NITROGEN MANAGEMENT

High-Yield and High-Protein Winter Wheat

Dr. Romulo Lollato

Extension Wheat Specialist

KANSAS STATE UNIVERSITY

LAYOUT

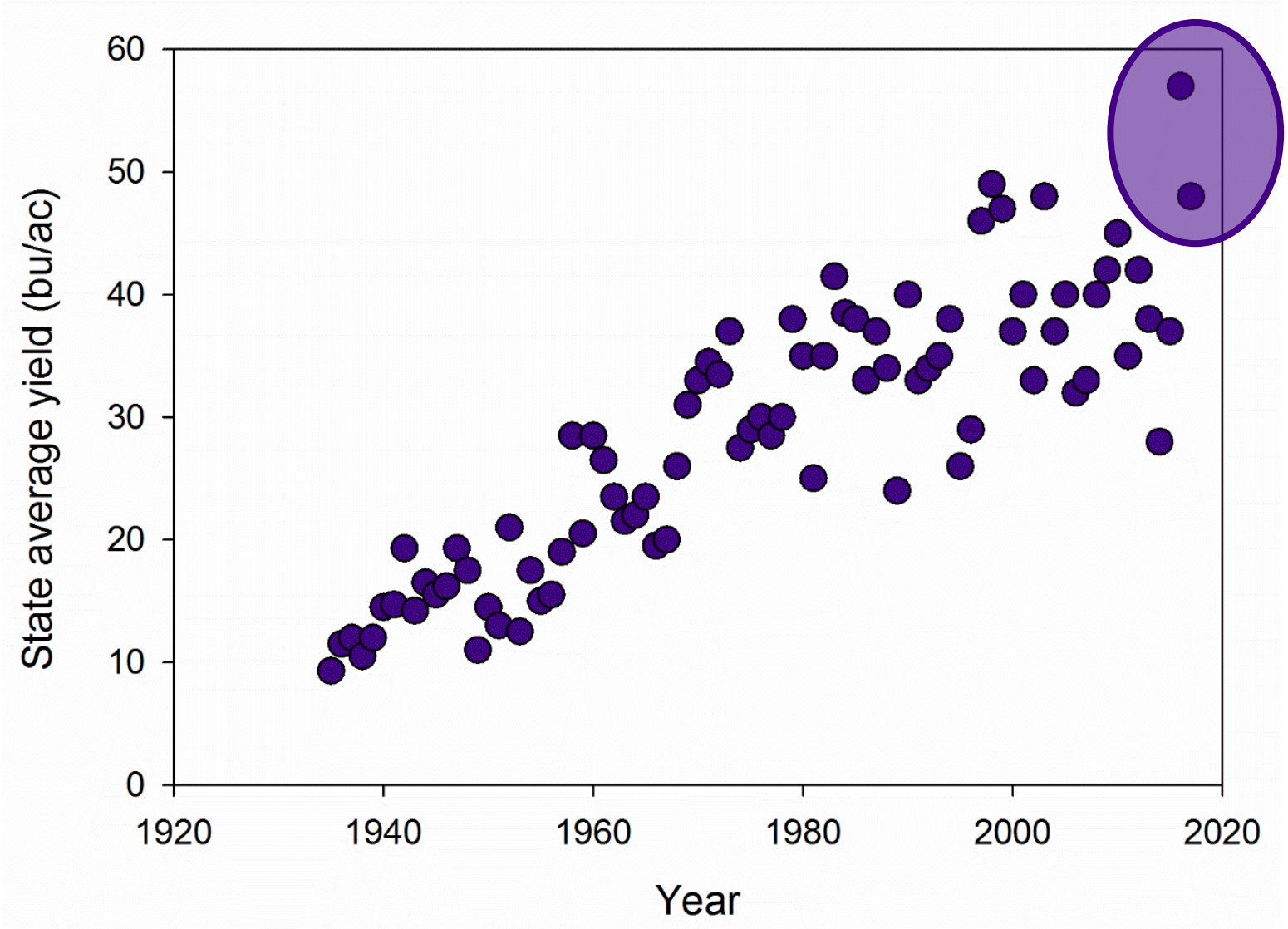
Project Background

Material and methods

Preliminary Results

PROJECT BACKGROUND

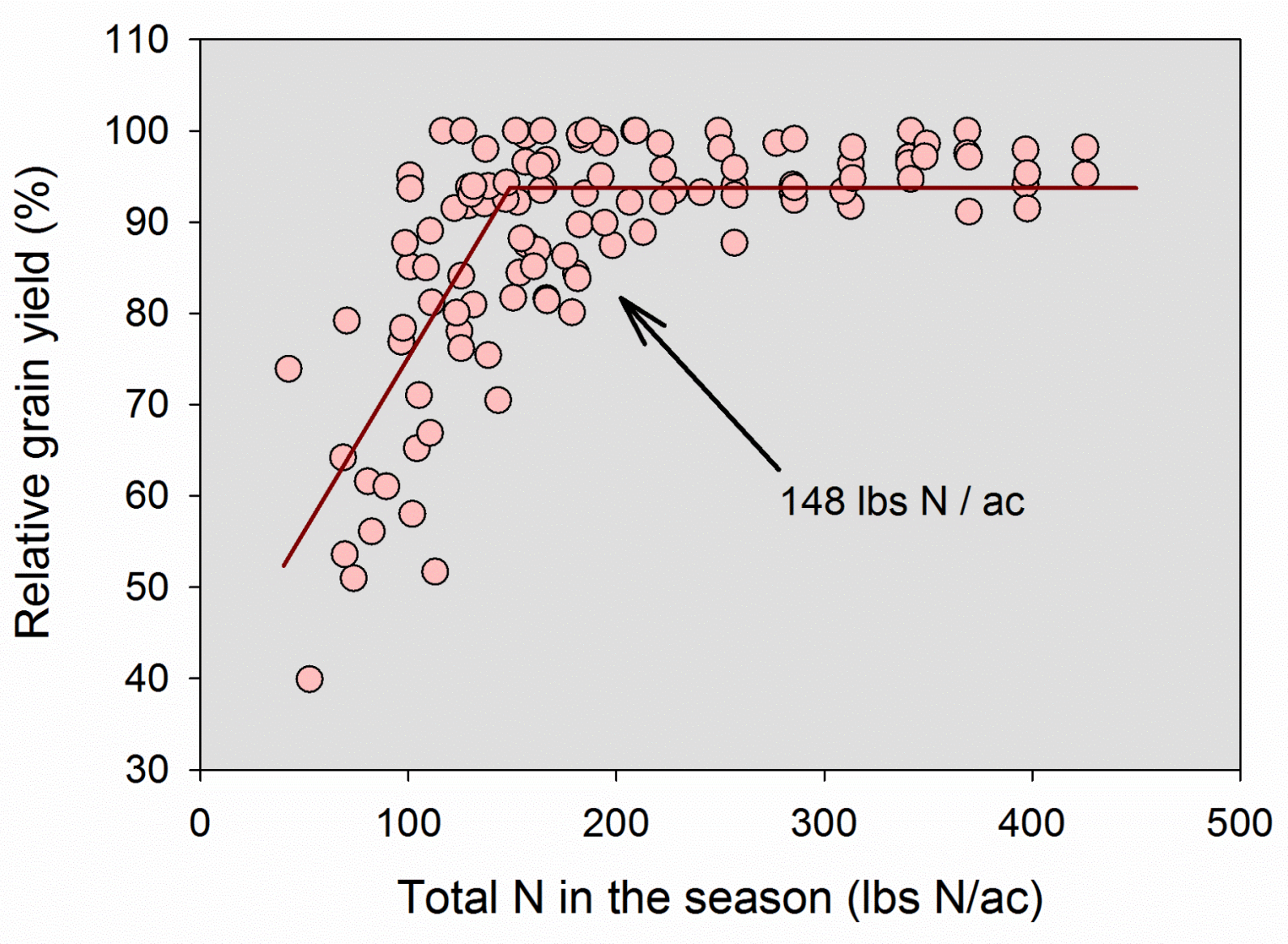
MARKETING WHEAT BASED ON PROTEIN

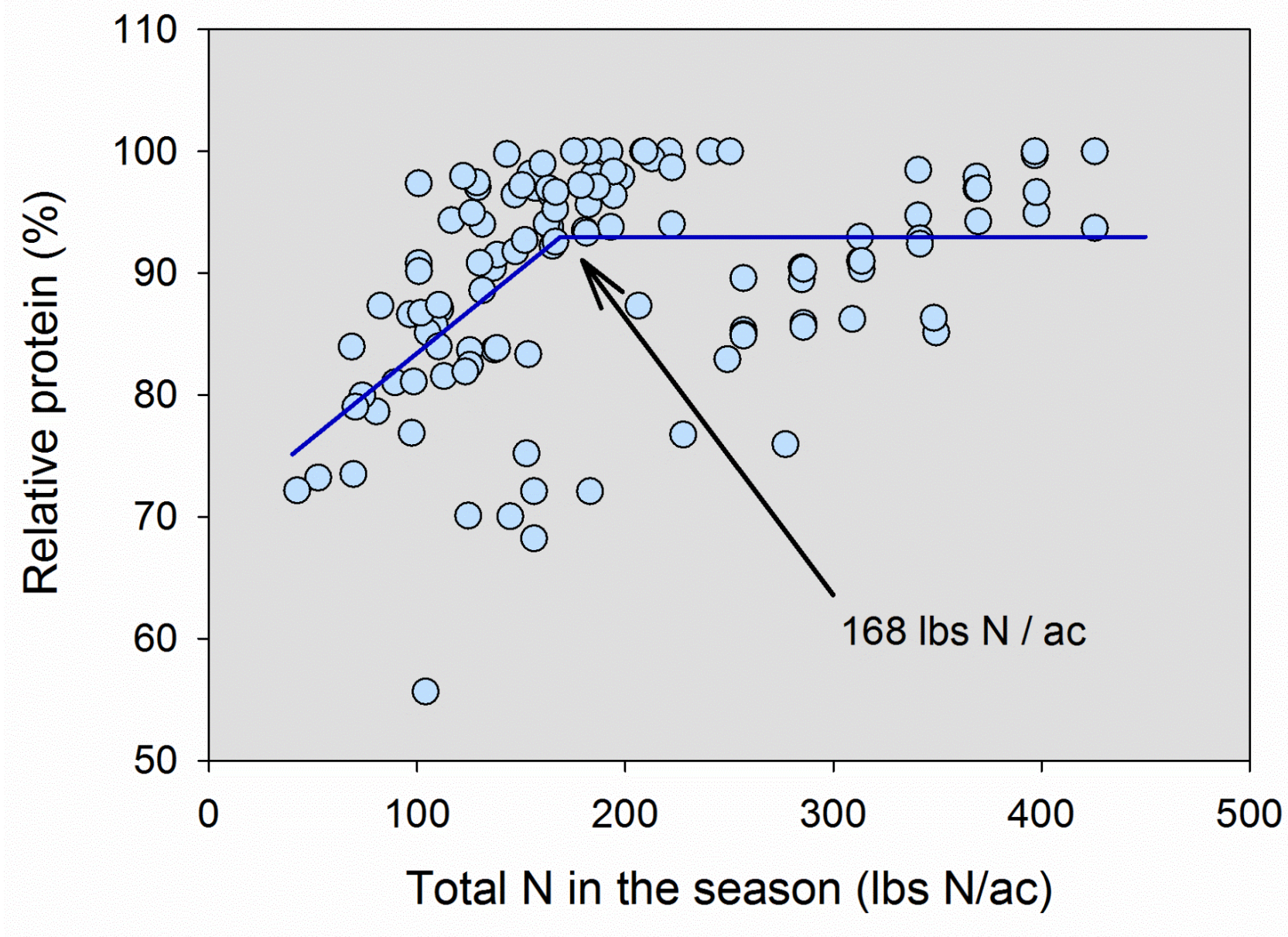


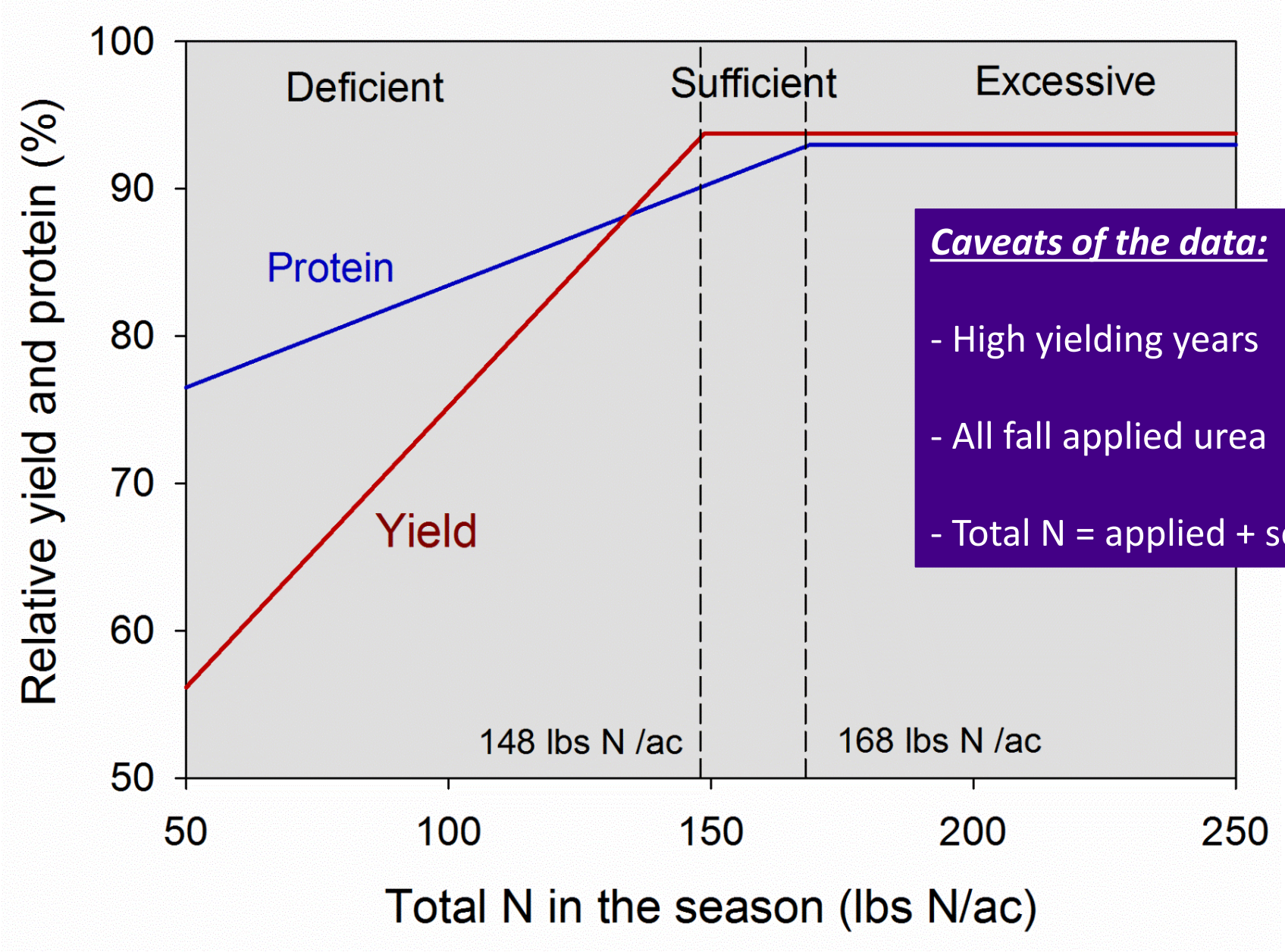
NITROGEN MANAGEMENT

- Nitrogen rate 0 to 150 lbs N/ac
- 10 locations 2 years
- Mean yield 64.5 bu/ac
- Mean protein 11.6%

Lewis® family bakers since 1925


110
100
90
80
