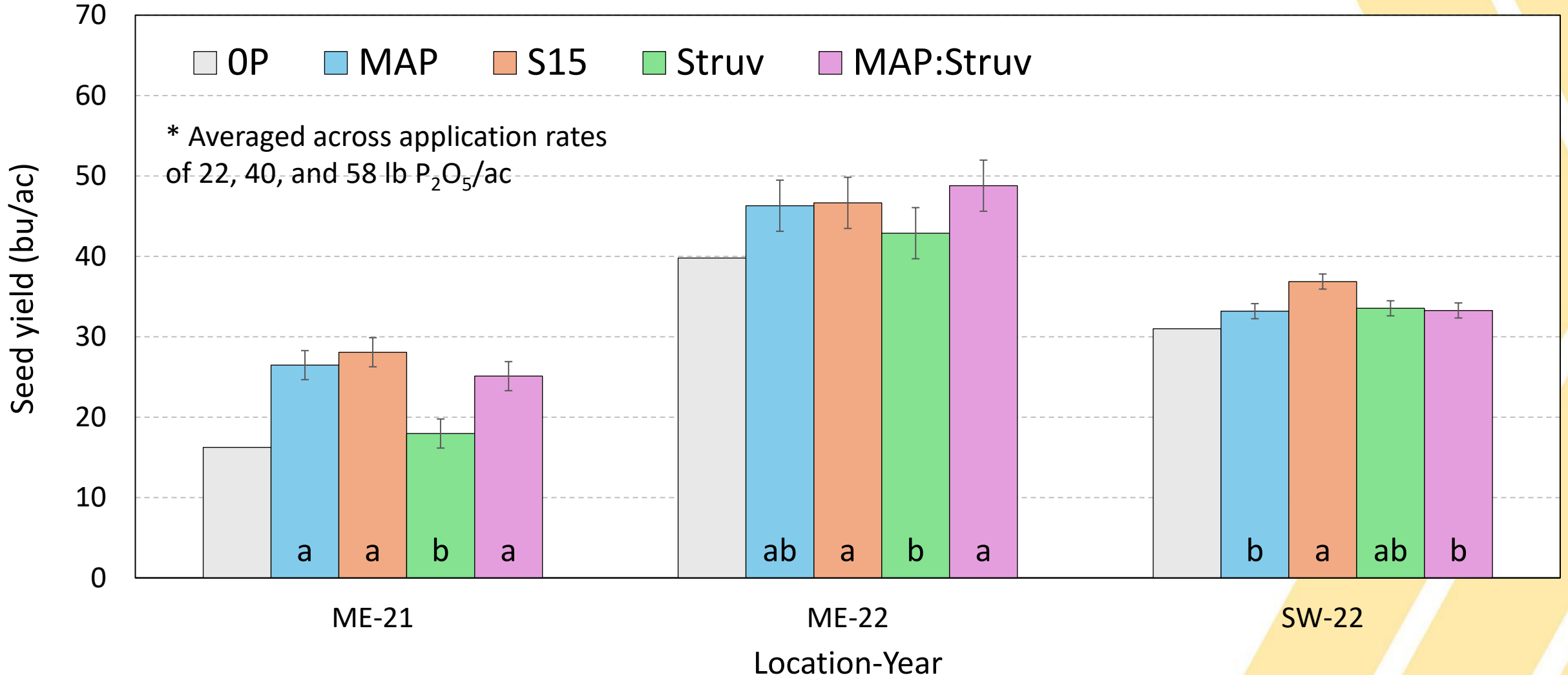
# Overall Canola Yield Response to Seed-Placed P

## Unfertilized Check versus Rest, averaged across forms & rates

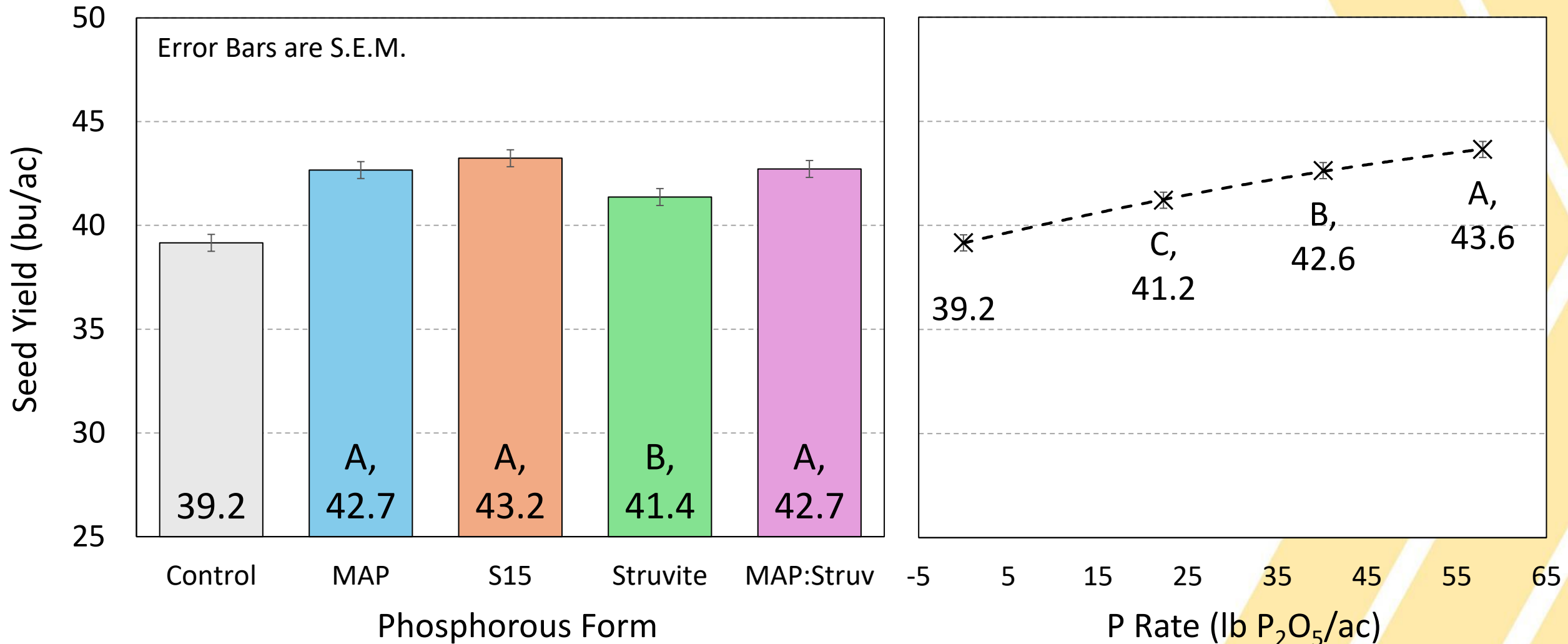


Site	pH	SOM (%)	Olsen-P (ppm)
IH20	7.9	5.2	7
IH21	7.8	4.8	8
IH22	8.0	5.2	6
ME21	5.9	12.1	8
ME22	5.7	9.3	10
OL21	7.9	2.7	11
RV21	8.0	3.6	6
SC20	6.4	4.0	12
SC21	5.5	4.4	6
SC22	5.8	4.2	8
SW20	6.6	2.8	10
SW21	6.5	2.4	16
SW22	6.4	2.4	10
YK21	7.1	4.7	13

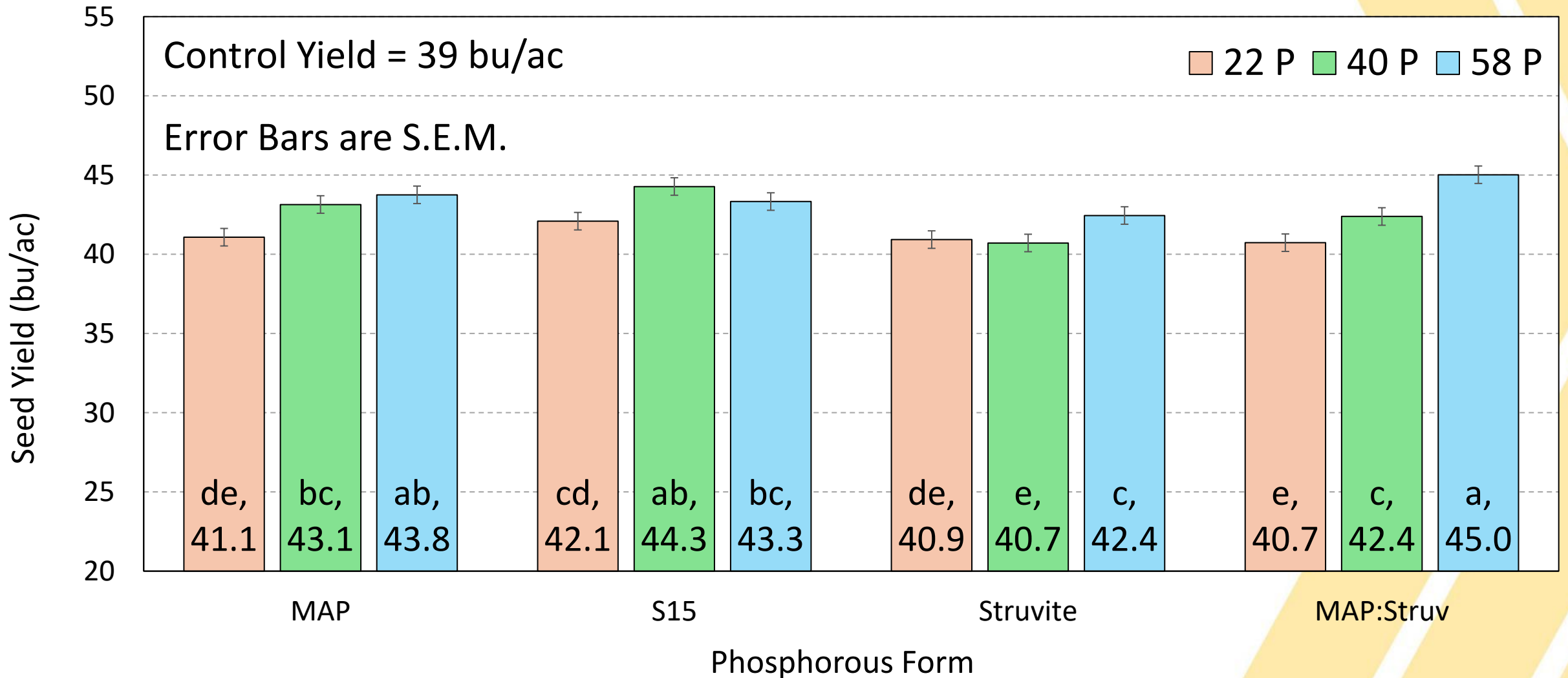
# Seed-Placed P Form Effects on Canola Yield at Sites where Differences Occurred (no Form Effect at 11/14 sites)



