2021 Wheat Soil Fertility Research Update & Preliminary Planning

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MICHIGAN WHEAT PROGRAM

MICHIGAN STATE UNIVERSITY EXTENSION

AgBioResearch
MICHIGAN STATE UNIVERSITY

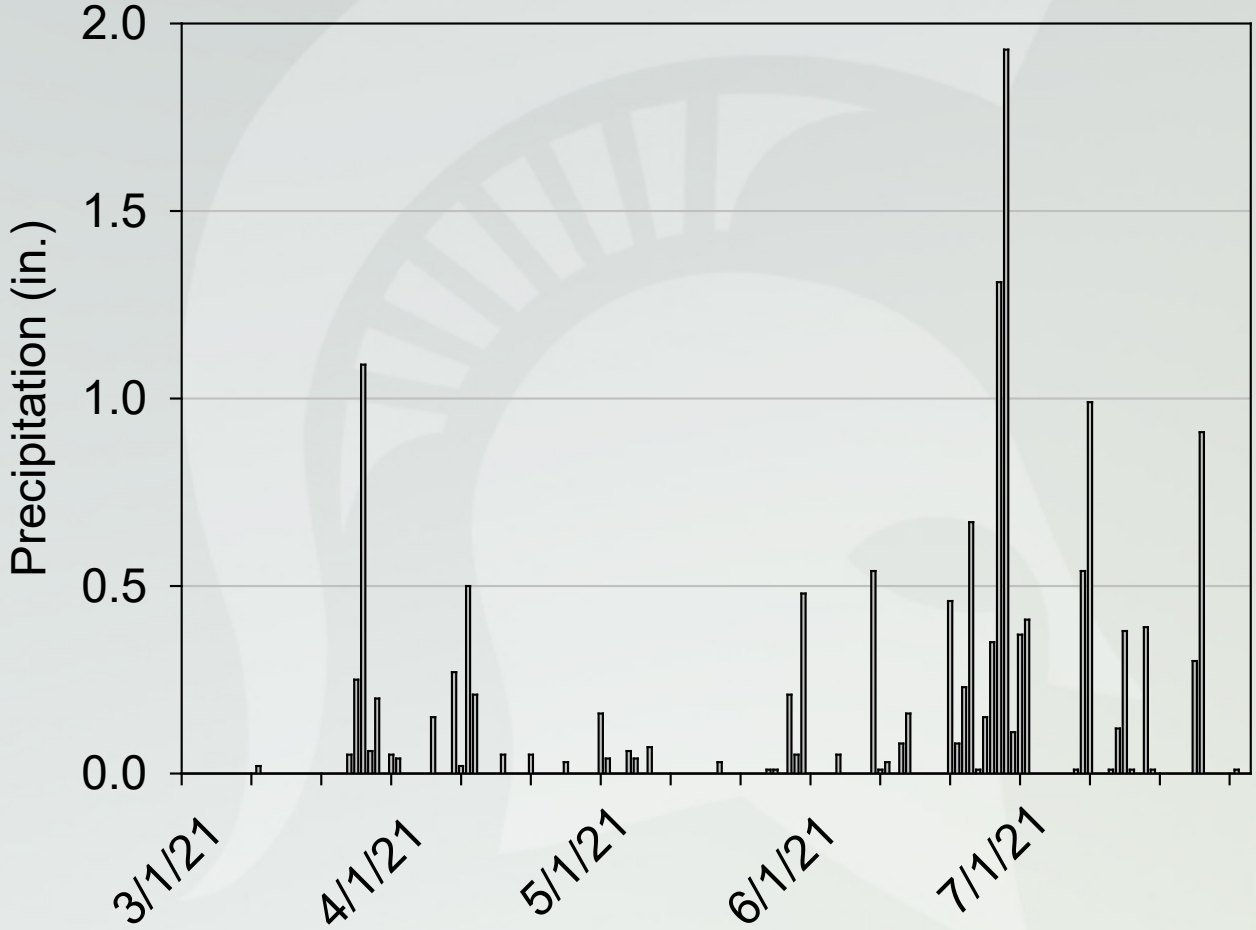
Overview

- 2021 Field Research Results
  - 15 studies completed and harvested
  - Discuss several today
- Soil Fertility & Nutrient mgmt. program
  - Results will be on website soil.msu.edu
  - Other wheat extension activities
    - Field Day Location?
- 2022 Proposed Field Research

2021 Plot Specifics

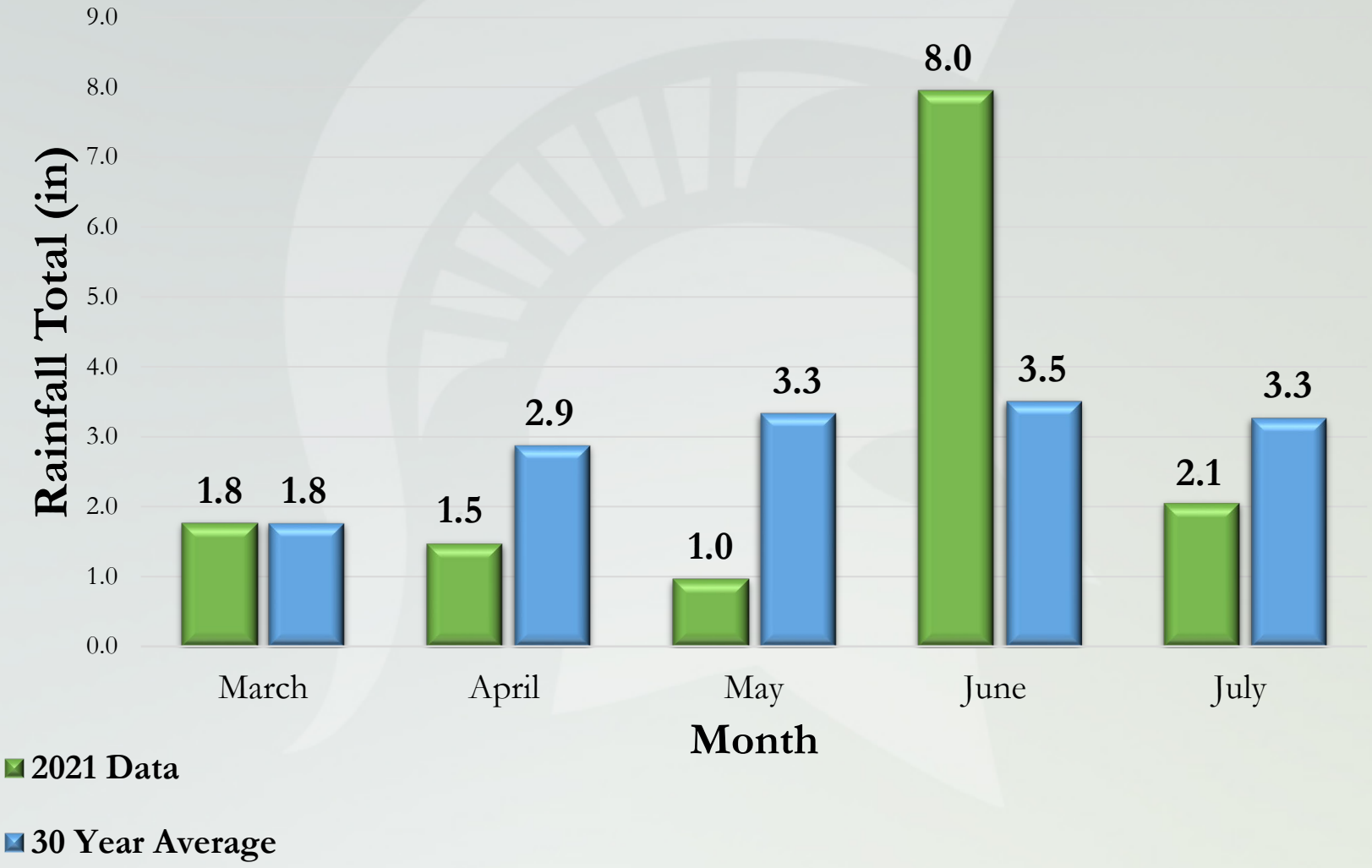
- Green-up Applications: March 23 (red) March 30 (white)
- Feekes 5: April 12 (red) – April 14 (white)
- Feekes 9: May 20 (red) – May 21 (white)
- Harvest Lansing, MI: July 14
- Harvest Richville, MI: July 14

Lansing, MI

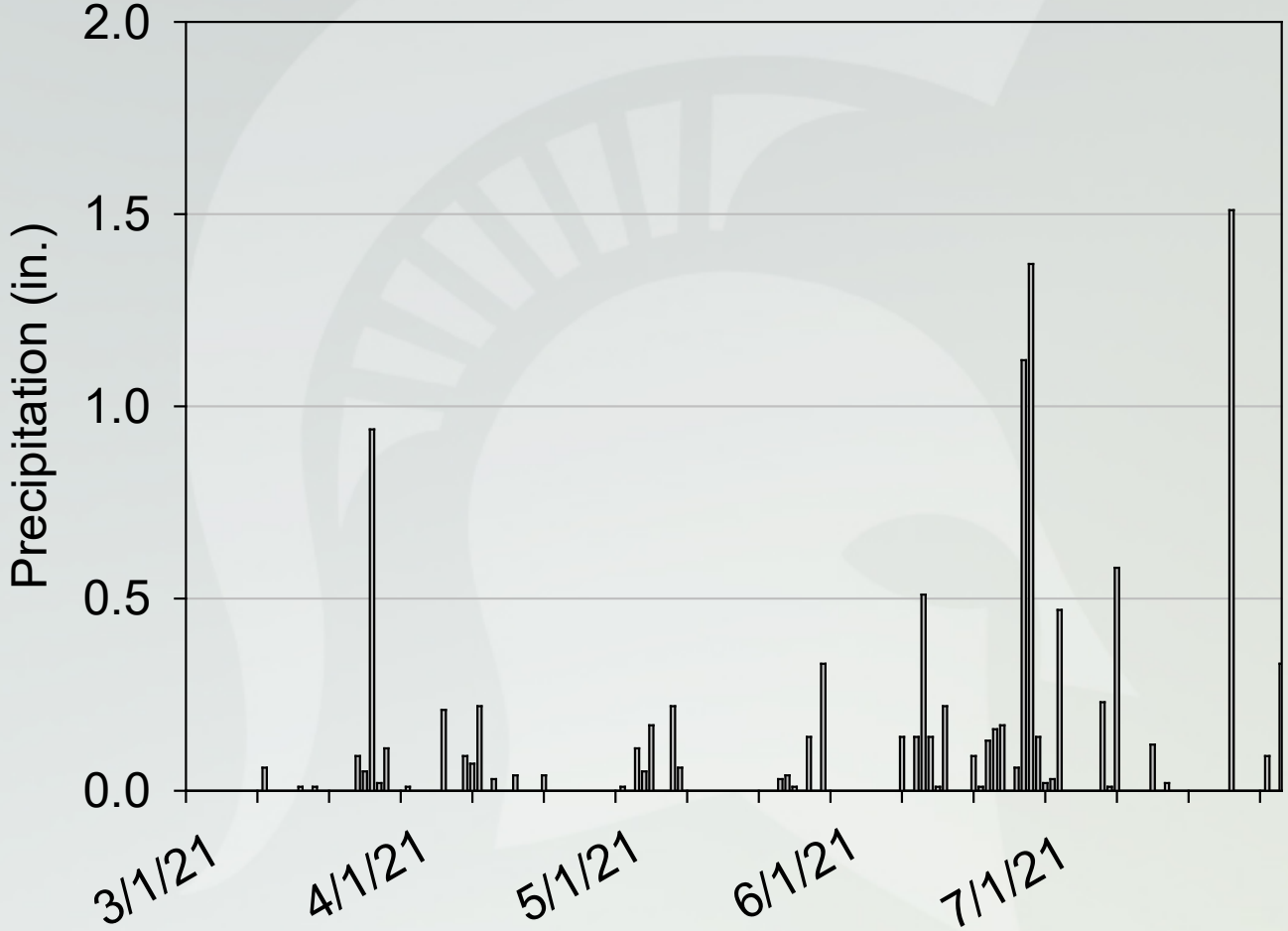


- **14.4 in. March 1 – Aug. 1**(12.3, 14.7, 13.5, 16.7, 10.9, 17.7, 13.8 in. ’14, ’15, ’16, ’17, ’18, ’19, ‘20)
  - 1.80 March, 1.5 April, 1.00 May, 8.0 June, 2.1 July

Precipitation Totals Lansing, MI

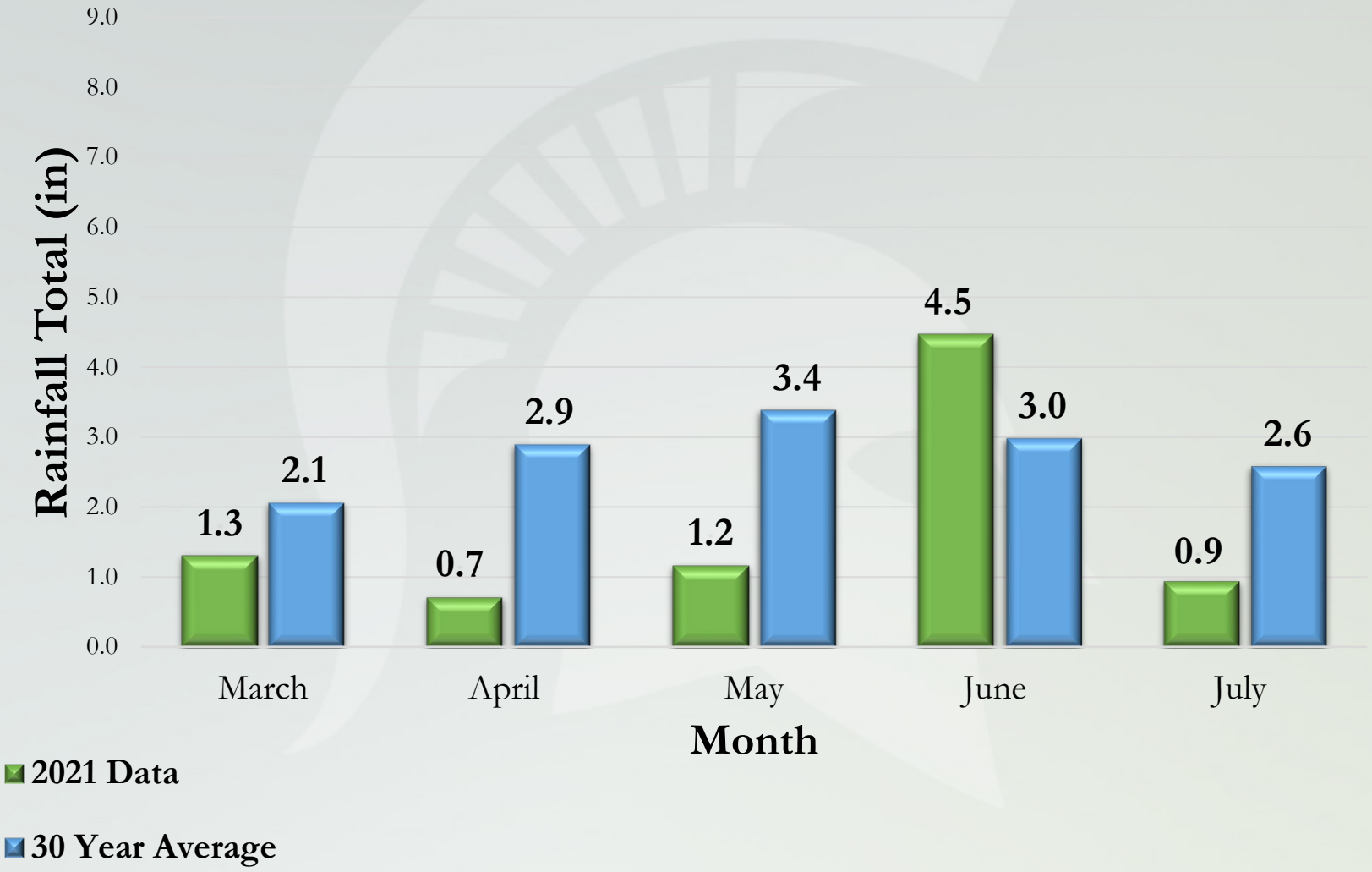


Richville, MI



- **8.6 in. March 1 – Aug 1**
  - 1.3 March, 0.7 April, 1.2 May, 4.5 June, 0.9 July

Precipitation Totals Richville, MI



Identify One Thing To Do in Autumn Study – SRWW and SWWW

- Field-Day focused study
  - Let's get some field day interaction!!
  - Provide soil test
    - **Does PD impact what we do in the autumn or soil test?**
  - Provide 8 management practices to do in autumn
  - 2021 SRWW – 8 practices and 2 planting dates
  - 2021 SWWW – 8 practices and single planting date
- SRWW - 2 PDs
  - Sept 21 and Oct 15
- SWWW – 1 PD
  - Sept 24

8 Practices to Choose From

- Plant and do nothing
- 25 lbs N
- 65 lbs P2O5 and 15 N (P = Crop removal)
- 25 lbs S
- 50 lbs K2O (K= crop removal)
- Starter MESZ (30N, 100P, 25S, 2.5 Zn)
- Spring N only (No fall treatments)
- Starter S and K (87K, 25S)

- ALL 100 N at GU

Feekes 9 Early Plant








Identify One Thing To Do in Autumn Study – SRWW – Early Plant (ALL 100 N at GU)

	Early Plant	Late Plant
Treatment	**Grain Yield (bu A^{-1})**	
Plant and Nothing	39.2 e	42.6 e
25 N Autumn	89.2 ab	74.3 d
65 P2O5, 15 N	89.1 ab	69.2 d
25 S	82.8 bc	69.2 d
50 K2O	75.0 cd	71.5 d
30 N, 100P , 25 S, 2.5 Zn	95.9 a	72.2 d
Spring N Only	87.9 b	67.6 d
87 K, 25 S	88.6 ab	73.7 d
P>F (< 0.01)	LSD (0.05) = 7.8	

Identify One Thing To Do in Autumn Study – SWWW

(ALL 130 N at GU)

Treatment	Grain Yield (bu A^{-1})
Plant and Nothing	55.4 d
25 N Autumn	85.8 bc
65 P2O5, 15 N	110.4 a
25 S	97.4 ab
50 K2O	84.3 bc
30 N, 100P , 25 S, 2.5 Zn	110.4 a
Spring N Only	80.5 c
87 K, 25 S	100.6 a
P>F	< 0.01

Variety x Intensive Mgmt.

- SRWW
  - Jonah, W304, and AgriMaxx
- SWWW
  - Whitetail, Jupiter, and Dyna Gro9362W
- Base N (90 red and 130 white)
- Base N with late N (40 N F7)
- Autumn Starter with base N (250 MESZ)
- Check

Variety x Intensive Mgmt.

- SRWW
  - No differences among varieties

Treatment	Grain Yield (bu A^{-1})
Base N only	83.6 b
Base N with 40 N late	86.7 b
Autumn Starter with Base N	93.7 a
Check	48.0 c
P>F	< 0.01

Variety x Intensive Mgmt.

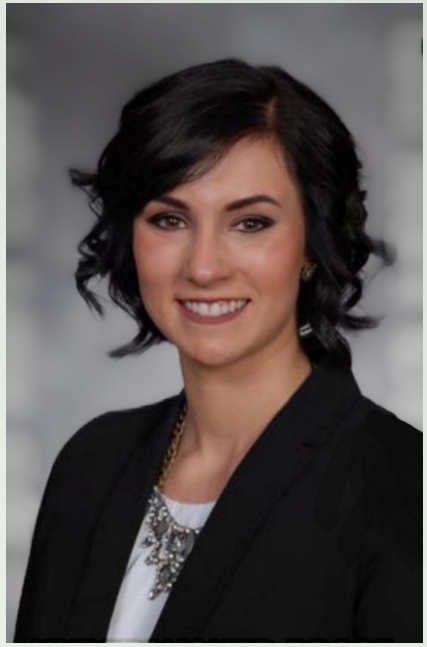
- SWWW
  - No differences among varieties

Treatment	Grain Yield (bu A^{-1})
Base N only	101.1 b
Base N with 40 N late	103.8 b
Autumn Starter with Base N	114.8 a
Check	53.2 c
P>F	< 0.01

Other Studies Not Presenting Today

- Results soon posted on soil.msu.edu
- Chlormequat chloride and Palisade combinations and timings on soft red wheat
- (2) Intensive nutrient management with fall and spring application
- Winter wheat N response and management
- Starter gradient study with PGR

Start Right to Finish Well: Nutrient Management for Winter Wheat Grain AND Straw Production



Lacie Thomas (M.S. student)

Study Objectives

- Evaluate wheat grain and straw yield response to 12-40-0 10S 1Zn autumn starter and spring N rates

- Evaluate wheat grain and straw yield response to short and tall varietal stature
  - Can starter further or better influence production than N?
  - Reduce N? Tall vs short varieties

- Determine the economic optimum of autumn and spring nutrient applications for both grain and straw production

Location, Planting Date, Variety

Lansing, MI

- **Planted**
  - September 22, 2020
- **Variety**
  - Flipper (Short Statured SRW)
  - Red Dragon (Tall Statured SRW)

Richville, MI

- **Planted**
  - September 24, 2020
- **Variety**
  - Jupiter (Short Statured SWW)
  - AC Mountain (Tall Statured SWW)

Measurables Collected

- Spring Tiller Counts (1ft^2)
- Canopeo App: 10-14 days
- Greenseeker NDVI (F5,F7,F9)
- Flag leaf samples: nutritional concentration, 40pp
- Plant Heights: 10pp
- Head Counts: (1ft^2)
- Peduncle Lengths: 10pp
- Straw Nutrient Analysis
- NIR Grain Analysis

GRAIN AND STRAW PRODUCTION IN WINTER WHEAT AS AFFECTED BY AUTUMN STARTER AND SPRING NITROGEN

Fertilizer Rates: Soft Red Winter Wheat			
Autumn Starter: 12-40-0 10S 1Zn		28% Nitrogen	
No Starter Fertilizer	0 lb/A	Low Spring N	50 lb/A
Low Autumn Starter	125 lb/A	Base Spring N	100 lb/A
High Autumn Starter	250 lb/A	High Spring N	150 lb/A

GRAIN AND STRAW PRODUCTION IN WINTER WHEAT AS AFFECTED BY AUTUMN STARTER AND SPRING NITROGEN

Fertilizer Rates: Soft White Winter Wheat			
Autumn Starter: 12-40-0 10S 1Zn		28% Nitrogen	
No Starter Fertilizer	0 lb/A	Low Spring N	60 lb/A
Low Autumn Starter	125 lb/A	Base Spring N	120 lb/A
High Autumn Starter	250 lb/A	High Spring N	180 lb/A

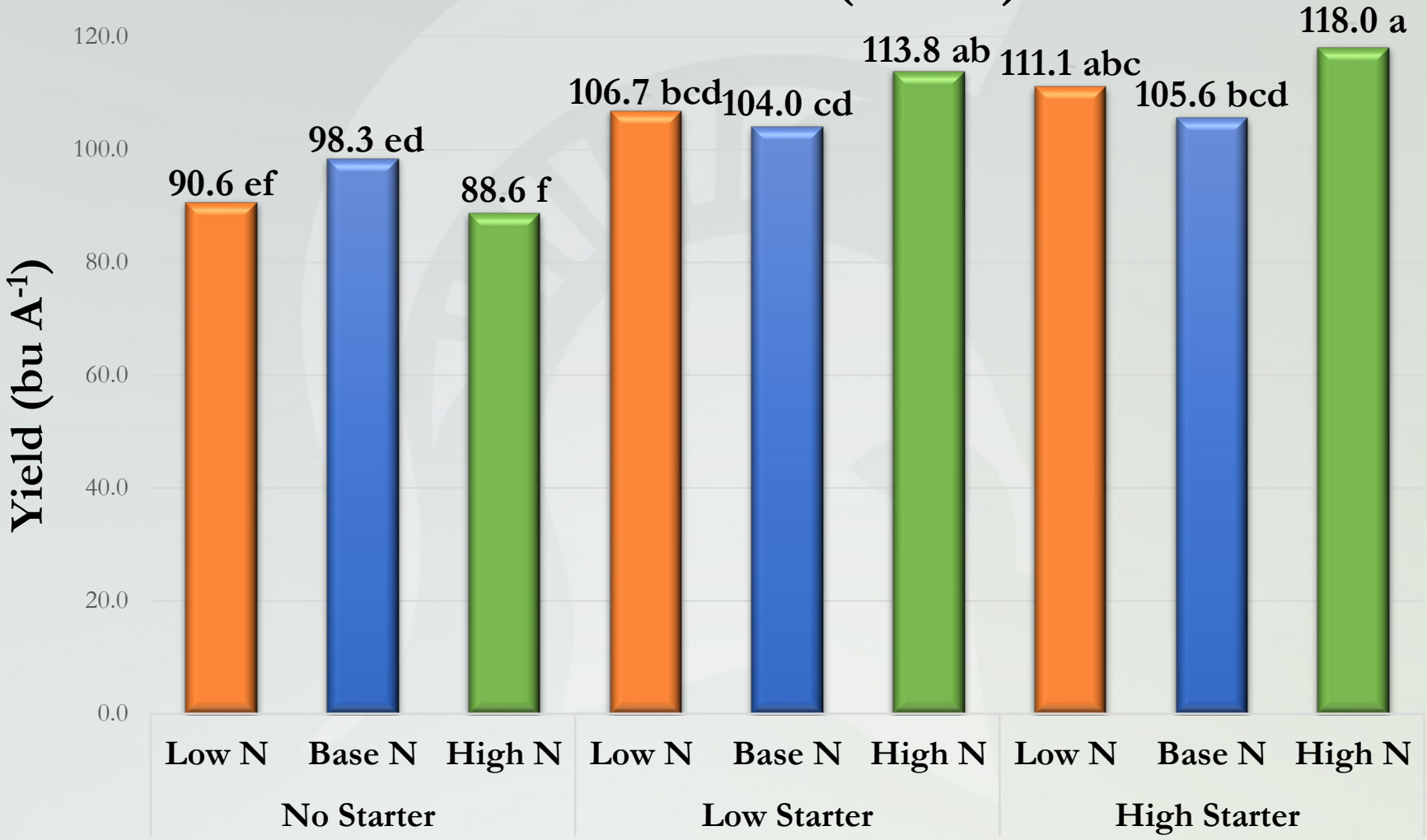
2021 Soft Red Winter Wheat
Michigan State University Campus Farm

2021 Soft White Winter Wheat
Michigan State University
Saginaw Valley Research & Extension Center

Spring Nitrate (NO_3^-) Conc. as Affected by Autumn-Applied Starter

Treatment	East Lansing, MI		Richville, MI	
	'Flipper'	'Red Dragon'	'Jupiter'	'AC Mountain'
	----------NO_3^- ppm----------			
No Starter	1.28	1.38	1.31	1.34
Low Starter	1.24	1.20	1.27	1.31
High Starter	1.34	1.38	1.25	1.24
Pr > F	NS	NS	NS	NS
Check	1.25	1.61	2.1	1.16

Flipper SRWW Grain Yield as Affected by Starter Fertilizer (bu A^{-1})