# Overall Seed-Placed Phosphorus Form and Rate Effects on Canola Seed Yield (14-Site Average)



# Overall Seed-Placed Phosphorus Form by Rate Effects on Canola Seed Yield (14-Site Average)



# Field Pea Response to Various Phosphorus Fertilizer Formulations and Placement (ADOPT)



# Field Pea Response to Phosphorus Fertilizer Formulations and Placement (ADOPT 2025)

#	Name / P Form	Placement	lb N-P <sub>2</sub> O <sub>5</sub> -K <sub>2</sub> O-S/ac
1	No Fertilizer	n/a	0-0-0-0
2	Nitrogen Only	n/a	23-0-0-0
3	MAP <sup>Z</sup>	Side-Band	23-40-0-0
4	MAP + AMS <sup>Y</sup>	Side-Band	23-40-0-17
5	MES15 <sup>X</sup>	Side-Band	23-40-0-18
6	MAP + MST <sup>W</sup>	Side-Band	23-40-0-15
7	Synchro50 <sup>V</sup> + AMS	Side-Band	23-40-0-17
8	MAP	In-Furrow	23-40-0-0
9	MAP + AMS	In-Furrow	23-40-0-17
10	MES15	In-Furrow	23-40-0-18
11	MAP + MST	In-Furrow	23-40-0-15
12	Synchro50 + AMS	In-Furrow	23-40-0-17

**Objectives:** To demonstrate the effects of phosphorus (P) fertilizer forms and placement on field pea establishment, growth, yield, and quality

## Locations

- 1) Indian Head
- 2) Melfort
- 3) Scott
- 4) Swift Current

## Data Collection

- 1) Plant density
- 2) Canopy Cover
- 3) Seed yield
- 4) Seed Protein

# Fertilizer Product Descriptions

## **MAP:** Monoammonium phosphate (11-52-0)

- Often considered the industry standard and is the least expensive form of granular P

## **AMS:** Ammonium sulfate (21-0-0-24)

- Standard form of granular sulfate included to balance S where required and enable more direct comparisons to multi-nutrient products like MES15 and MAP+MST

## **MES15:** MicroEssentials<sup>®</sup> S15 (13-33-0-15)

- Well-established product from Mosaic, essentially comprised of MAP, AMS, and elemental S

## **MAP+MST:** Smart Nutrition MAP + MST (9-43-0-16)

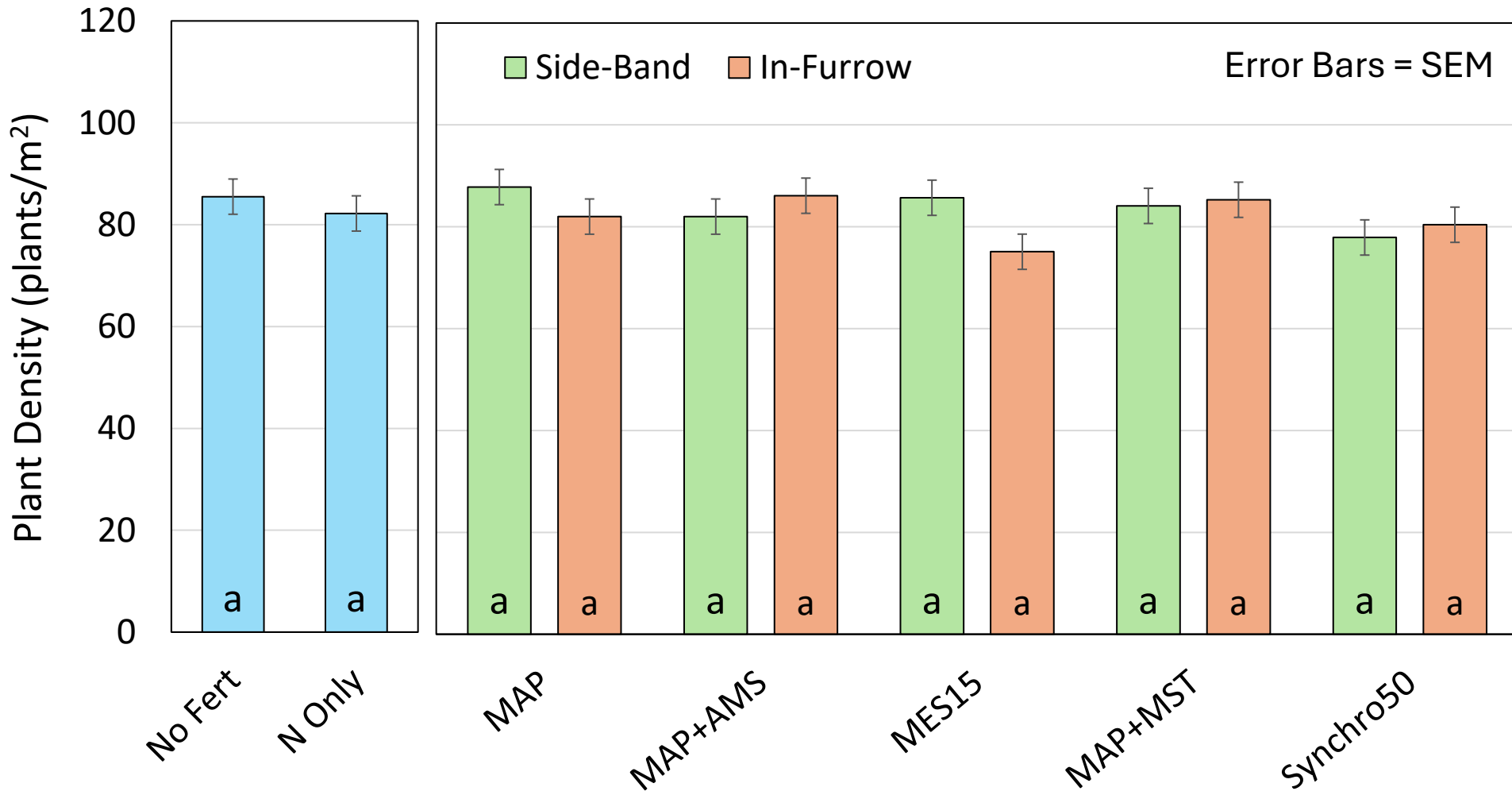
- Newer product from Nutrien, essentially MAP homogenized with micronized (~15 microns) elemental S

## **Crystal Green Synchro<sup>™</sup> 50:** (9-42.5-0-0 + 7% Mg)<sup>z</sup>

- Newer product from Ostara/Taurus that is essentially a homogenized blend of MAP and struvite boasting a combination of quick and slow-release P with improved seed safety relative to pure MAP

<sup>z</sup> AMS was always side-banded with Synchro 50 to balance fertility without diminishing potential seed-safety advantages

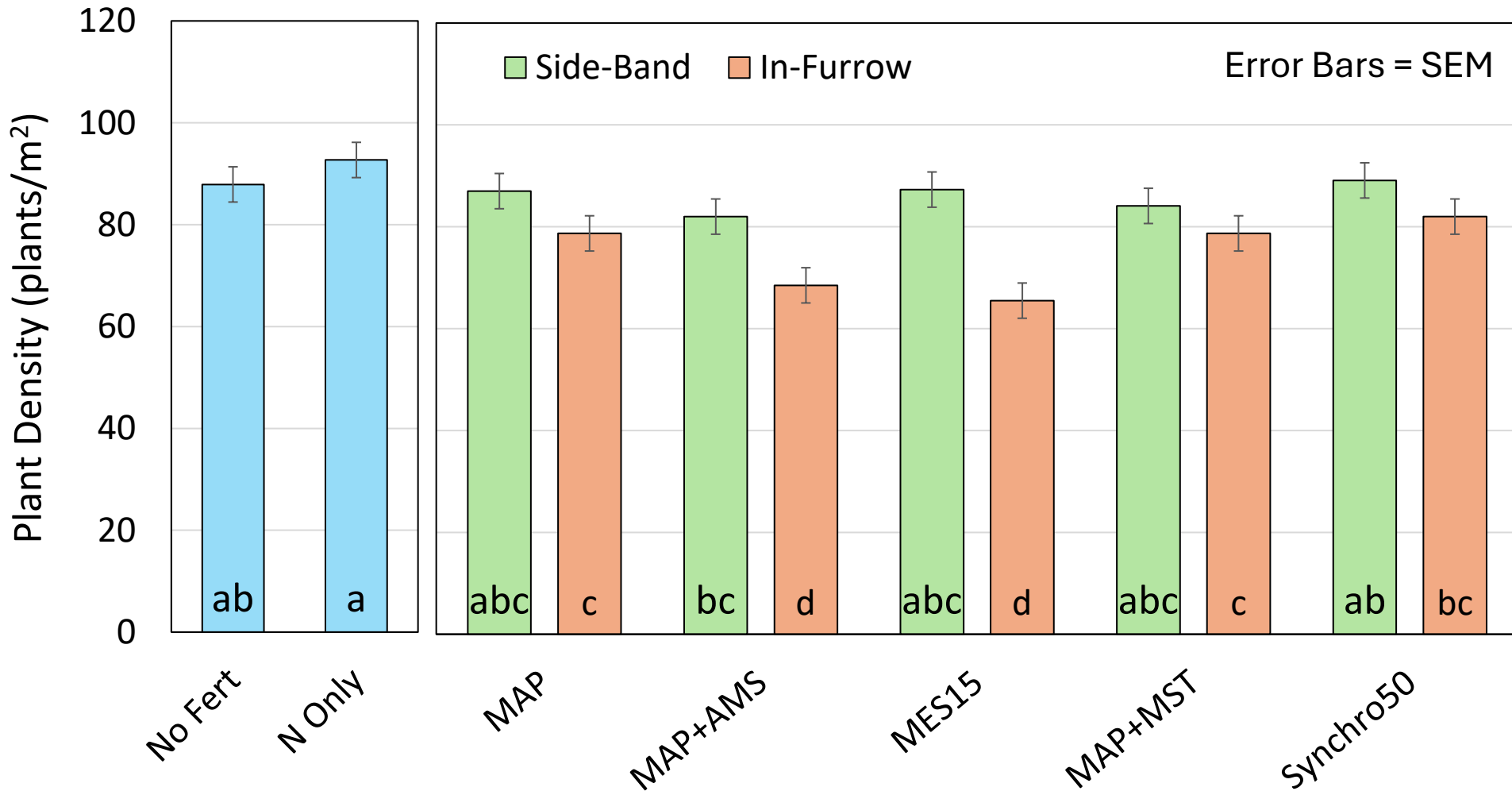
# Phosphorus Treatment Effects on Field Pea Establishment (Indian Head 2025 – thin Black Soil Zone)



Slice/Contrast	Pr > F
FERT	0.213
OP vs P applied	0.904
OP vs SB	0.718
OP vs IF	0.896
SB vs IF	0.395