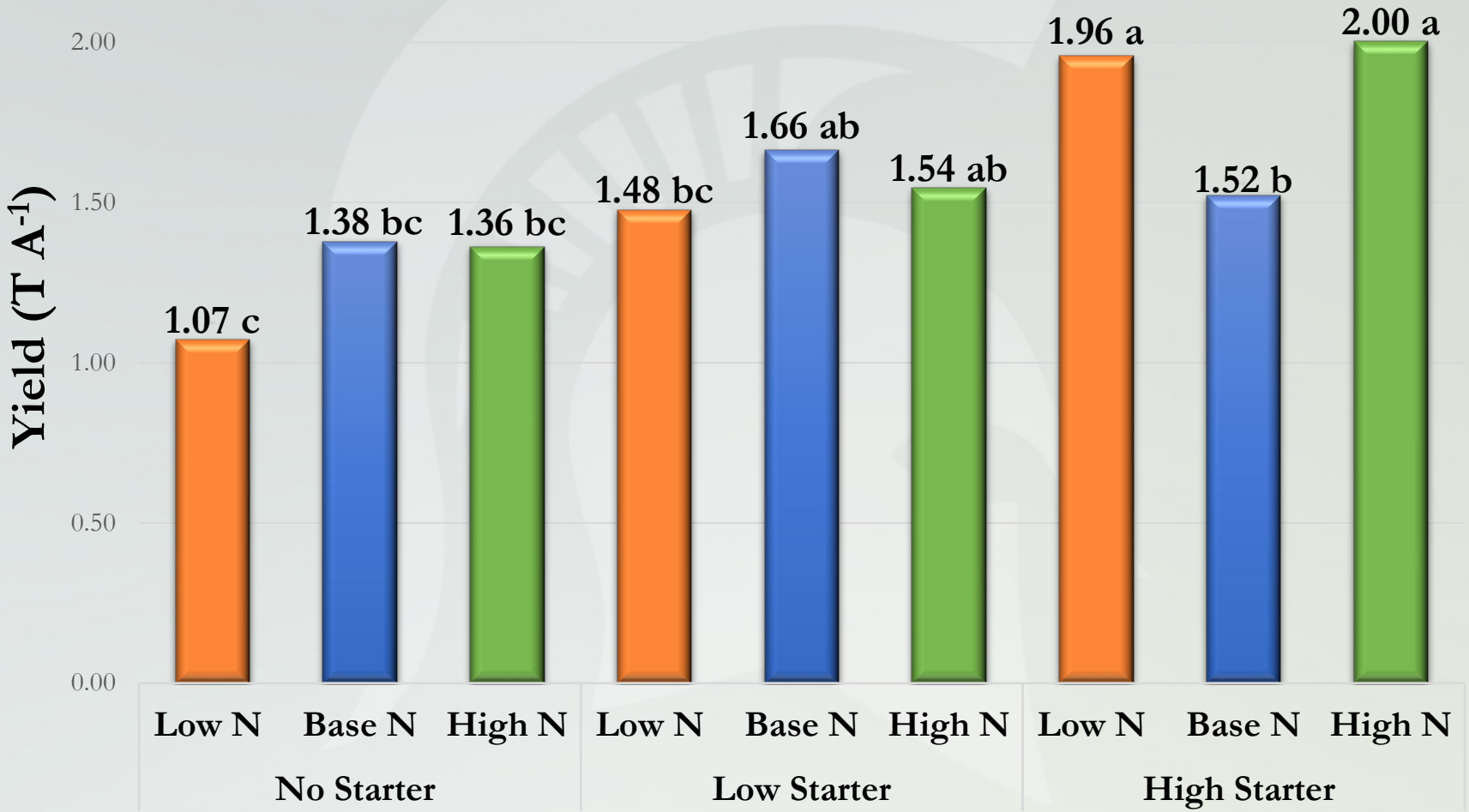


P = 0.04

MESZ Rate (lb A^{-1})

Check: 43.7

Flipper SRWW Straw Yield as Affected by Starter Fertilizer (T A^{-1})

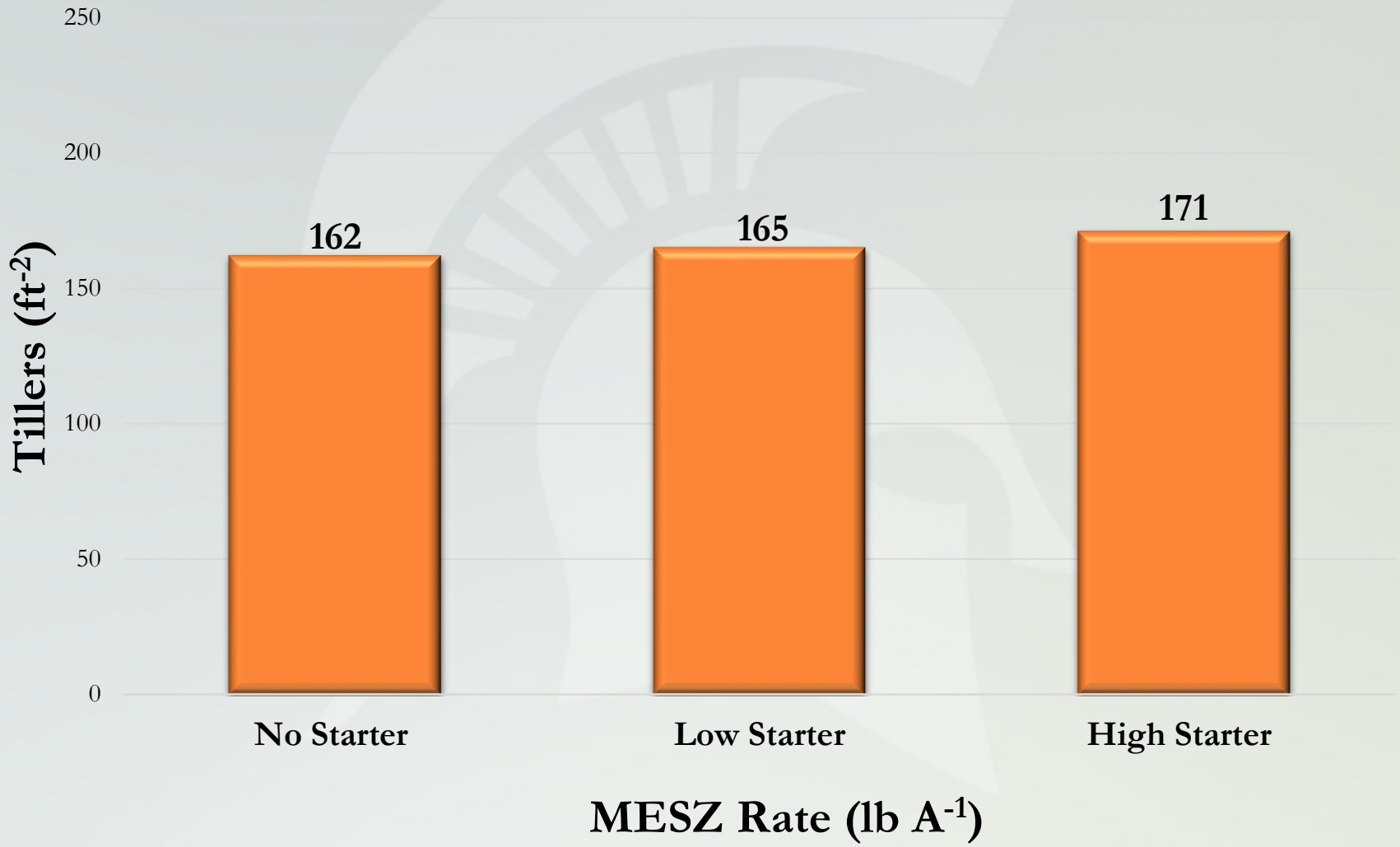


P = 0.04

MESZ Rate (lb A^{-1})

Check: 0.53

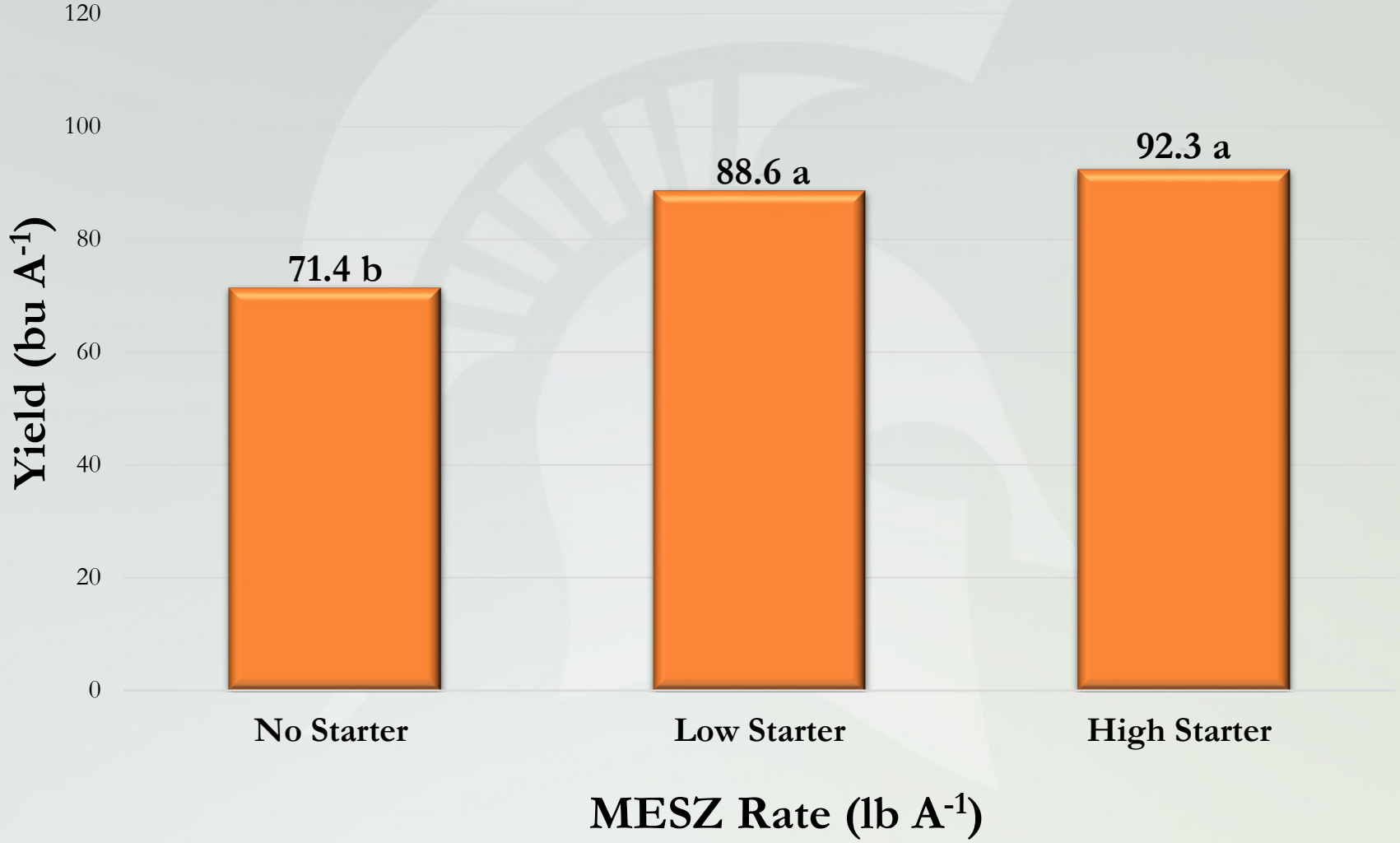
Flipper SRWW Tiller Count as Affected by Autumn Fertilizer (ft^{-2})



P = 0.79

Check: 160.8

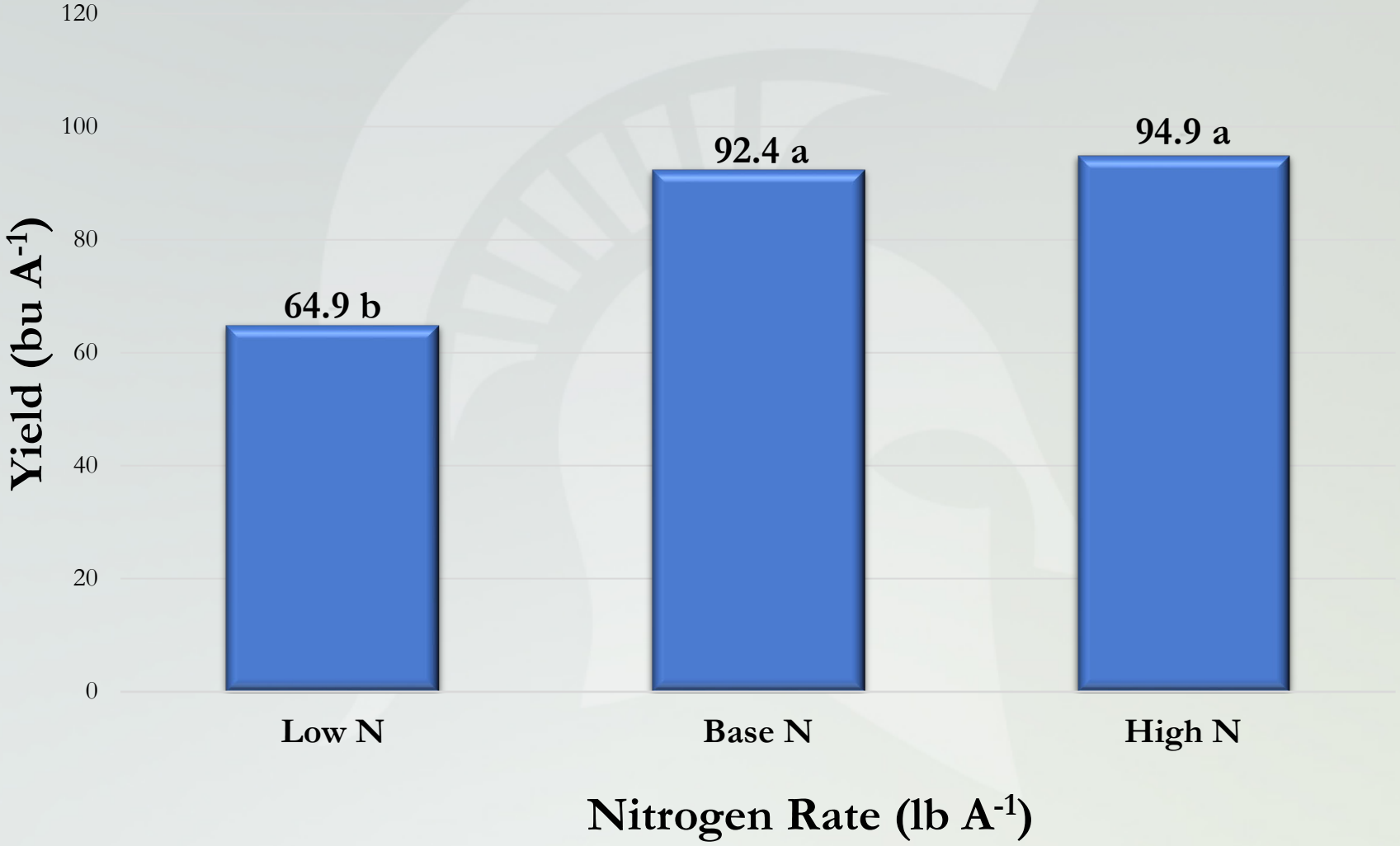
Red Dragon SWWW Grain Yield as Affected by Autumn Fertilizer (bu A^{-1})



$P < 0.01$

Check: 40.8

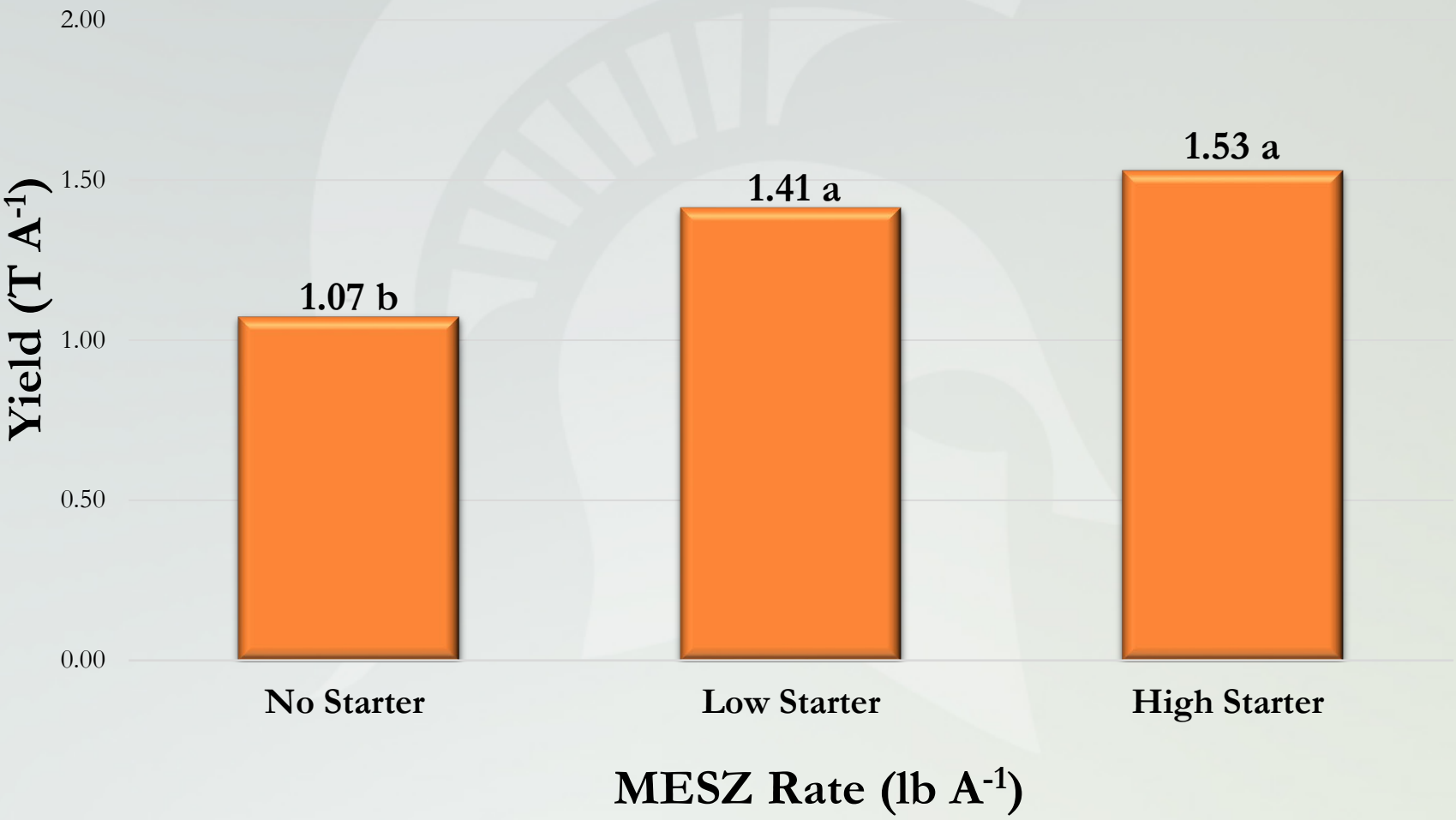
Red Dragon SWWW Grain Yield as Affected by Spring Nitrogen (bu A^{-1})



$P < 0.01$

Check: 40.8

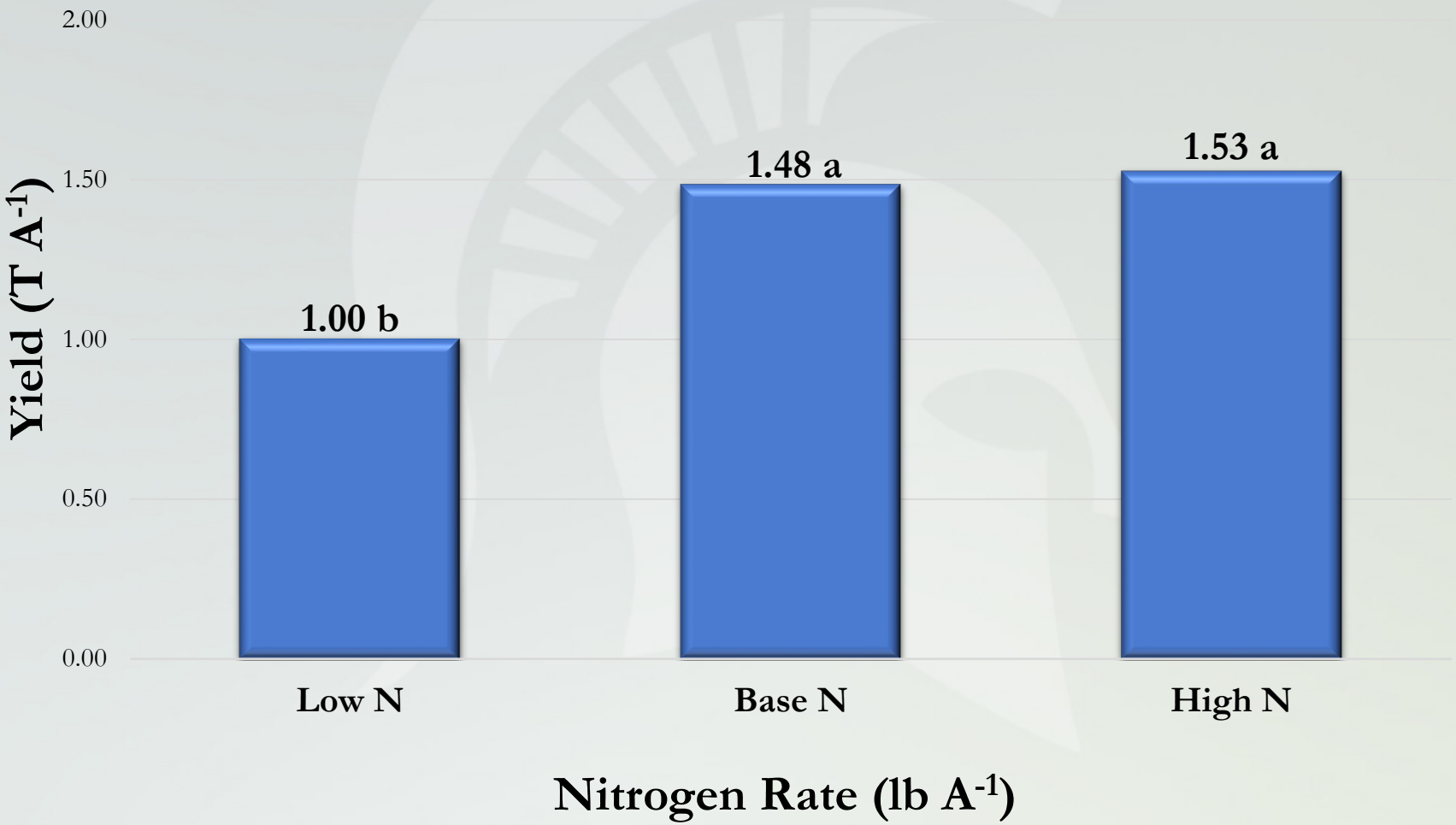
Red Dragon SRWW Straw Yield as Affected by Autumn Fertilizer (T A^{-1})



$P < 0.01$

Check: 0.58

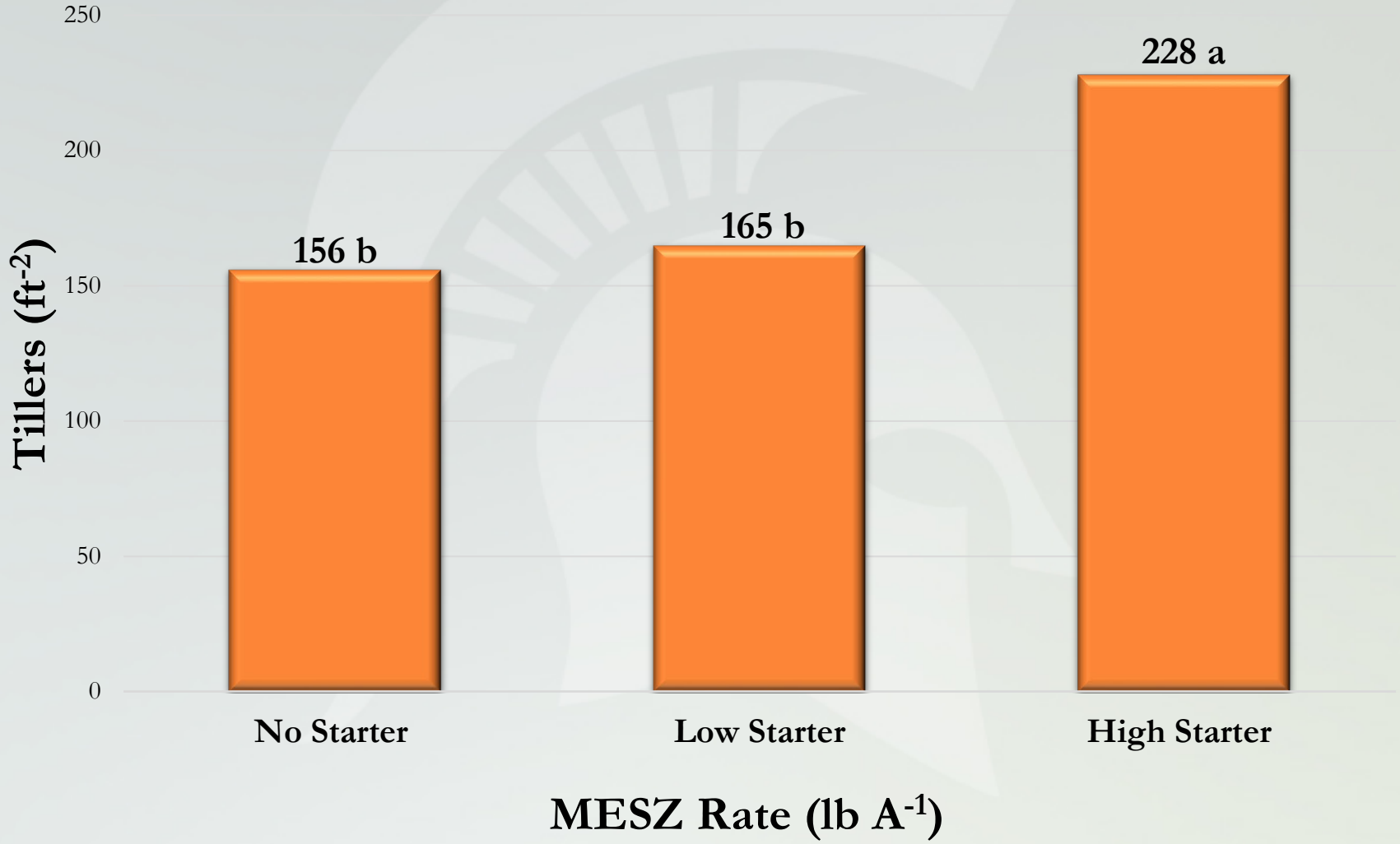
Red Dragon SRWW Straw Yield as Affected by Spring Nitrogen (T A^{-1})



$P < 0.01$

Check: 0.58

Red Dragon SRWW Tiller Count as Affected by Autumn Fertilizer (ft^{-2})