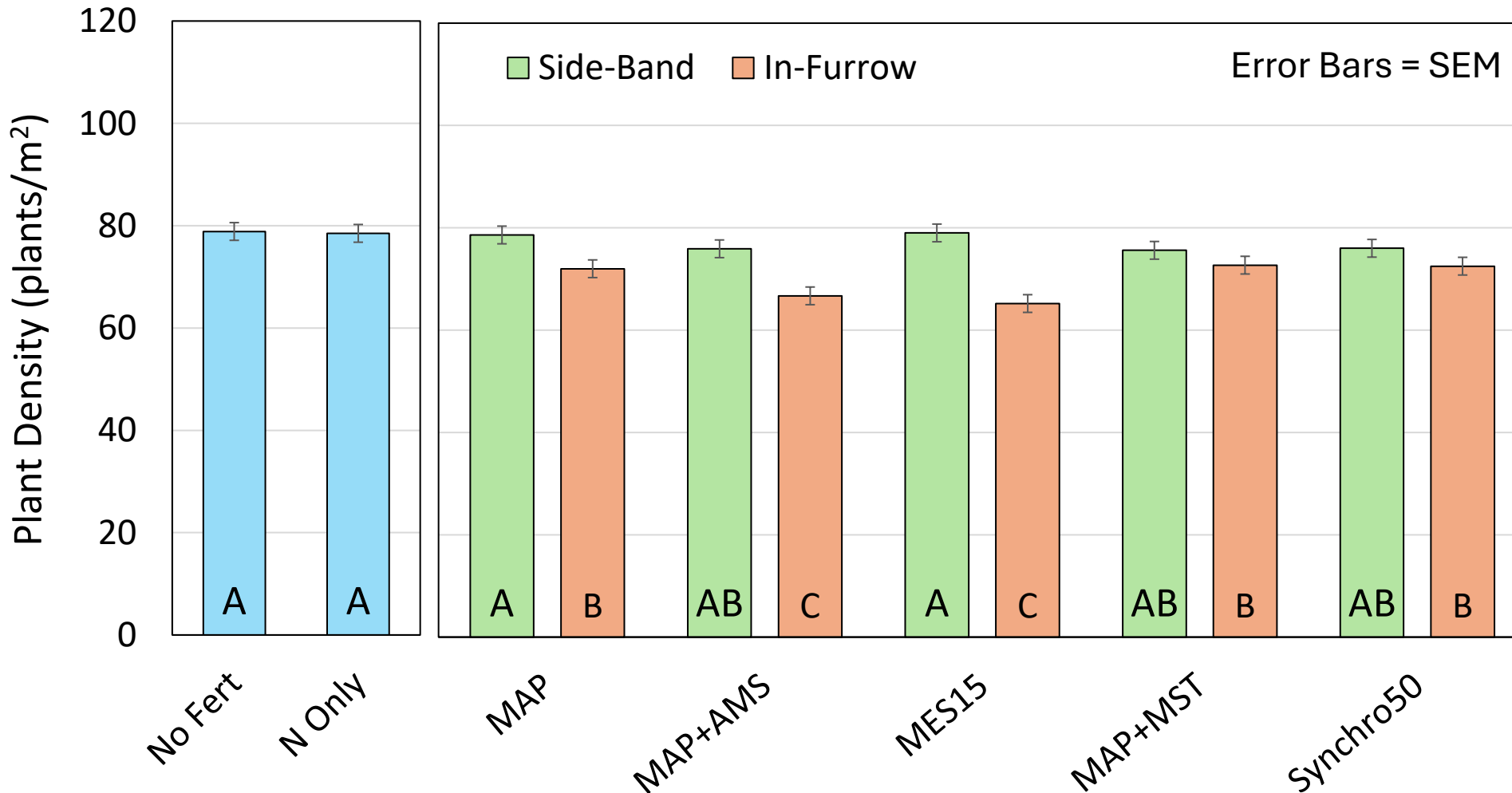
# Phosphorus Treatment Effects on Field Pea Establishment (Swift Current 2025 – dry Brown Soil Zone)



Slice/Contrast	Pr > F
FERT	0.001
OP vs P applied	<0.001
OP vs SB	0.054
OP vs IF	<0.001
SB vs IF	<0.001



# Phosphorus Treatment Effects on Field Pea Establishment (Overall Average – All Sites)



Effect/Contrast	Pr > F
SITE	<0.001
FERT	<0.001
SITE x FERT	0.007
OP vs P applied	0.003
OP vs SB	0.404
OP vs IF	<0.001
SB vs IF	<0.001

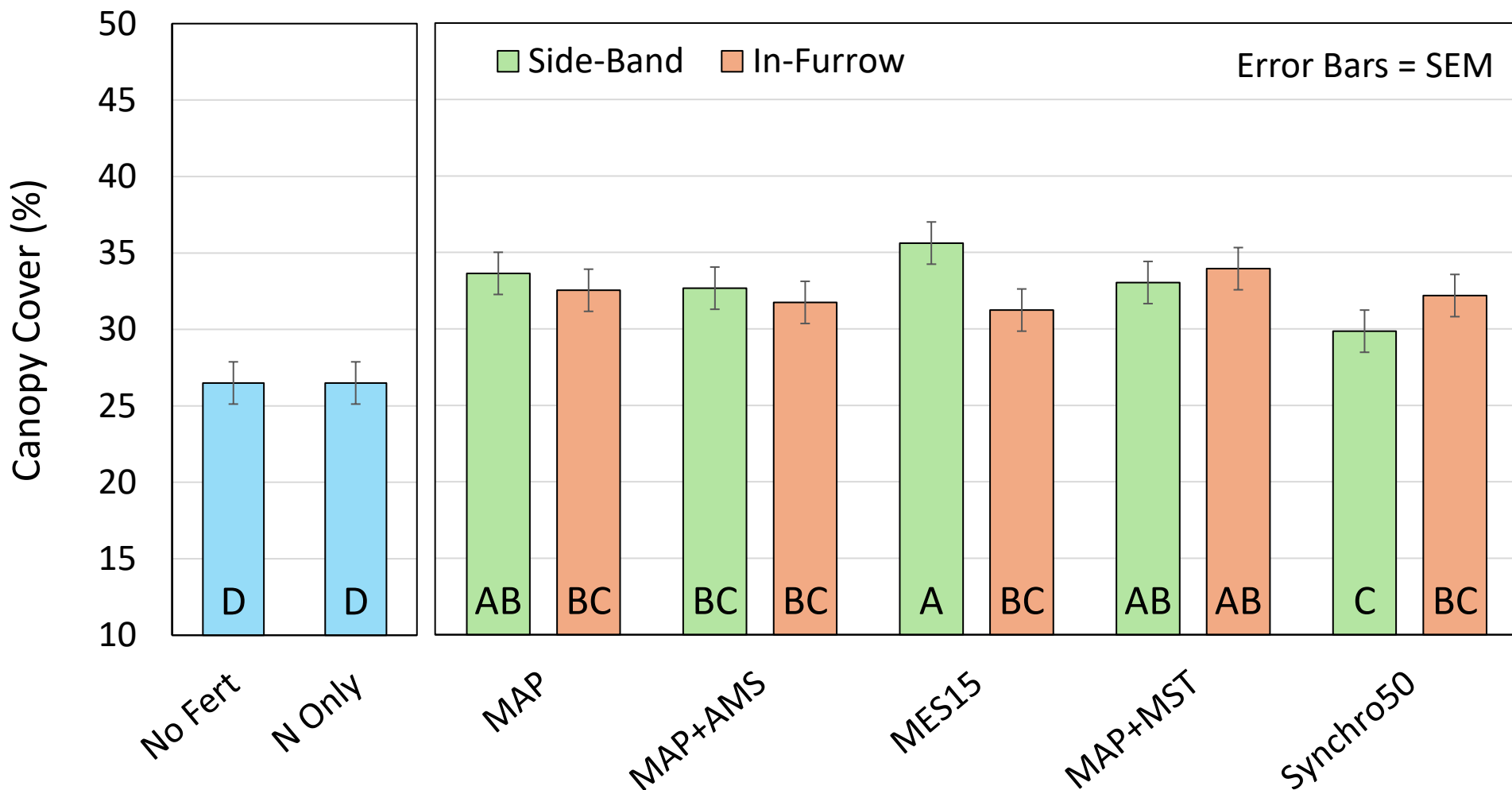
**IMPORTANT: Fertilizer treatment effects on field pea establishment varied with site.**



Indian Head, June 19, 2025  
MAP + AMS, side-banded  
34% Canopy Closure



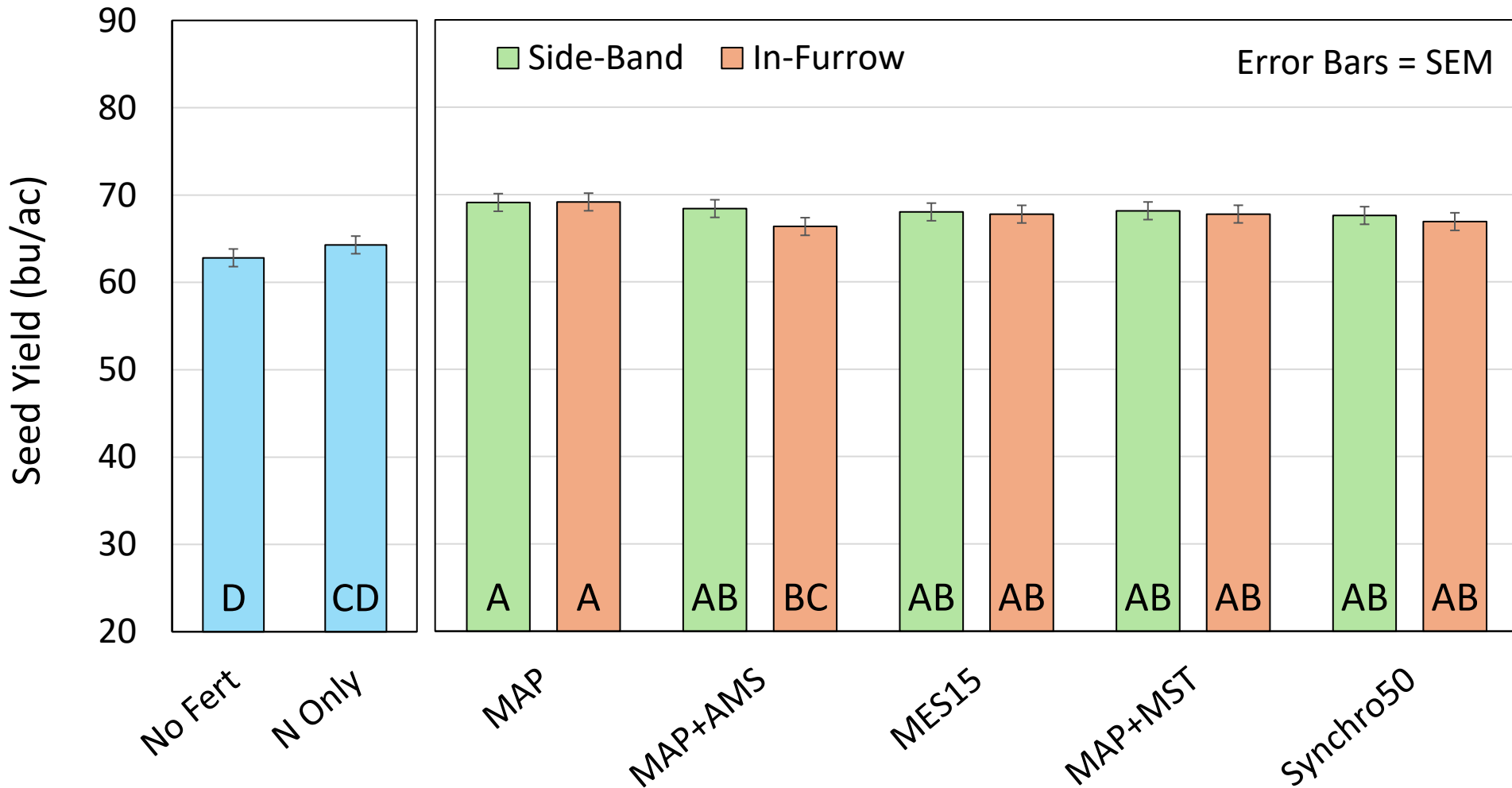
# Phosphorus Treatment Effects on Early Season Growth in Field Pea (Overall Average – All Sites)