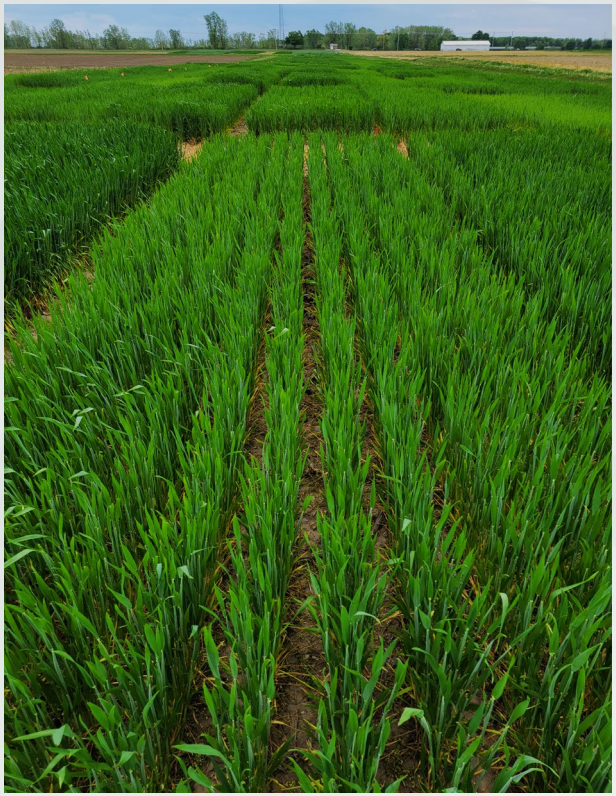
P = 0.03

Check: 120.5

Low Spring Nitrogen (50 lb/A)

SRWW – Red Dragon

No Autumn Starter

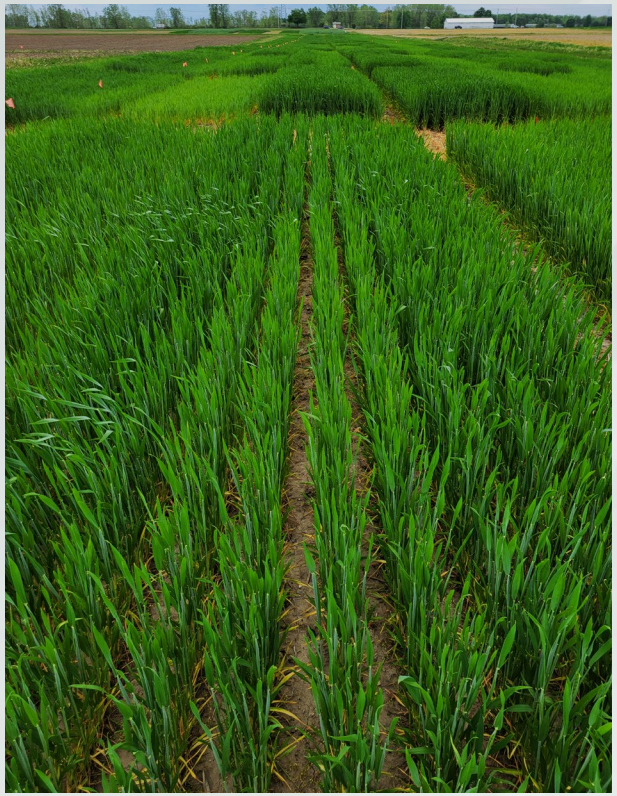


Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

Base Spring Nitrogen (100 lb/A)

SRWW – Red Dragon



No Autumn Starter

Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

High Spring Nitrogen (150 lb/A)

SRWW – Red Dragon

No Autumn Starter

Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

Low Spring Nitrogen (60 lb/A)

SWWW – AC Mountain

No Autumn Starter

Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

Base Spring Nitrogen (120 lb/A)

SWWW – AC Mountain

No Autumn Starter

Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

High Spring Nitrogen (180 lb/A)

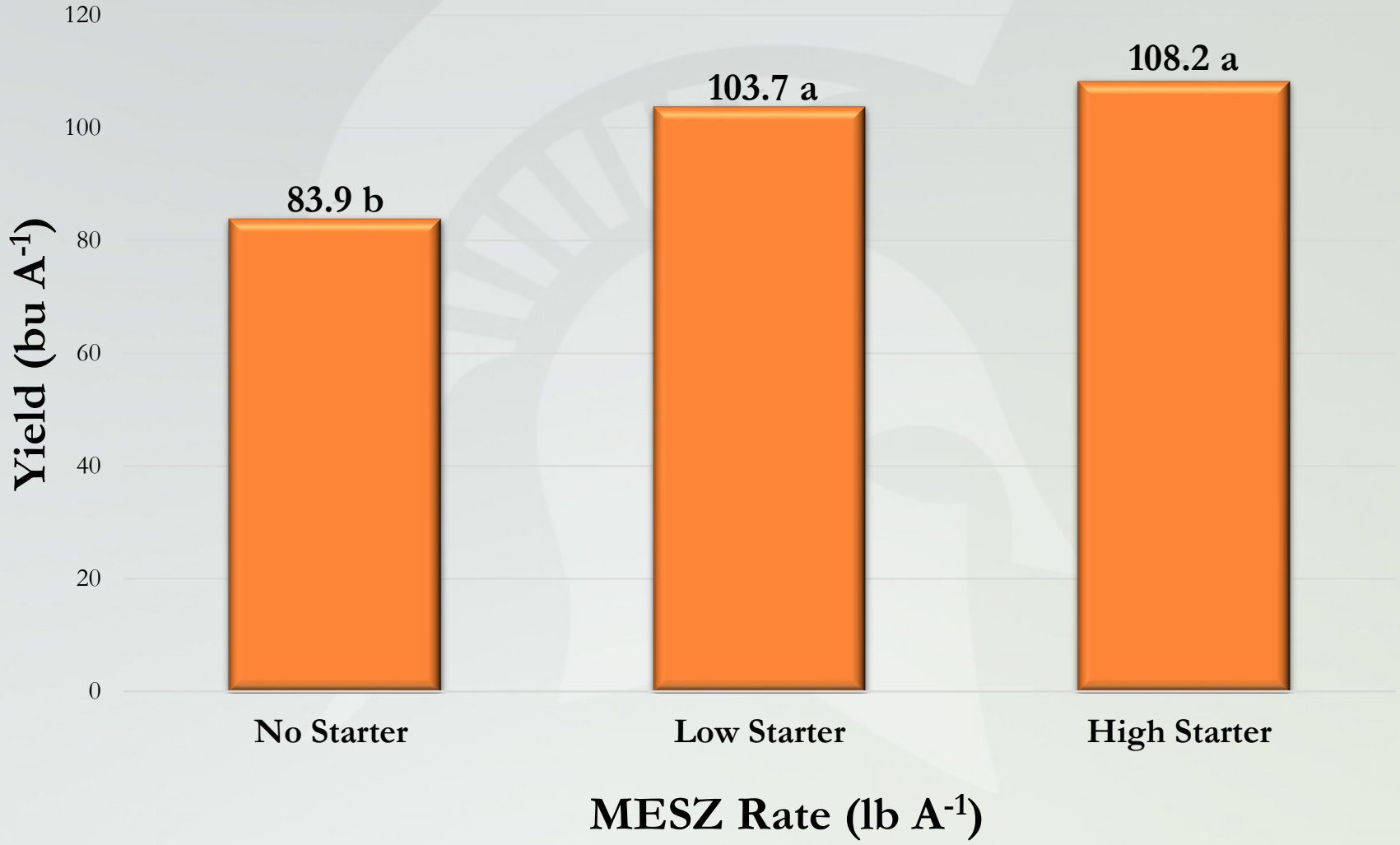
SWWW – AC Mountain

No Autumn Starter

Low Autumn Starter (125 lb/A)

High Autumn Starter (250 lb/A)

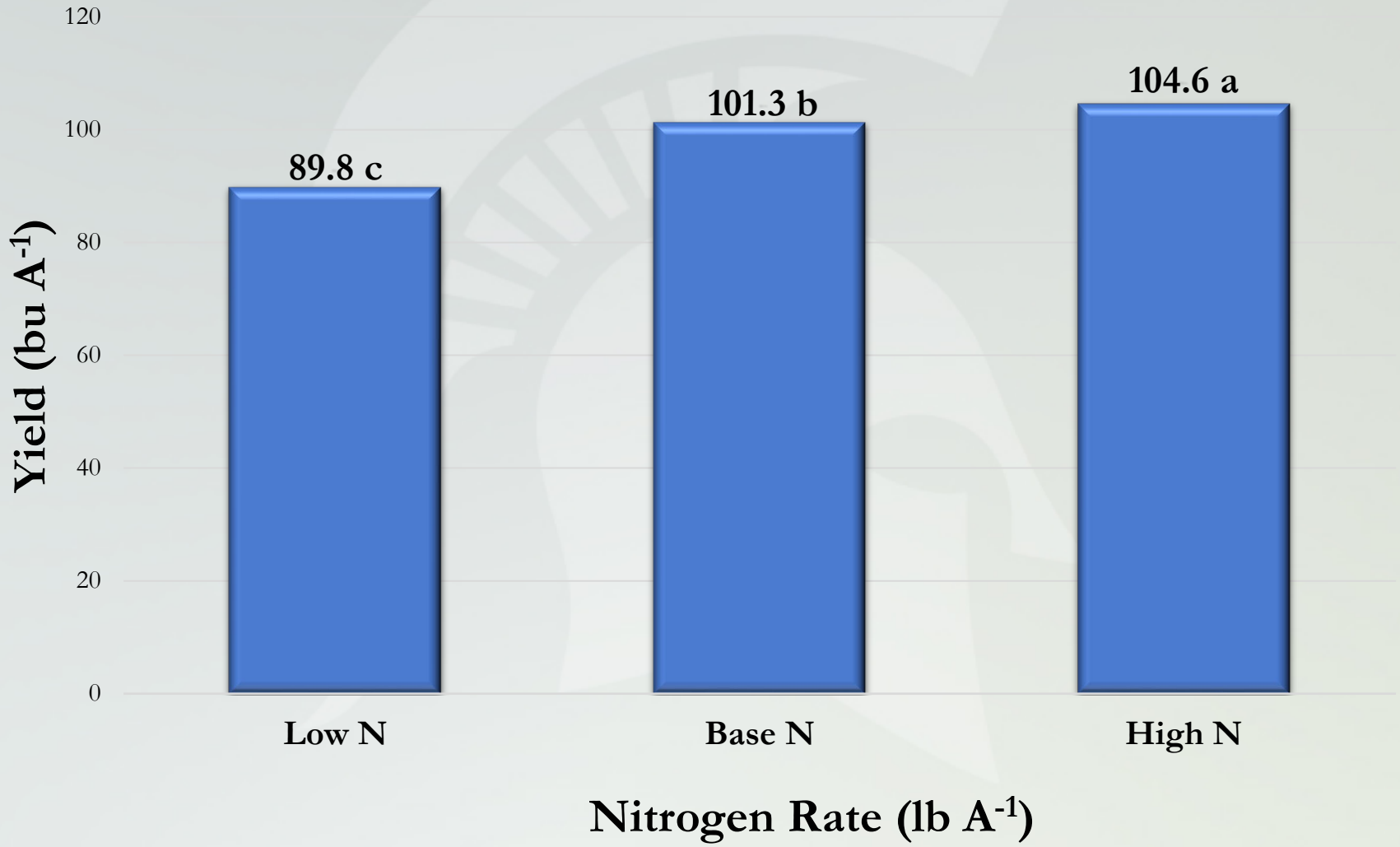
Jupiter SWWW Grain Yield as Affected by Autumn Fertilizer (bu A^{-1})



P < 0.01

Check: 52.3

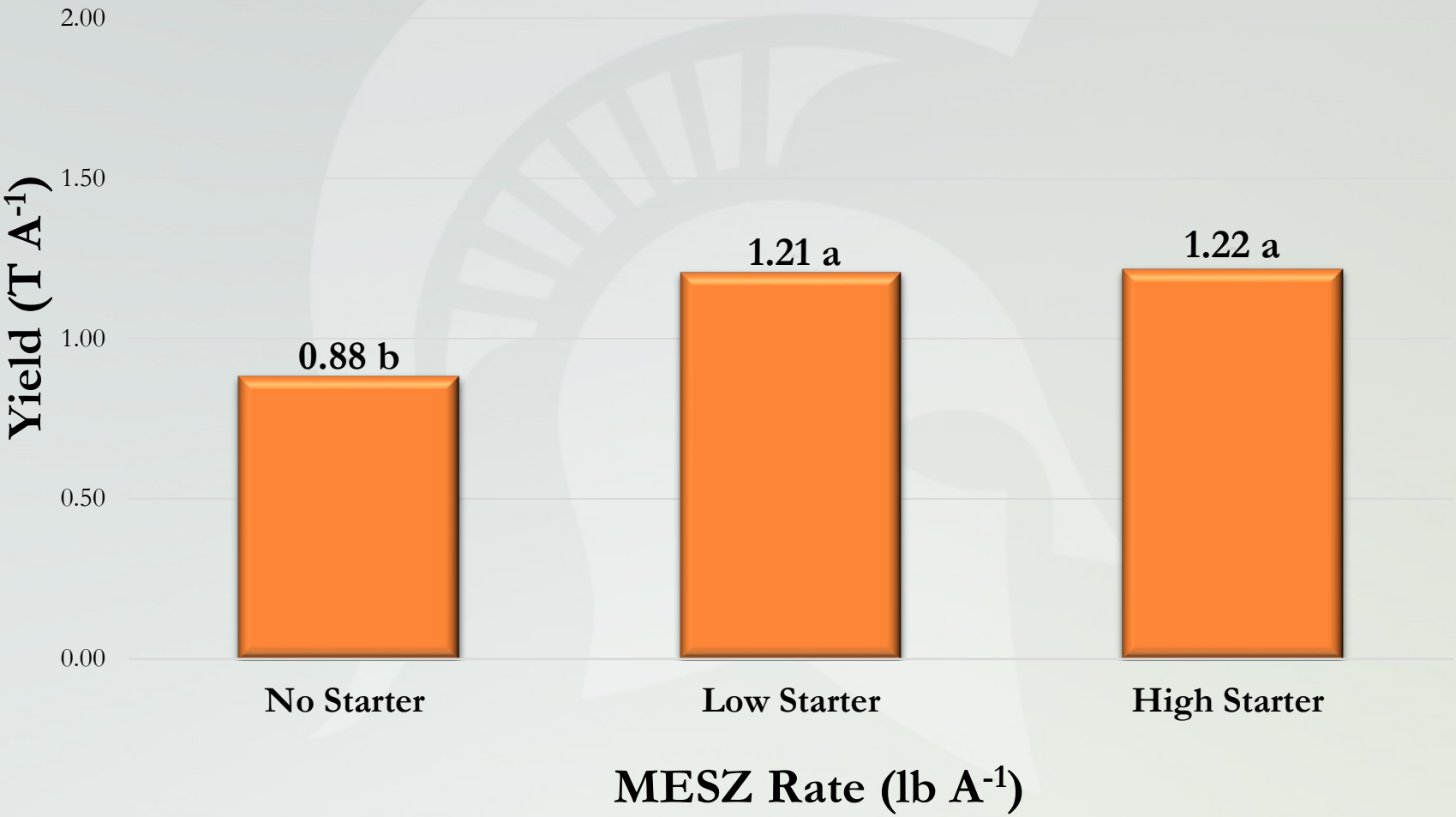
Jupiter SWWW Grain Yield as Affected by Spring Nitrogen (bu A^{-1})



P < 0.01

Check: 52.3

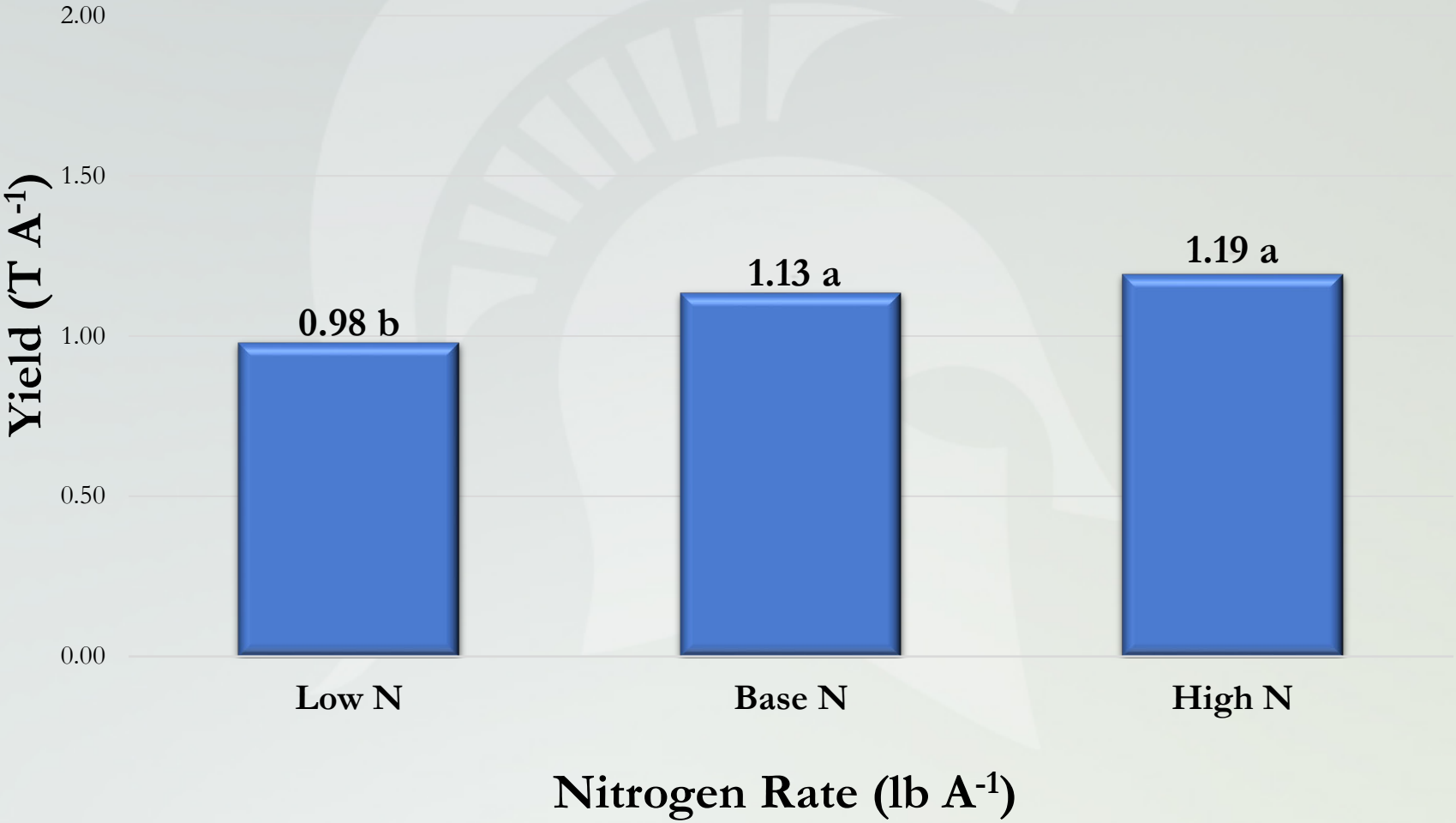
Jupiter SWWW Straw Yield as Affected by Autumn Fertilizer (T A^{-1})



P < 0.01

Check: 0.58

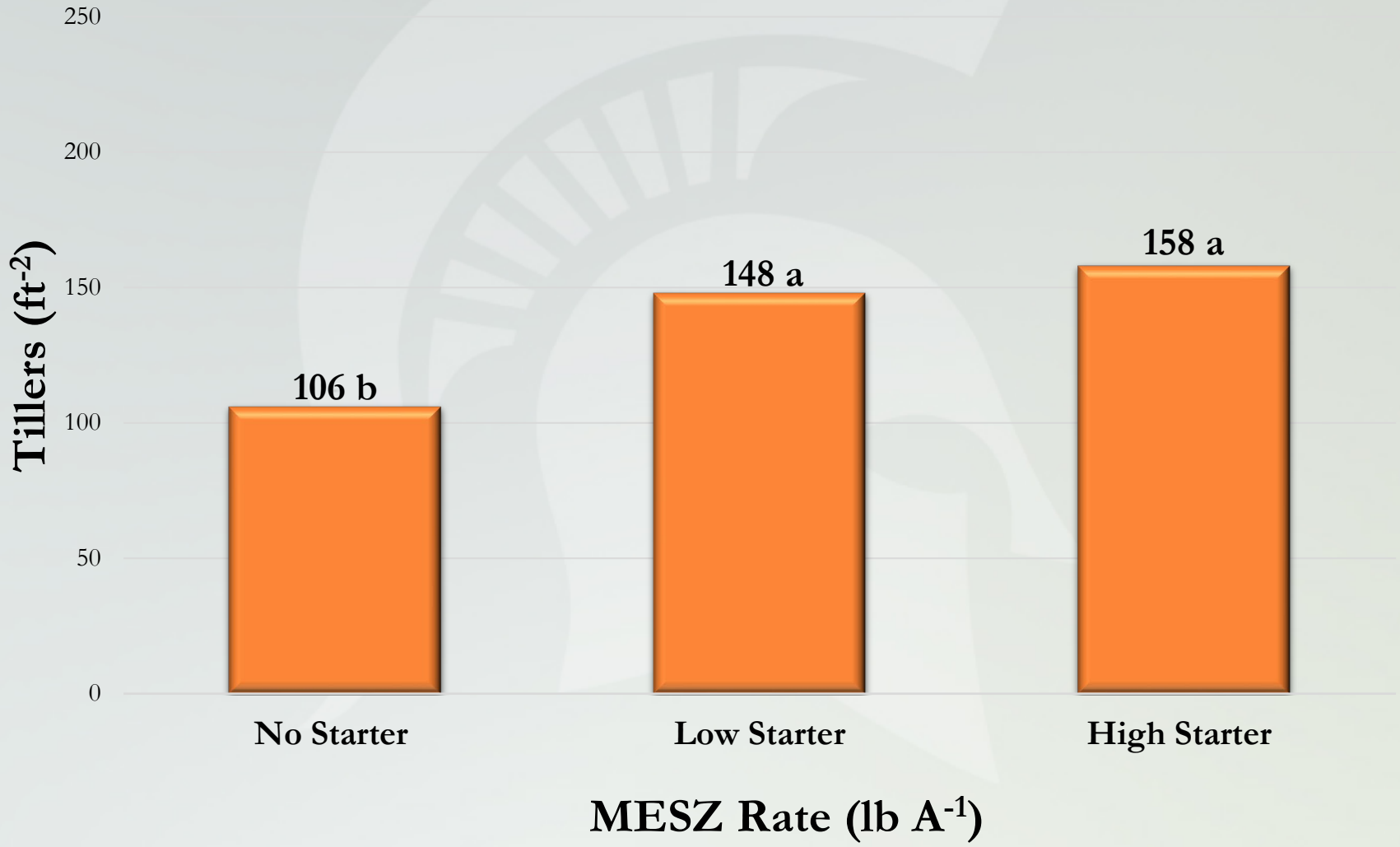
Jupiter SWWW Straw Yield as Affected by Spring Nitrogen (T A^{-1})



P < 0.01

Check: 0.58

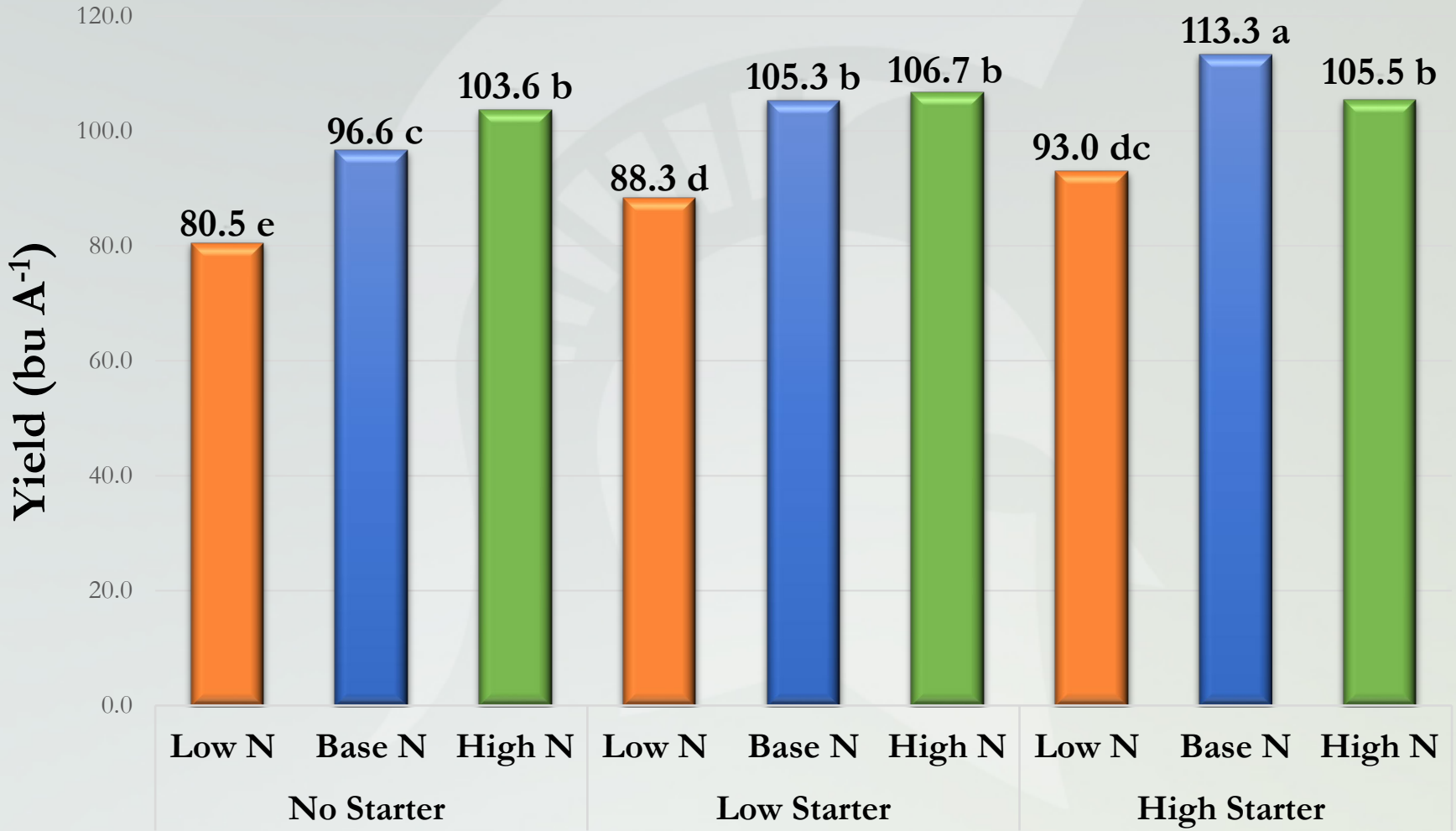
Jupiter SWWW Tiller Count as Affected by Autumn Fertilizer (ft^{-2})



P < 0.01

Check: 98.3

AC Mountain SRWW Grain Yield as Affected by Starter Fertilizer (bu A^{-1})