Effect/Contrast	Pr > F
SITE	<0.001
FERT	<0.001
SITE x FERT	<0.001
OP vs P applied	<0.001
OP vs SB	<0.001
OP vs IF	<0.001
SB vs IF	0.327

**IMPORTANT: Fertilizer treatment effects on field pea canopy cover varied with site.**

# Phosphorus Treatment Effects on Field Pea Seed Yield (Overall Average – All Sites)



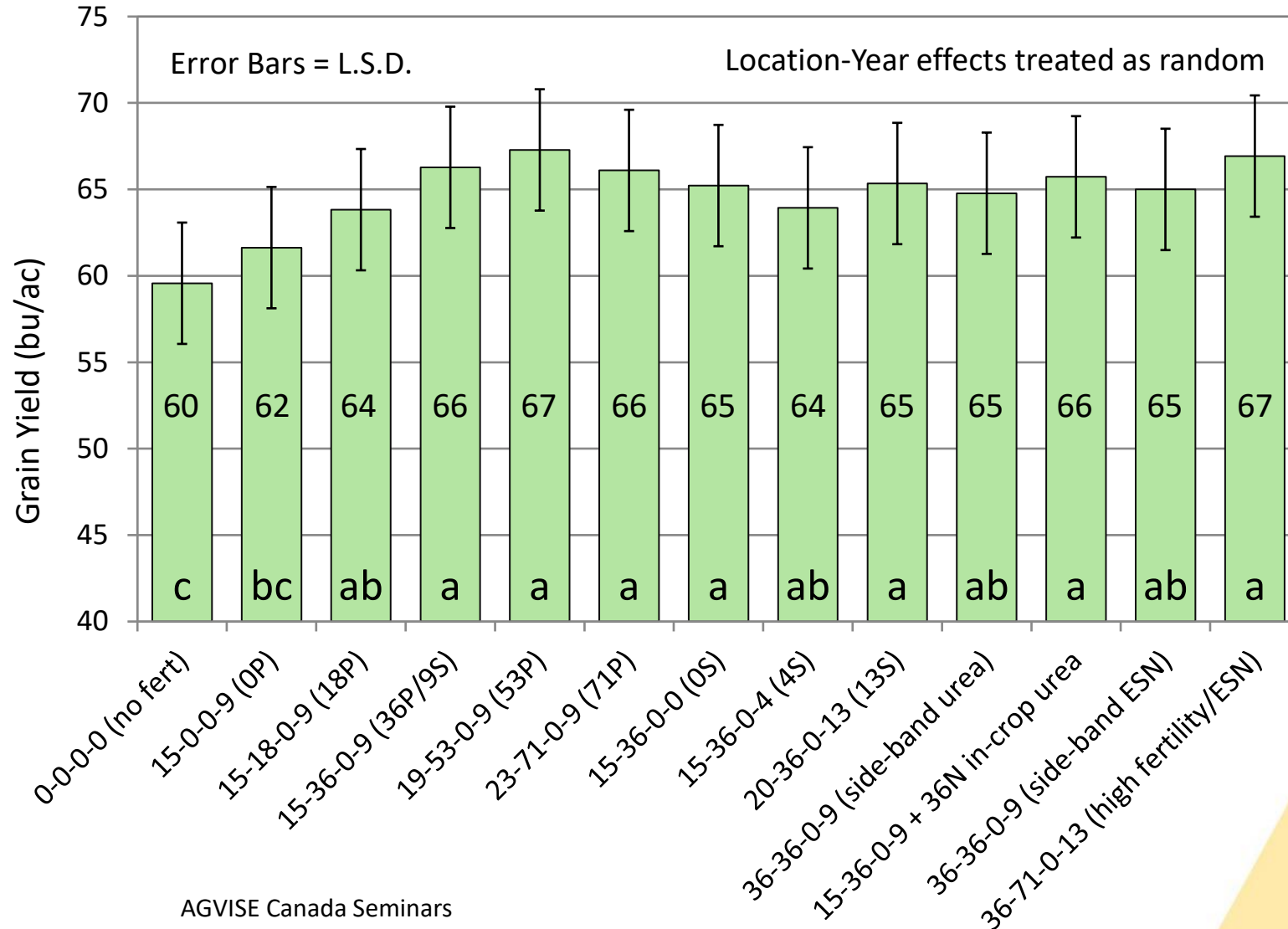
Effect/Contrast	Pr > F
SITE	<0.001
FERT	0.042
SITE x FERT	0.026
OP vs P applied	<0.001
OP vs SB	<0.001
OP vs IF	<0.001
SB vs IF	0.195

**IMPORTANT: Fertilizer treatment effects on field pea seed yield varied with site.**

# Fertility Treatment Effects on Field Pea Yield

## Average of 12 Location-Years (2019-20)

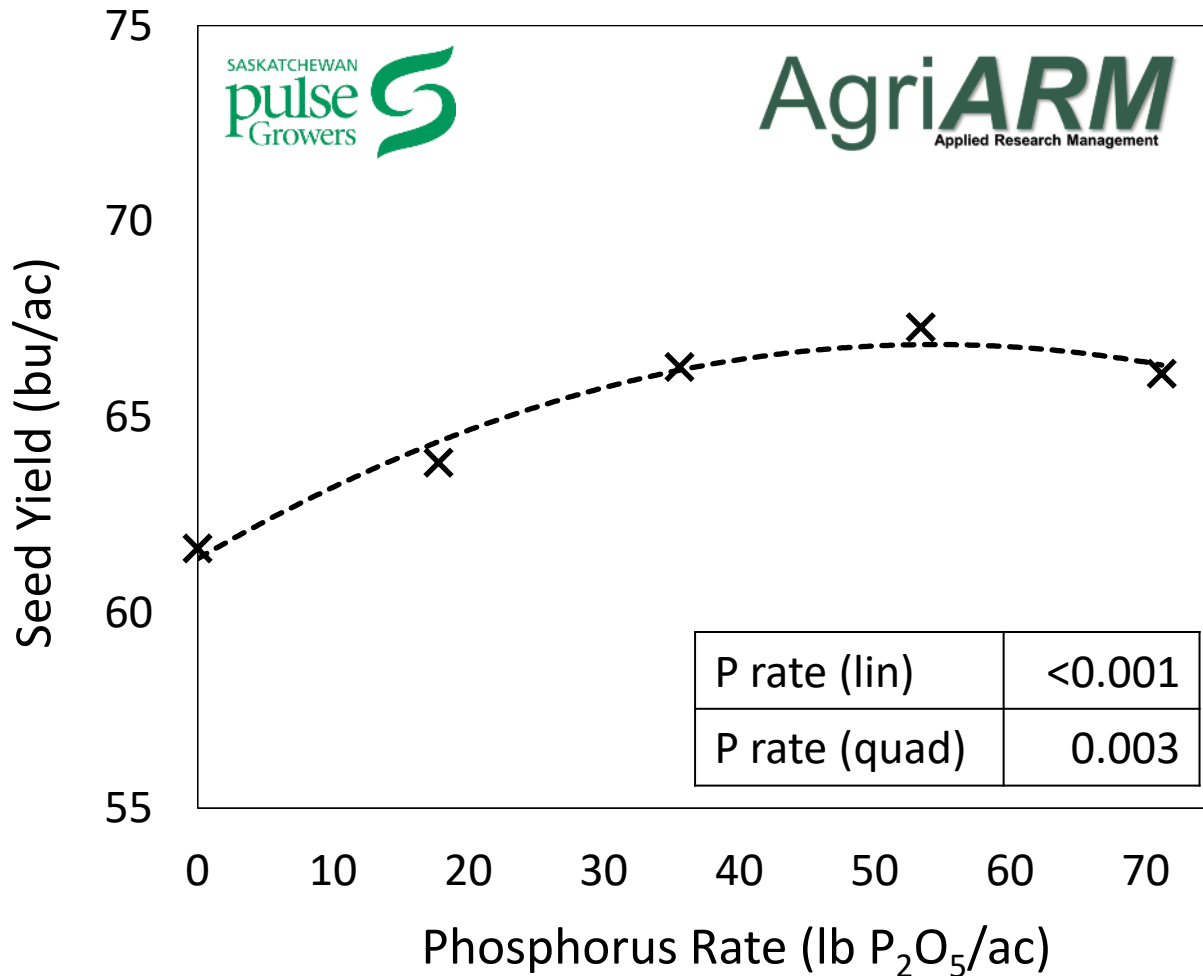
Site	Olsen-P (ppm)
IH-19	4
IH-20	3
ME-19	9
ME-20	9
OL-19	5
OL-20	24
SC-19	12
SC-20	12
SW-19	8
SW-20	9
YK-19	9
YK-20	7



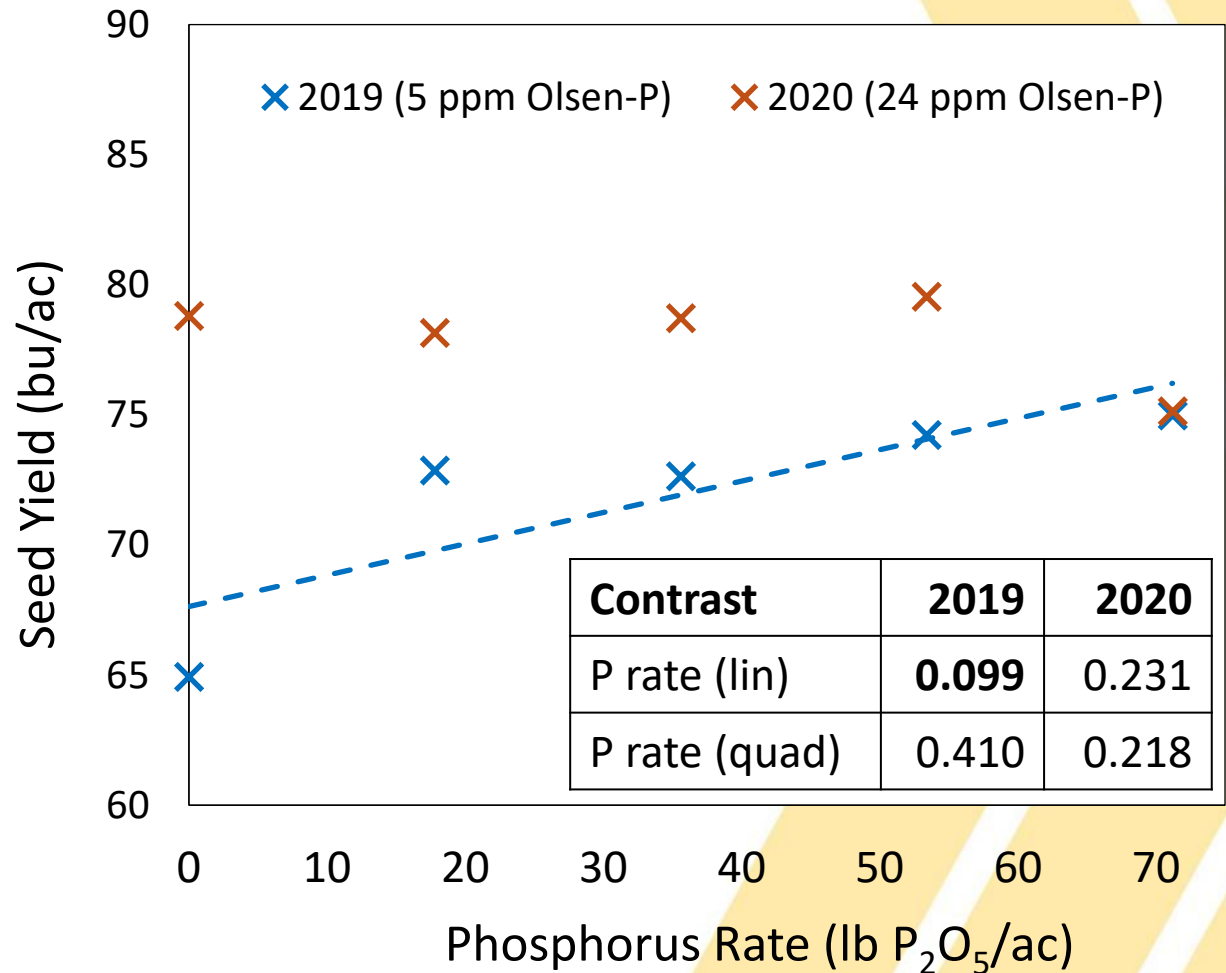
Source	Pr > F
Fertility (F)	<0.001
Check vs Fertilized	<0.001
Normal vs Extra N	0.202
P Rate – lin	<0.001
P Rate – quad	0.004
S Rate – lin	0.422
S Rate – quad	0.812

# Field Pea Response to Phosphorus Rate (2019-20)

12 Site Average



Outlook, Saskatchewan



# Long-Term Effects of Fertility on Wheat Yields

## Indian Head AAFC Long-Term Rotation Trial

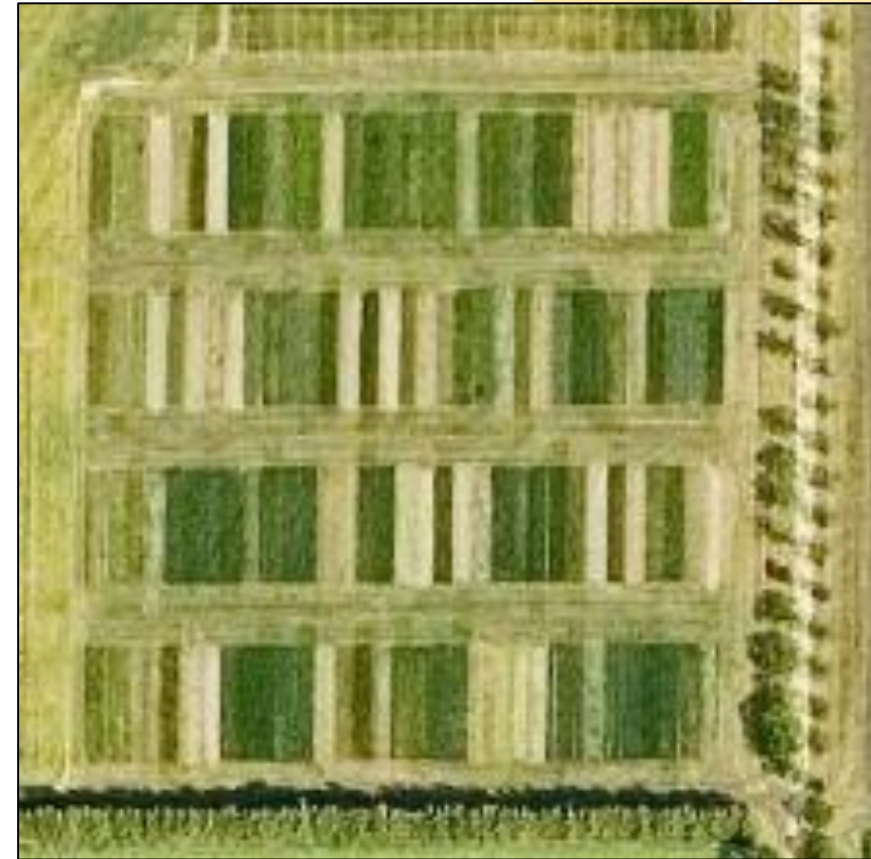
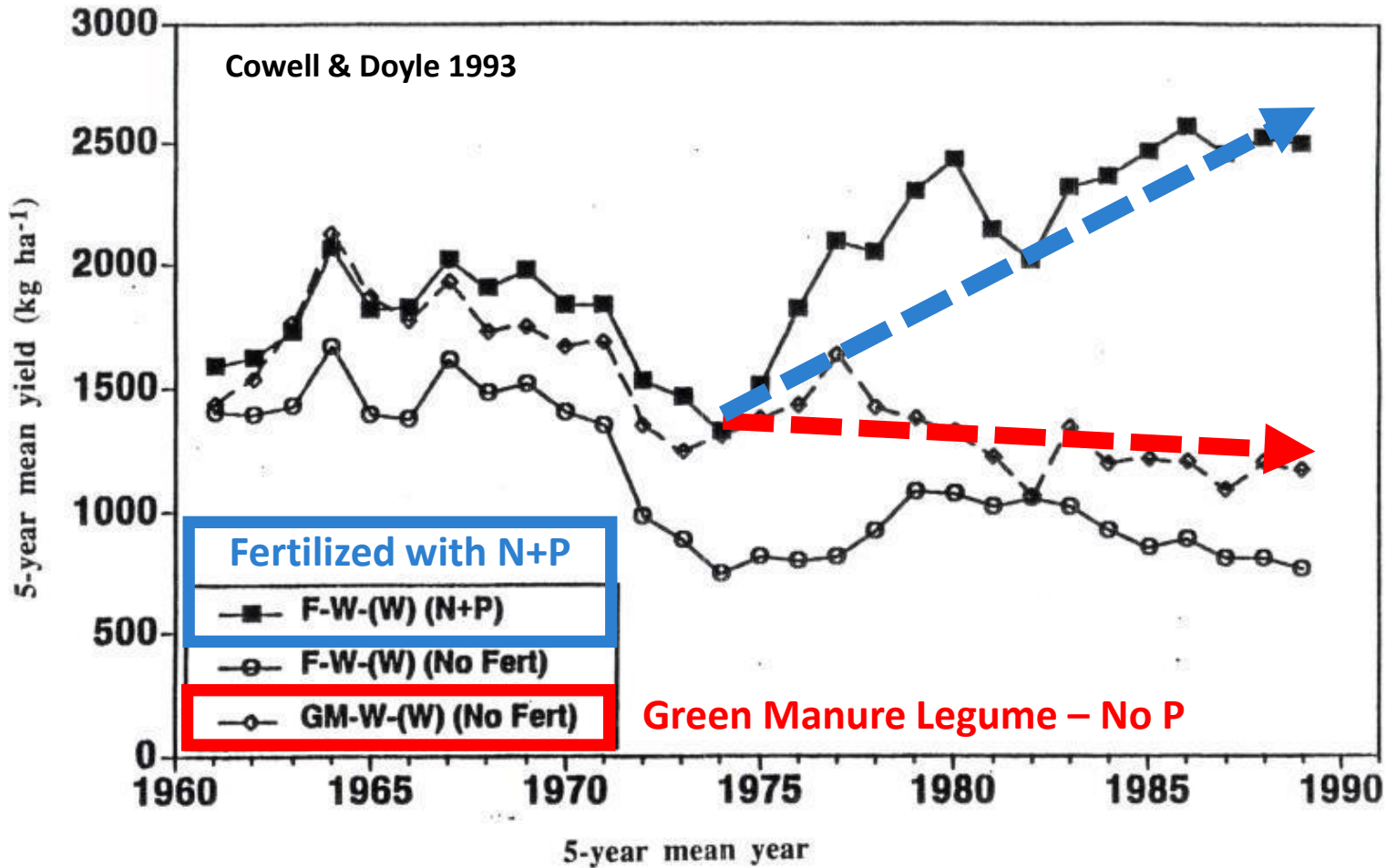
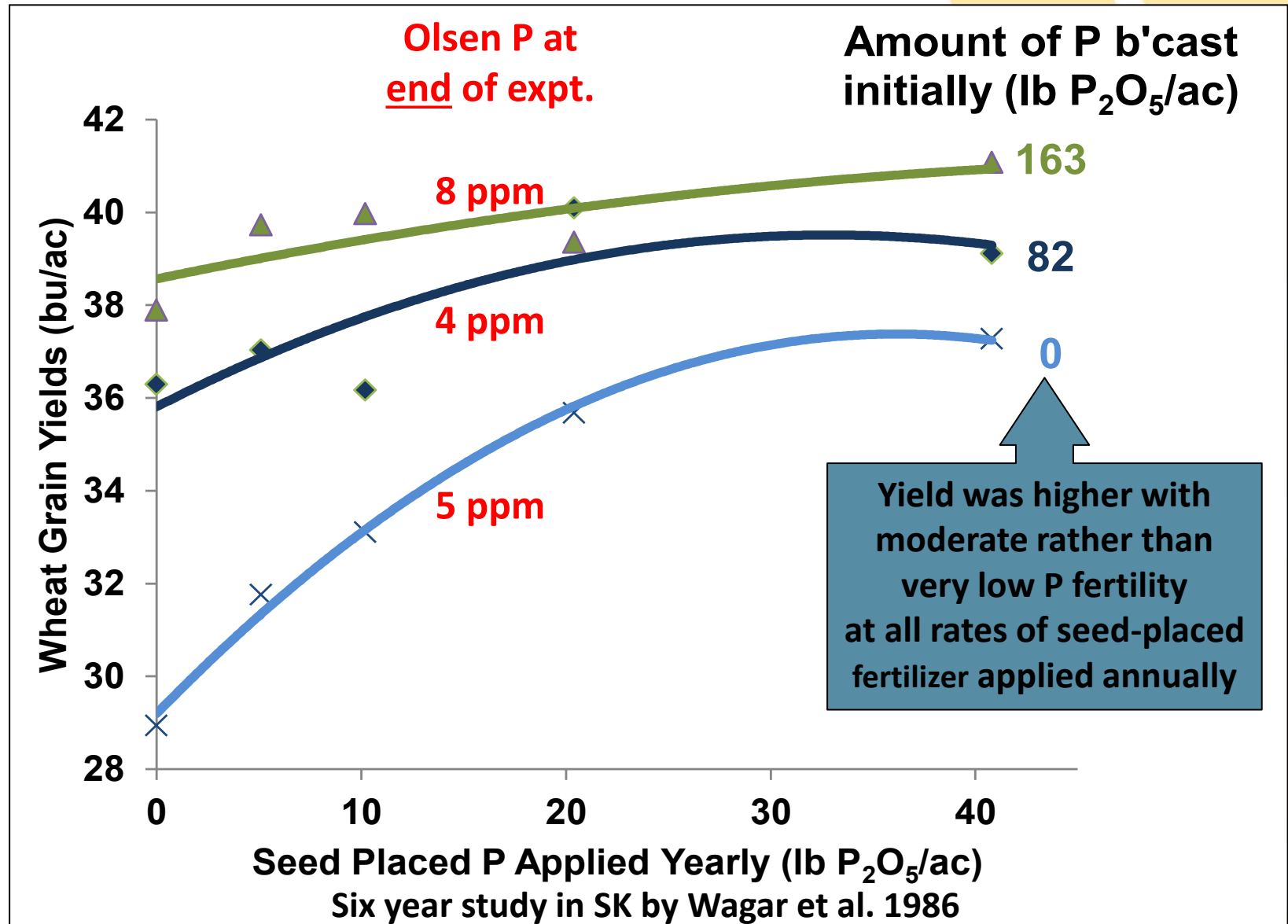