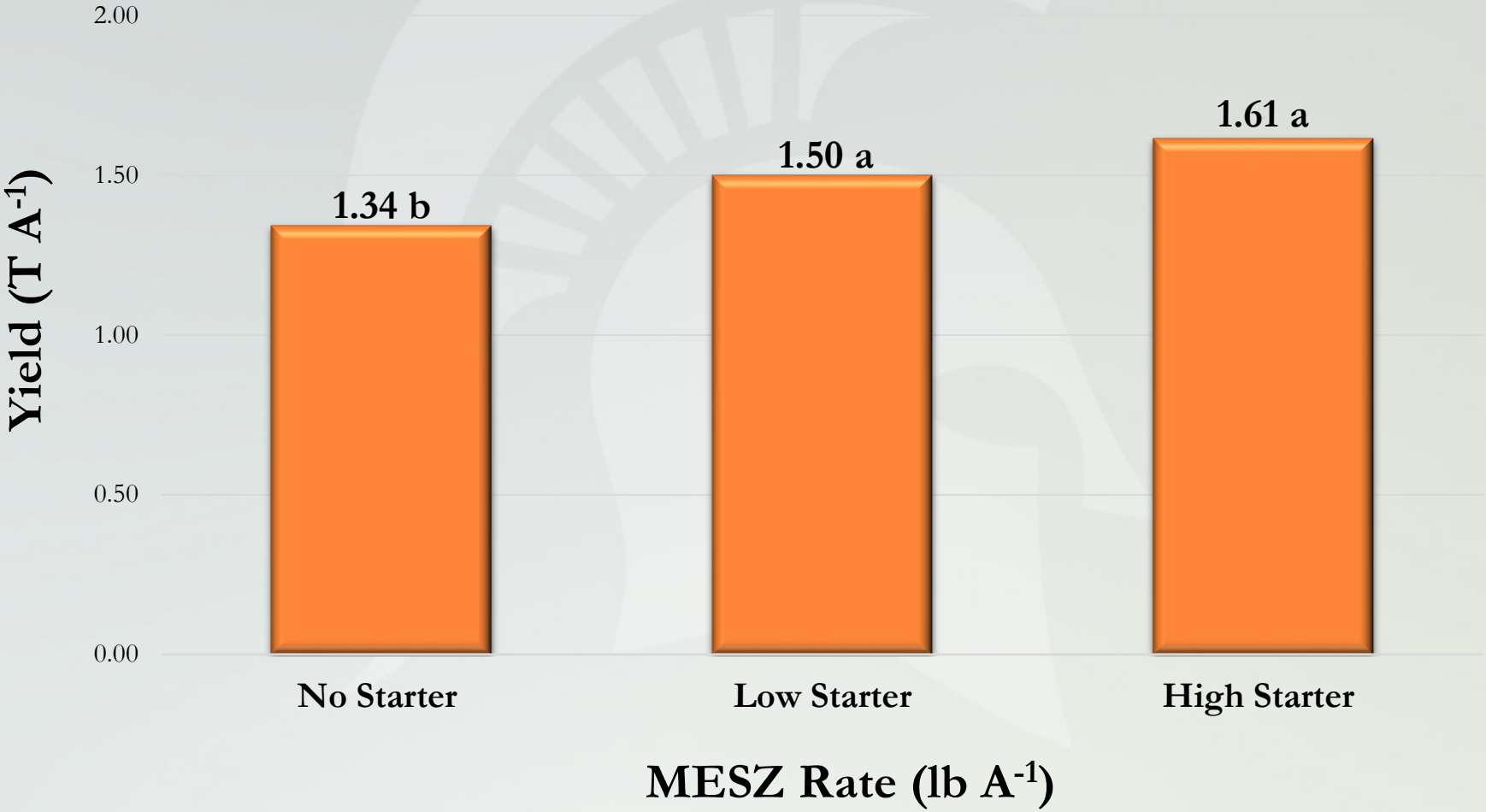


P = 0.06

MESZ Rate (lb A^{-1})

Check: 48.0

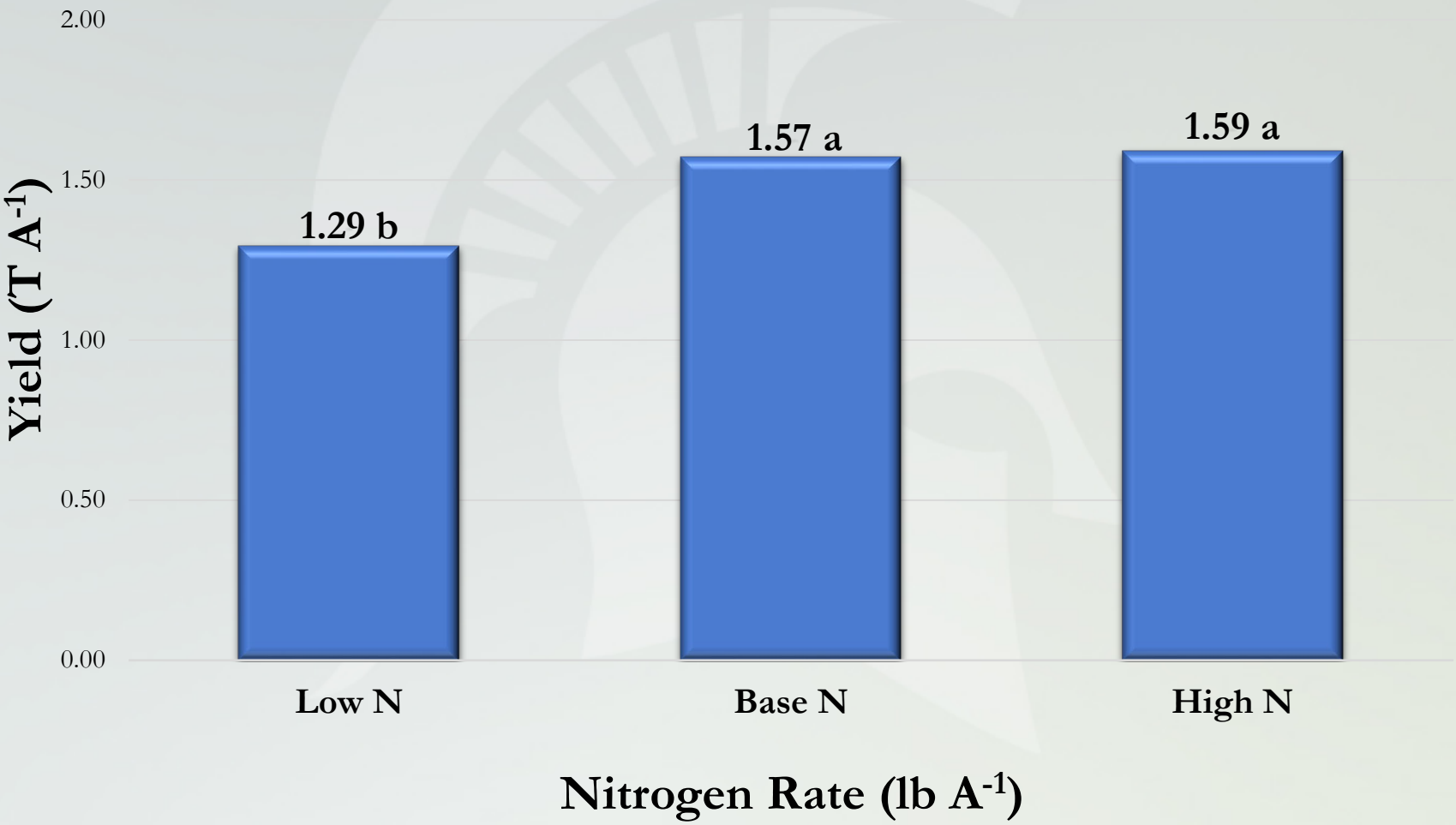
AC Mountain SWWW Straw Yield as Affected by Autumn Fertilizer (T A^{-1})



P = 0.03

Check: 0.80

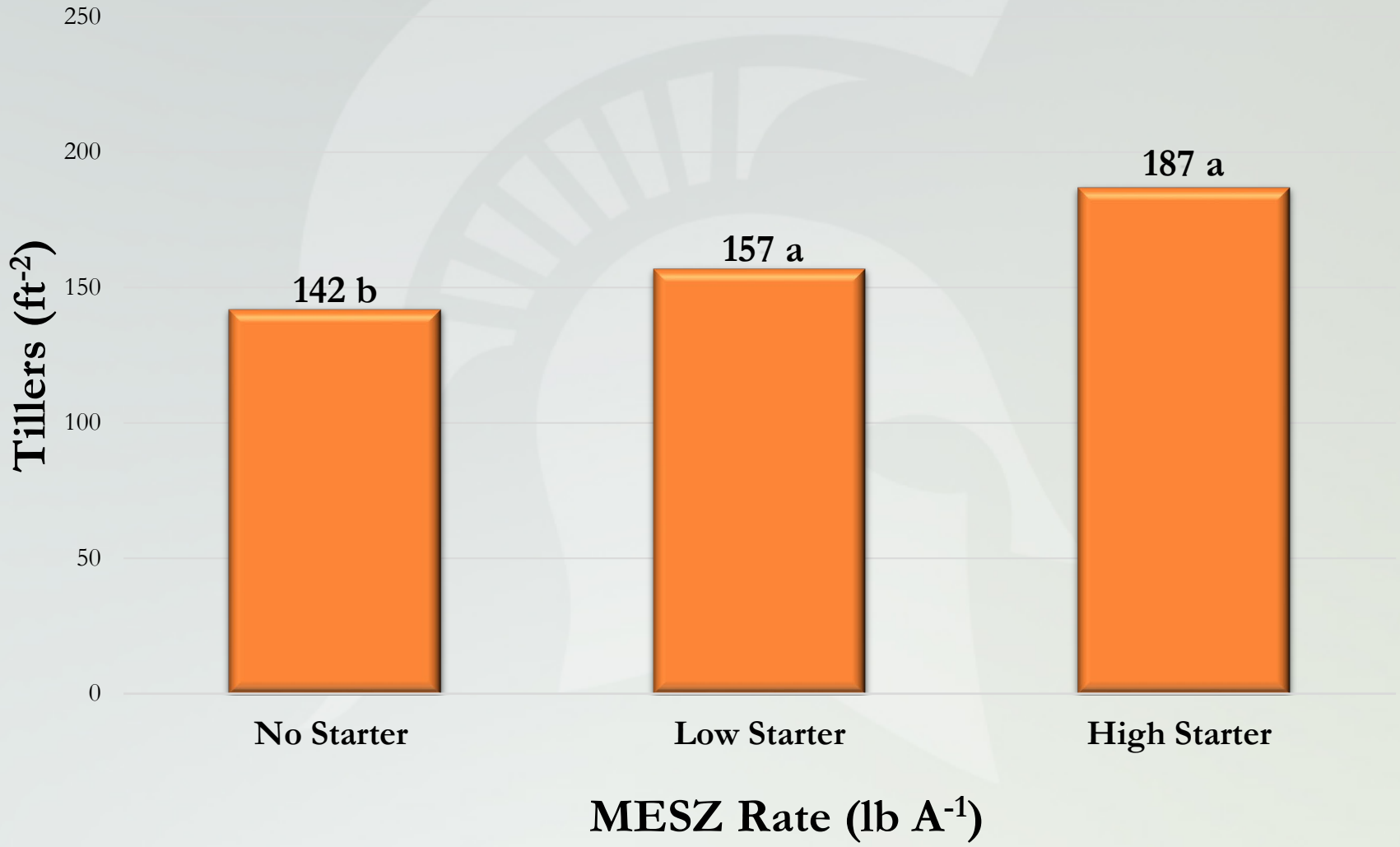
AC Mountain SWWW Straw Yield as Affected by Spring Nitrogen (T A^{-1})



P < 0.01

Check: 0.80

AC Mountain SWWW Tiller Count as Affected by Autumn Fertilizer (ft^{-2})



P = 0.03

Check: 136

Plant Height as Affected by Autumn Starter & Spring N

Treatment	Flipper	Treatment	Red Dragon	Jupiter	AC Mountain
No Starter, Low N	67.75 c †	No Starter	77.93 b	63.88 b	74.19 b
No Starter, Base N	71.60 a	Low Starter	82.55 a	70.26 a	77.12 a
No Starter, High N	68.80 bc	High Starter	83.74 a	72.14 a	78.93 a
Low Starter, Low N	73.02 a	*Pr > F*	=0.01	< 0.01	=0.03
Low Starter, Base N	71.50 ab				
Low Starter, High N	72.63 a	Low N	77.20 b	67.29 b	75.57 b
High Starter, Low N	72.45 a	Base N	83.12 a	69.40 a	77.24 a
High Starter, Base N	71.15 ab	High N	83.90 a	69.59 a	77.43 a
High Starter, High N	71.57 ab	*Pr > F*	< 0.01	< 0.01	=0.01
Check‡	58.20				
$P_r > F$	=0.04	Check‡	63.08	60.38	61.50

Straw Nutrient Removal as Affected by Autumn Starter & Spring N – 'Flipper' SRWW

Treatment	K_2O	Sulfur	Treatment	P_2O_5	Nitrogen
	----------lbs T^{-1}----------				
Low Starter, Base N	20.59 cd †	0.70 ed	Low Starter	2.53 c	8.75 b
Low Starter, High N	23.25 b	0.80 cd	High Starter	3.03 b	9.25 b
Low Starter, Low N	21.23 cbd	0.80 cd	No Starter	4.41 a	10.06 a
High Starter, Base N	21.85 cb	0.90 cb	*Pr > F*	< 0.01	= 0.04
High Starter, High N	25.96 a	1.25 a			
High Starter, Low N	20.63 cd	0.95 b	Base N	2.83 b	8.95 b
No Starter, Base N	20.95 cd	0.65 e	High N	4.08 a	11.13 a
No Starter, High N	19.86 cd	0.59 e	Low N	3.06 b	7.97 c
No Starter, Low N	19.16 d	0.60 e	*Pr > F*	< 0.01	< 0.01
Check‡	18.19	0.95			
$P_r > F$	=0.06	< 0.01	Check‡	4.03	7.21

Straw Nutrient Removal as Affected by Autumn Starter & Spring N – 'Red Dragon' SRWW