Figure 1. Yields of stubble wheat crops in fallow-wheat-wheat (F-W-W), fallow-wheat-wheat plus fertilizer (F-W-W (N+P)) and green manure-wheat-wheat (GM-W-W) rotations at Indian Head (Black soil zone) (C.A. Campbell, unpublished data).

- Crops can respond to both P fertilizer and soil P fertility, so depleted soil P can decrease crop yield potential
- Additionally, starter P can still be beneficial, even in higher P soils



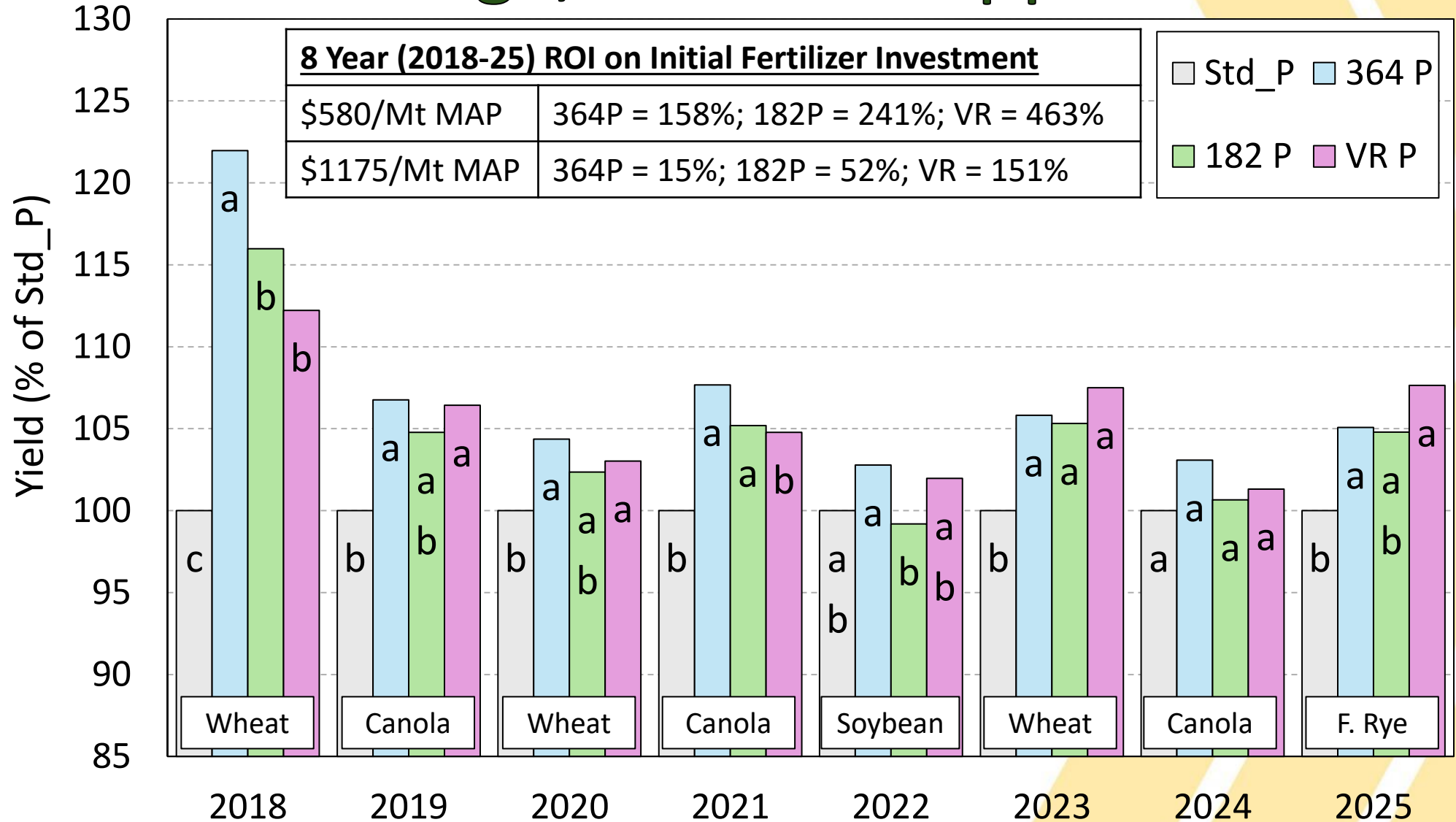
# Does it make agronomic & economic sense to build up low P soils with large, one-time applications?

## 2018

Banded 0, 364, 182, or VR (140) lb P<sub>2</sub>O<sub>5</sub> as MAP

## 2018-25

Annual applications of 36 lb P<sub>2</sub>O<sub>5</sub>/ac for all crops/treatments



# Costs of Various Phosphorus Fertilizer Forms

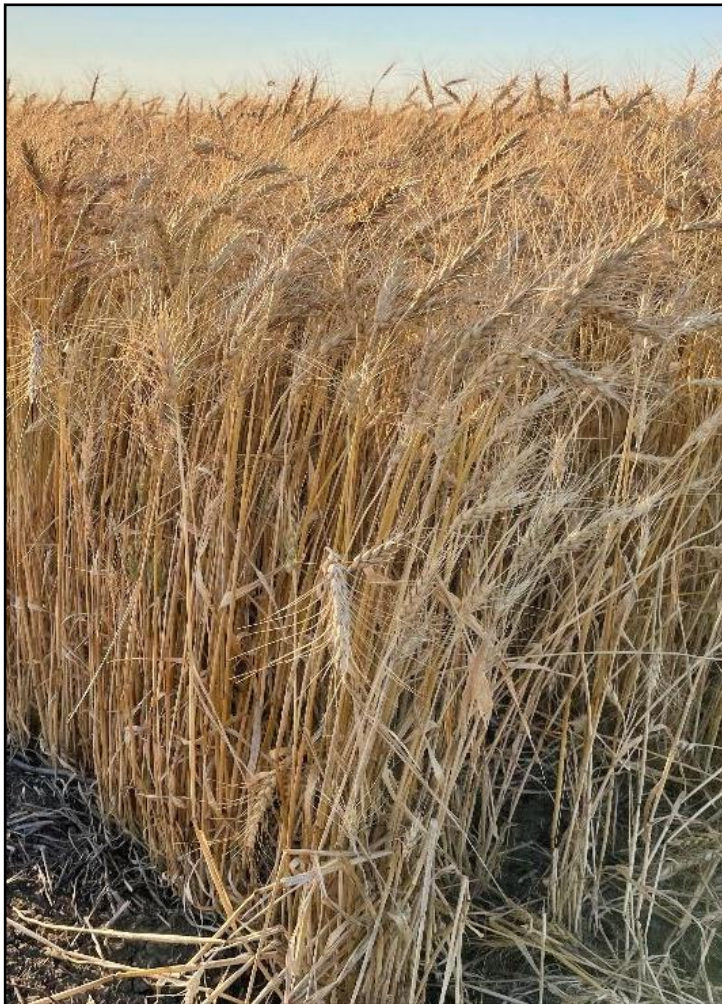
Product	\$/Mt	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	S
Urea	\$790	46	0	0	0
Ammonium sulfate	\$560	21	0	0	24
Monoammonium phosphate	\$1195	11	52	0	0
Ammonium polyphosphate	\$1073	10	34	0	0
MicroEssentials® S15	\$1169	13	33	0	15
MAP+MST®	\$1259	9	43	0	16
Crystal Green® Pearl	\$1520	5	28	0	0
50% MAP:50% CG Pearl	\$1358	8	40	0	0
Crystal Green® Sychro50	\$1720	8	40	0	0

\$/lb N	\$/lb S	\$/lb P <sub>2</sub> O <sub>5</sub>
\$0.78		
	\$0.38	
		\$0.88
		\$1.20
		\$1.13
		\$1.03
		\$2.32
		\$1.38
		\$1.80

\* Prices from various retailer and distributors on Nov. 28, 2025

\* Prices/lb P are adjusted for both the N (based on urea) and S (based on AMS) provided by each form

# Misc. Soil Fertility Trials & Demos



# Crop Uptake of Sulfur from MAP Fortified with Sulfate & Elemental S (Degryse et al. 2020)

**Objective:** To assess how much S in crops was derived from S fortified MAP fertilizers under contrasting climate conditions over a 2-yr period

## **A: Argentina (Humid subtropical)**

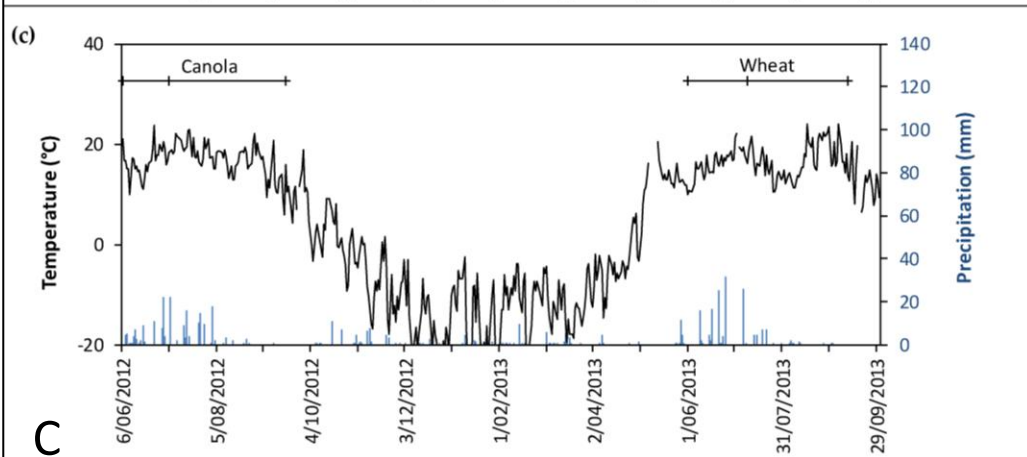
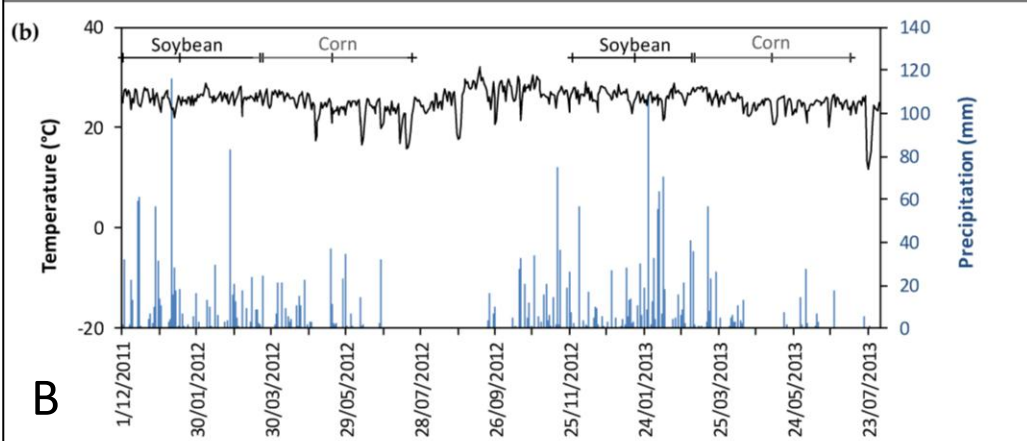
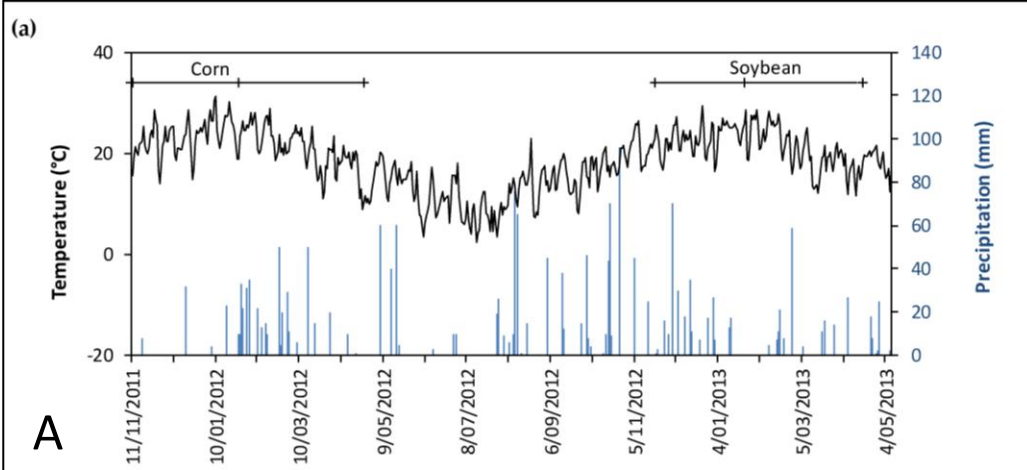
- Intermediate temp. & precipitation
- Corn / Soybean
- MES10 (5% SO<sub>4</sub>-S, 5% ES)

## **B: Brazil (Tropical)**

- Warmest & wettest climate
- Soybean / Corn / Soybean / Corn
- MES9 (2% SO<sub>4</sub>-S, 7% ES)

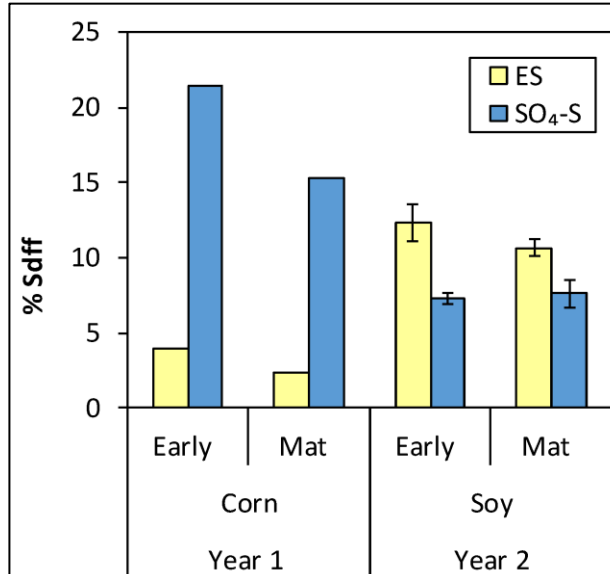
## **C: Canada (Humid continental)**

- Coolest & driest climate, short season
- Canola / Spring Wheat
- MES15 (7.5% SO<sub>4</sub>-S, 7.5% ES)



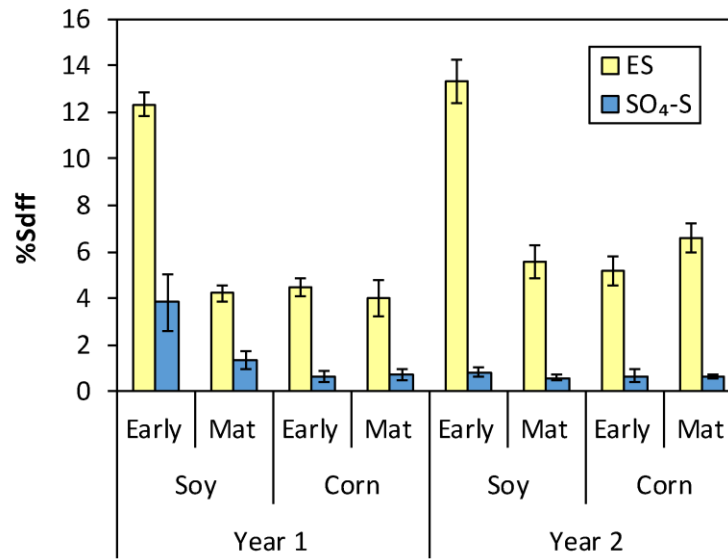
# Crop Uptake of Sulfur from MAP Fortified with Sulfate & Elemental S (Degryse et al. 2020)

## Argentina



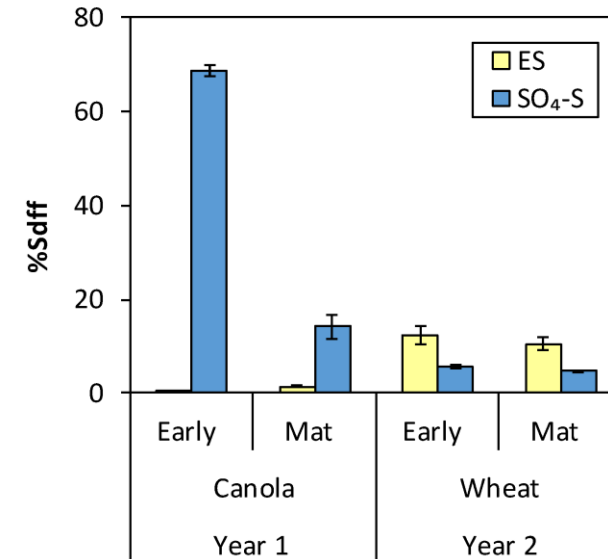
(a)

## Brazil



(b)

## Canada



(c)



Percentage of total plant S plant derived from fertilizer SO<sub>4</sub>-S vs ES at late vegetative stage & maturity

- By the end of year 2, cumulative recoveries of added S were > 65% for SO<sub>4</sub>-S & 20-25% for ES in the Argentina & Canada sites but at Brazil recovery was less for SO<sub>4</sub>-S (9%) than ES (16%)

# Reducing Cadmium Uptake in Flax Using Agronomic Strategies (ADOPT 2022)

**Objectives:** To explore potential for reducing Cd uptake in flaxseed through the addition of competing cations (Zn and Ca) as side-banded fertilizer

#	Treatment	Rate ai/ac
1	Control	n/a
2	ZnSO <sub>4</sub> - 1x	2.2 lb Zn/ac
3	ZnSO <sub>4</sub> - 0.5x	1.1 lb Zn/ac
4	ZnSO <sub>4</sub> - 2x	4.5 lb Zn/ac
5	Gypsum - 1x	~21 lb Ca/ac
6	Gypsum - 0.5x	~11 lb Ca/ac
7	Gypsum - 2x	~42 lb Ca/ac

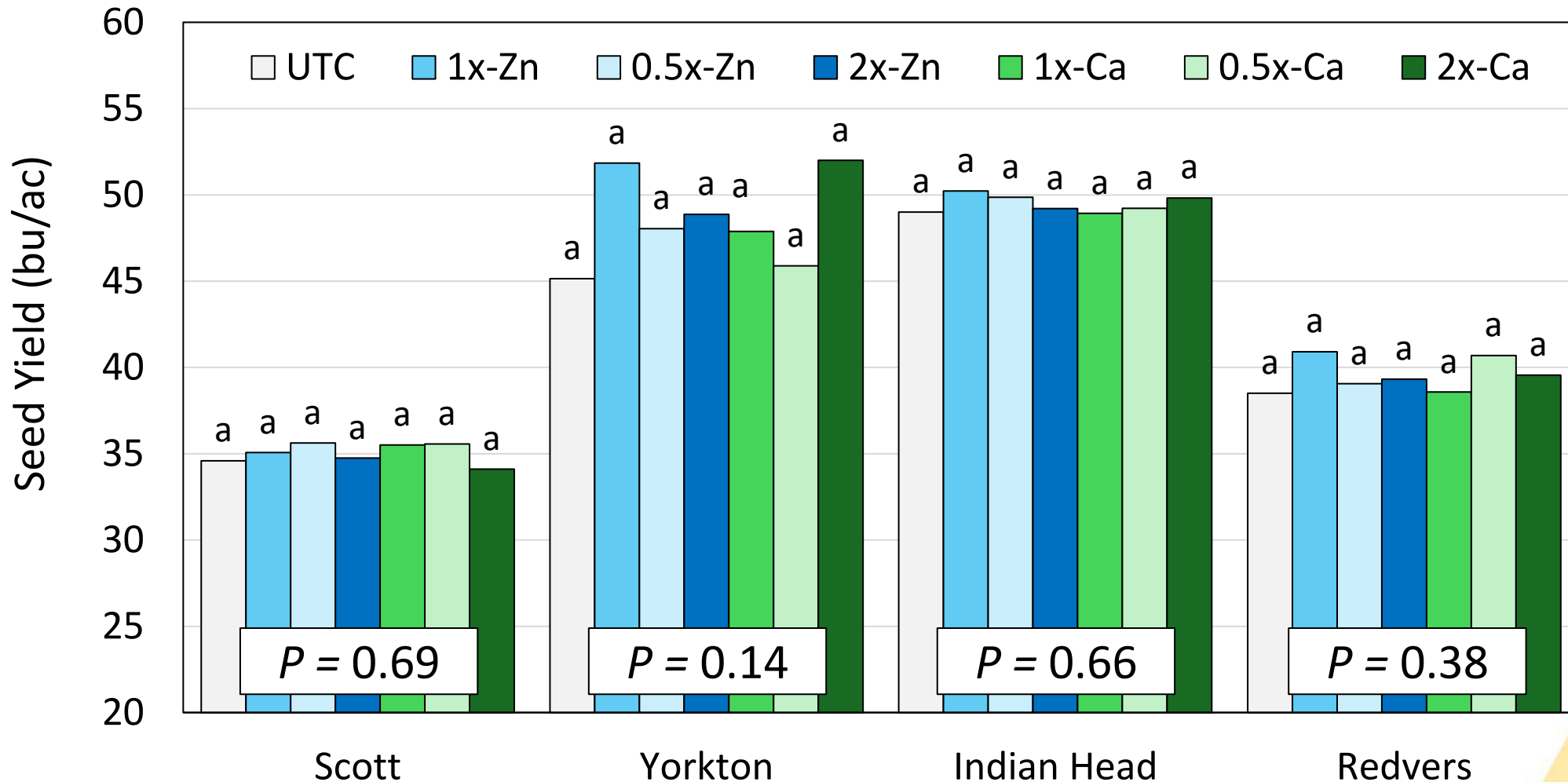
**Locations:** Redvers, Indian Head, Scott, & Yorkton