Treatment	P_2O_5	Nitrogen	K_2O	Treatment	Sulfur
	---------lbs T^{-1}----------				
Low Starter, Base N	1.61 d †	7.6 bcd	19.26 b	Low Starter	0.75 b
Low Starter, High N	1.96 bdc	8.45 bc	19.36 b	High Starter	0.85 a
Low Starter, Low N	1.96 bdc	7.85 fe	15.72 c	No Starter	0.53 c
High Starter, Base N	2.53 a	8.8 b	19.32 ab	*Pr > F*	< 0.01
High Starter, High N	2.30 bac	8.6 b	17.64 bc		
High Starter, Low N	1.96 bcd	6.6 cd	21.3 a	Base N	0.68 b
No Starter, Base N	2.56 a	7.95 bc	19.62 ab	High N	0.77 a
No Starter, High N	2.46 ba	10.95 a	18.00 b	Low N	0.68 b
No Starter, Low N	1.84 d	5.95 d	17.76 b	*Pr > F*	=0.14
Check‡	3.56	7.20	17.34		
$P_r > F$	=0.09	=0.07	< 0.01	Check‡	0.80

Straw Nutrient Removal as Affected by Autumn Starter & Spring N – 'Jupiter' SWWW

Treatment	P_2O_5	Nitrogen	K_2O	Sulfur
	----------lbs T^{-1}----------			
Low Starter	1.69 ba†	6.94	25.66	0.71 b
High Starter	1.95 a	6.38	25.08	0.80 a
No Starter	1.48 b	5.93	24.36	0.58 c
Pr > F	< 0.01	NS	NS	< 0.01
Base N	1.48 b	6.36	24.50 b	0.66
High N	1.81 a	6.51	28.47 a	0.72
Low N	1.83 a	6.38	22.13 c	0.70
Pr > F	=0.10	NS	< 0.01	NS
Check‡	4.37	6.75	24.12	1.15

Straw Nutrient Removal as Affected by Autumn Starter & Spring N – 'AC Mountain' SWWW

Treatment	P_2O_5	Nitrogen	K_2O	Sulfur
	----------lbs T^{-1}----------			
Low Starter	1.27 b†	6.47	23.22	0.70 b
High Starter	1.61 a	7.01	23.56	0.88 a
No Starter	1.15 b	6.48	22.02	0.62 c
Pr > F	=0.07	NS	NS	< 0.01
Base N	1.23	6.55 b	23.00 b	0.72
High N	1.42	7.58 a	26.88 a	0.77
Low N	1.38	6.20 b	18.92 c	0.72
Pr > F	NS	< 0.01	< 0.01	NS
Check‡	4.03	6.85	20.10	1.40

Preliminary Conclusions – 'Flipper' SRWW

- Grain Yield
  - Low starter yielded equal or better than high starter
- Straw Yield
  - High starter + low N > no starter high N
- Tiller Production
  - NS
- Plant Height
  - Autumn starter, spring N interacted
  - Plant height increased with addition of autumn starter
- Head Length
  - Addition of autumn starter & spring N increased head length
- Head Count
  - Increased with addition of autumn starter

Preliminary Conclusions – 'Red Dragon' SRWW

- Grain & Straw Yield
  - Autumn starter increased grain yield 17-21 bu A^{-1}, respectively
  - Autumn starter increased straw yield 0.34-0.46 T A^{-1}, respectively
- Tiller Production
  - High autumn starter > low autumn starter
- Plant Height
  - Plant height increased with addition of autumn starter
- Head Length
  - Spring N increased head length
- Head Count
  - Increased with addition of autumn starter

Preliminary Conclusions – 'Jupiter' SWWW

- Grain & Straw Yield
  - Autumn starter increased grain yield 20-24 bu A^{-1}, respectively
  - Autumn starter increased straw yield 0.34 T A^{-1}, respectively
- Tiller Production
  - No significant difference in low vs. high starter
- Plant Height
  - Plant height increased with addition of autumn starter
- Head Length
  - Addition of autumn starter & spring N increased head length
- Head Count
  - Increased with addition of autumn starter

Preliminary Conclusions – 'AC Mountain' SWWW

- Grain & Straw Yield
  - High starter + base N > no starter + high N
  - High N rate NS across all starter rates
  - Autumn starter increased straw yield → NSD between low & high rate
- Tiller Production
  - No significant difference in low vs. high starter
- Plant Height
  - Plant height increased with addition of autumn starter
- Head Length
  - Autumn starter increased head length
  - High spring N > Base spring N > Low spring N
- Head Count
  - Increased head production with high autumn starter

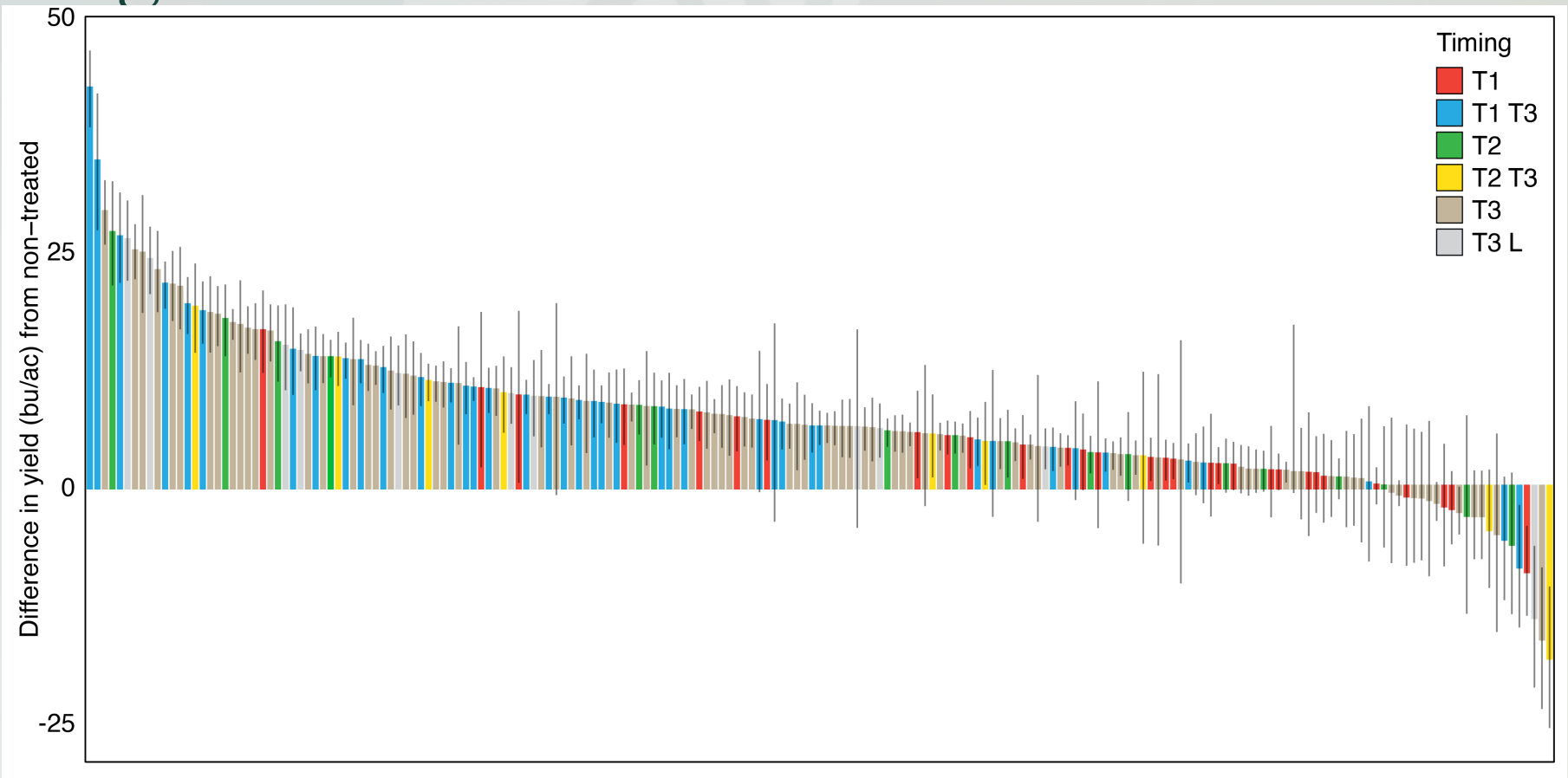
Summary

- Autumn practices are NOT only tied to grain yield
  - Straw production also influenced
  - This factors into cost of starter and profit (in progress)
- High spring N did not compensate for lack of autumn starter
  - Varietal (stature) differences
- Plant height increased with autumn starter across all varieties
  - Direct impact on variety selection for straw production
- Pre-plant soil test levels crucial to determining plant response

2022 Proposed Soil Fertility Wheat Research

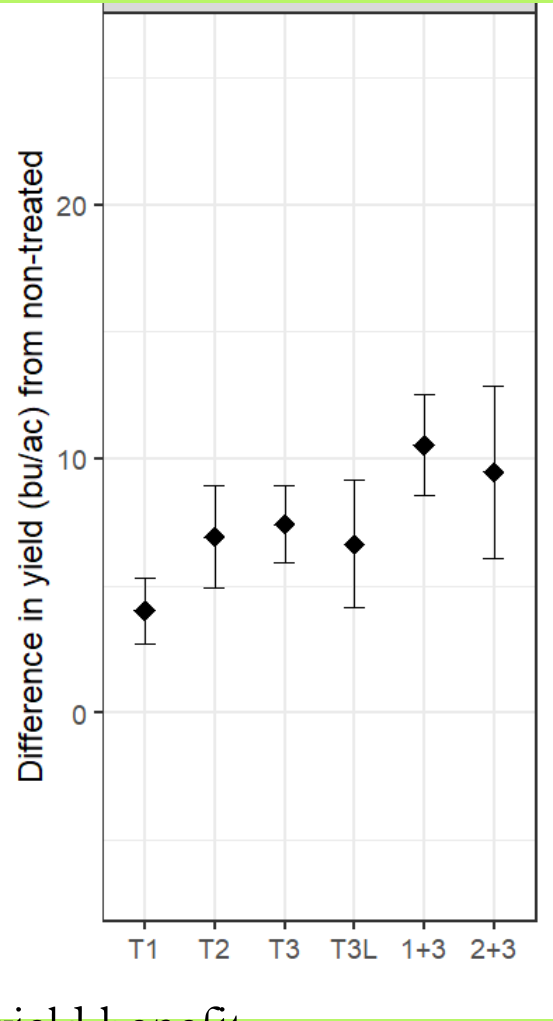
- Fertilizer, Fungicide, and Food: Improving Wheat Yield, Straw, and Quality
  - Up to Three Projects/Locations
    - Non-irrigated soft red, irrigated soft red, non-irrigated soft white
  - **Collaboration between Marty Chilvers (Plant Path.) and myself (Soil Fertility)**
  - Builds on results form BOTH programs from last 4-6 years
    - 10-37 bu/A yield increases with starter when soil nitrate < 10 ppm
    - Increased grain AND straw with starter helps offset cost and improves profitability
    - Meta-analysis (in review) found:
      - 10.5 bu/A increase with F5-7 app and F10.5.1 app
      - 4 bu/A increase with F5-7 alone

Meta-analysis of 93 individual studies on difference in grain yield between fungicide treated and non-treated wheat



Meta-Analysis of yield response to fungicide

Timing	Yield response bu/ac ($\bar{D}_t$)	Among-study variance $\hat{\sigma}^2$
T1	4.01 A	8.65
T2	6.93 B	37.16
T3	7.41 B	40.79
T3_L	6.65 B	31.72
T1_T3	10.53 C	60.76
T2_T3	9.48 CB	64.14



- On average, all application timings provided significant yield benefit
- T1 provided the least benefit
- Combination treatments provided highest benefit on average, but also largest variance

2022 Proposed Soil Fertility Wheat Research

- Fertilizer, Fungicide, and Food: Improving Wheat Yield, Straw, and Quality
  - Treatments to include:
    - 2 starter fertilizer rates (0 and 250 lb./A (12-40-0-10)
    - 5 fungicide application timings
      - None
      - F5-7 and F10.5.1
      - F10.5.1 individually
      - F9 and F10.5.1
      - F5-7 plus F9 plus F10.5.1
    - 2 late season applied N rates (0 and 40 lb N/A)
  - 3 separate environments

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2022 Proposed Soil Fertility Wheat Research

- Fertilizer, Fungicide, and Food: Improving Wheat Yield, Straw, and Quality
  - **Objective . Determine whether starter fertilizer, multiple fungicide application timings, and late-applied N influence wheat grain yield, straw production, and grain quality.**
  - ***Hypothesis:*** autumn-applied starter fertilizer with low soil nitrate levels will influence fungicide application timings which in turn may affect response to late-season N and affect **wheat grain yield, straw production, and quality (protein, nutritive value).**
  - The overall plant growth response may also be able to address climate variability related production issues.

2022 Proposed Soil Fertility Wheat Research

- Fertilizer, Fungicide, and Food: Improving Wheat Yield, Straw, and Quality
- **MWP Priorities Addressed in proposal:**
  - Improve the efficiency and management of N fertilizer
  - Identify plant nutrients limiting grain yields
  - Identify difference in varietal responses to agronomic inputs
  - Develop network of cooperators for on-farm research
  - Identify varieties and practices advantageous to growers with marginal soils
  - Evaluate the efficacy of fungicides, herbicides, and insecticides
  - Develop management strategies to mitigate losses due to pests
  - Evaluate the interaction of pesticides, varieties, and agronomic practices
  - Develop strategies to manage FHB to ensure a quality product for end users
- Matching funds match MWP request

2022 Proposed Soil Fertility Wheat Research

- Other Proposed Work:
  - Interactions Between Nutrient Management Strategies Across Varieties on Red and White Winter Wheat
  - Identifying One Management Practice to Initiate in Autumn
  - Balancing Cost and Profitability within Starter Fertilizer Programs
- On-Farm PGR Integration into Winter Wheat Management Systems

Thank you!

Michigan State University

Soil Fertility & Nutrient Management Research

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MICHIGAN WHEAT PROGRAM