## Data Collection

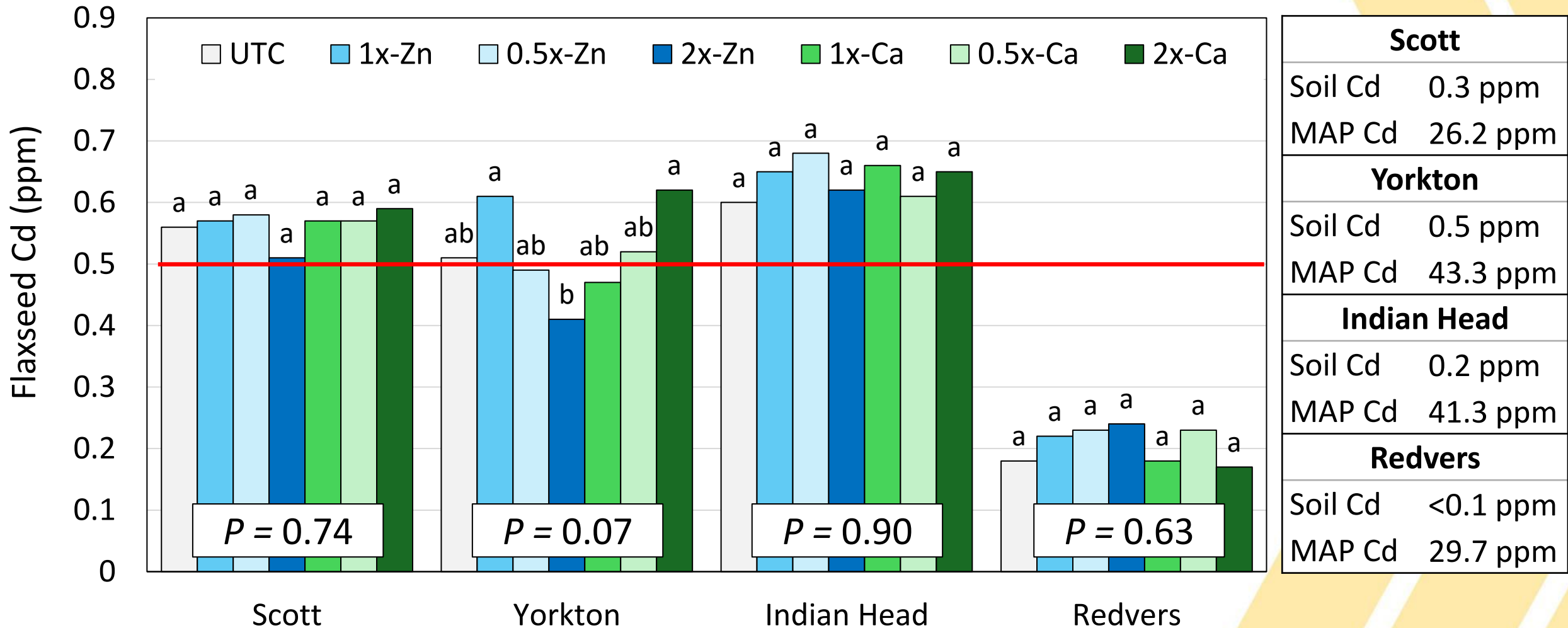
- 1) Soil Test Cd
- 2) Fertilizer Cd
- 3) Emergence
- 4) Height
- 5) Yield
- 6) Seed Cd (ppm)



# Side-banded ZnSO<sub>4</sub> and Gypsum Effects on Flax Seed Yield (2022)



# Side-banded ZnSO<sub>4</sub> and Gypsum Effects on Cadmium Accumulation in Flaxseed (2022)



# Canola Response to In-Furrow vs Foliar Applied Micronutrient Products (ADOPT-SaskOilseeds)

**Objectives:** To demonstrate the response of canola to Boron, Copper, and Zinc applied either during seeding or late bolting/start of flowering

#	Treatment	Rate ai/ac
1	Control	n/a
2	In-Furrow Boron	0.9 lb B/ac
3	Foliar Boron	0.3 lb B/ac
4	In-Furrow Copper	2 lb Cu/ac
5	Foliar Copper	0.2 lb Cu/ac
6	In-Furrow Zinc	4.5 lb Zn/ac
7	Foliar Zinc	0.25 lb Zn/ac

## Locations

- 1) Melfort (lead)
- 2) Scott
- 3) Indian Head
- 4) Redvers
- 5) Swift Current

## Data Collection

- 1) Soil Nutrients
- 2) Emergence
- 3) Tissue Nutrients
- 4) Maturity
- 5) Seed Yield
- 6) Seed Oil/Protein



# Soil Test Micronutrient Levels and Tissue Test Results from the Untreated Control (Indian Head)

Pertinent Soil Test Results					
Nutrient	ppm	Vlow	Low	Med	High
Boron	1.4	*****	*****	*****	***
Copper	2.35	*****	*****	*****	**
Zinc	0.45	*****	***		

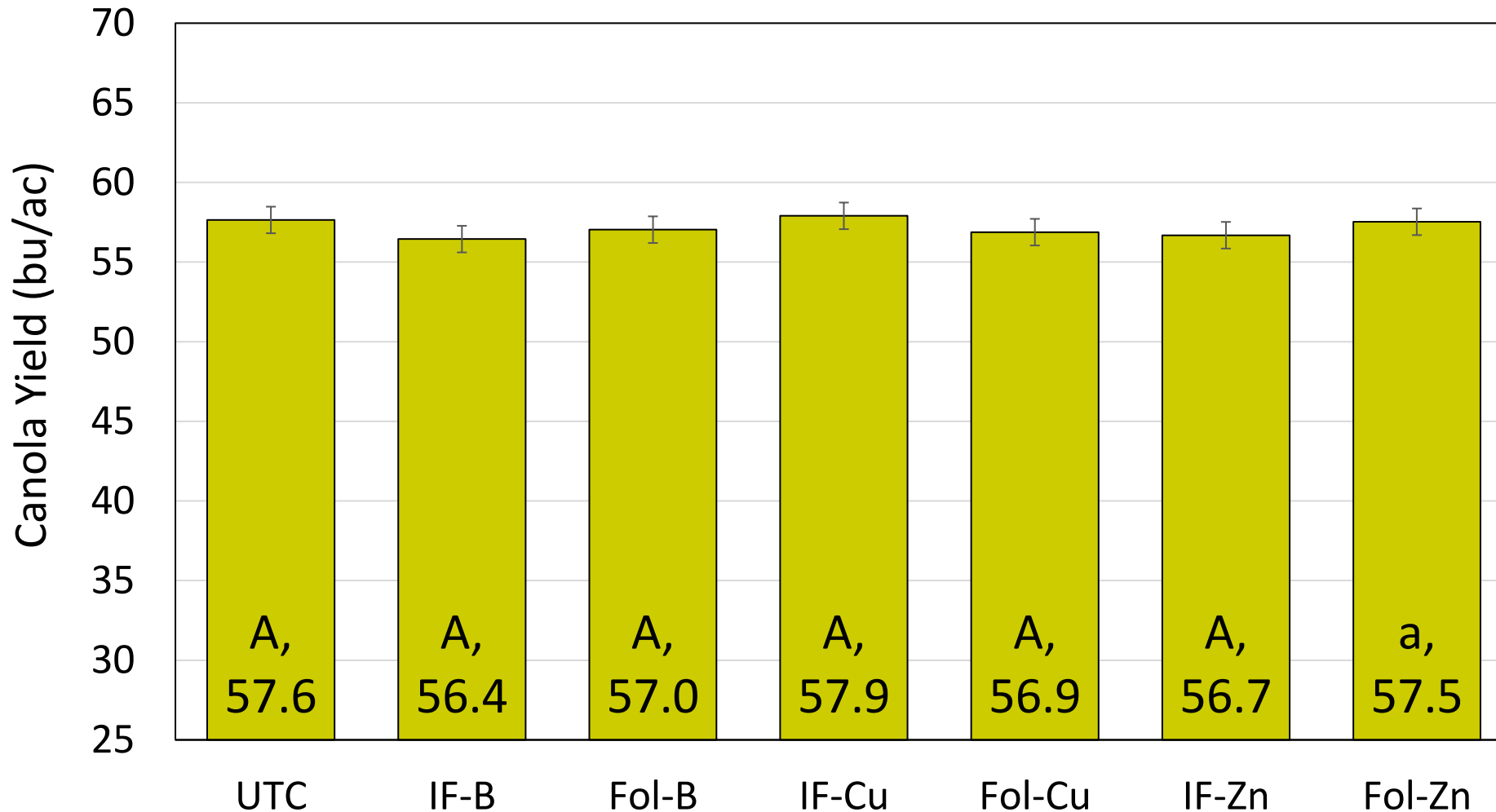
Pertinent Tissue Analyses Results (UTC)			
Nutrient	ppm	Interpretation	Sufficiency Range
Boron	22	Sufficient	15 to 54
Copper	18	Sufficient	4 to 25
Zinc	20	Low	22 to 49

## Soil Test Micronutrient Recommendations:

2 lb banded Zn/ac for a 55 bu/ac canola crop



# In-Furrow vs Foliar Micronutrient Effects on Canola Seed Yield (Indian Head 2025)



Effect/Contrast	Pr > F
Treatment	0.431
UTC vs Micros	0.337
UTC vs IF	0.315
UTC vs Fol	0.428
UTC vs B	0.180
UTC vs Cu	0.701
UTC vs Zn	0.420





# THANK YOU

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