70
60
50
40
30
Relative grain yield (%)
0
100
200
300
400
500
Total N in the season (lbs N/ac)
148 lbs N / ac


110
100
90
80
70
60
50
Relative protein (%)
0
100
200
300
400
500
Total N in the season (lbs N/ac)
168 lbs N / ac



Caveats of the data:

- High yielding years
- All fall applied urea
- Total N = applied + soil(NO_3 + NH_4)

OBJECTIVES

To test these thresholds (e.g. ~148.7 and ~168.9 lbs N/ac) across different varieties and N management strategies;

To determine the importance of N rate, timing, and variety on:

- Nutrient uptake and partitioning into plant components,
- Grain yield
- Grain protein concentration.

WINFIELD® UNITED

Fluid Fertilizer Foundation

MATERIAL AND METHODS

FIELD METHODOLOGY

Three locations Hutchinson, Belleville, and Manhattan

Two growing seasons 2017-18 and 2018-19

Treatment structure 3-way complete factorial + control

Split-split plot design 4 blocks

Previous crop Soybean

Plots size 5 x 40 ft

WINFIELD® UNITED

Fluid Fertilizer Foundation

26 TREATMENTS

Two varieties
- LCS Chrome (high protein)
- WB Grainfield (low protein)

Four N rates
- 0 control
- 148 lbs total N/ac (max. yield)
- 168 lbs total N/ac (max. protein)
- 188 lbs total N/ac (excessive)

Four N timings
- 100 Fall
- 100 Spring
- 40 Fall and 60 Spring
- 40 Fall, 50 Spring and 10 Anthesis

N sources
- UAN or Gradual-N (anthesis)

BIOMASS SAMPLING

Four timings
- Jointing
- Anthesis
- Soft dough
- Maturity

Partitioning
- Leaves
- Stem
- Head

Treatments
- 0 N control
- 188 N (Timing 40:60)
- 188 N (Timing 40:50:10)
- Both varieties

STATISTICAL ANALYSIS

Raw data by site-year

Three way ANOVA on SAS PROC GLIMMIX
Repeated measurement analysis (canopy cover and biomass)

Normalized using max. yield

Residuals of protein and grain yield

Residuals of biomass and N%

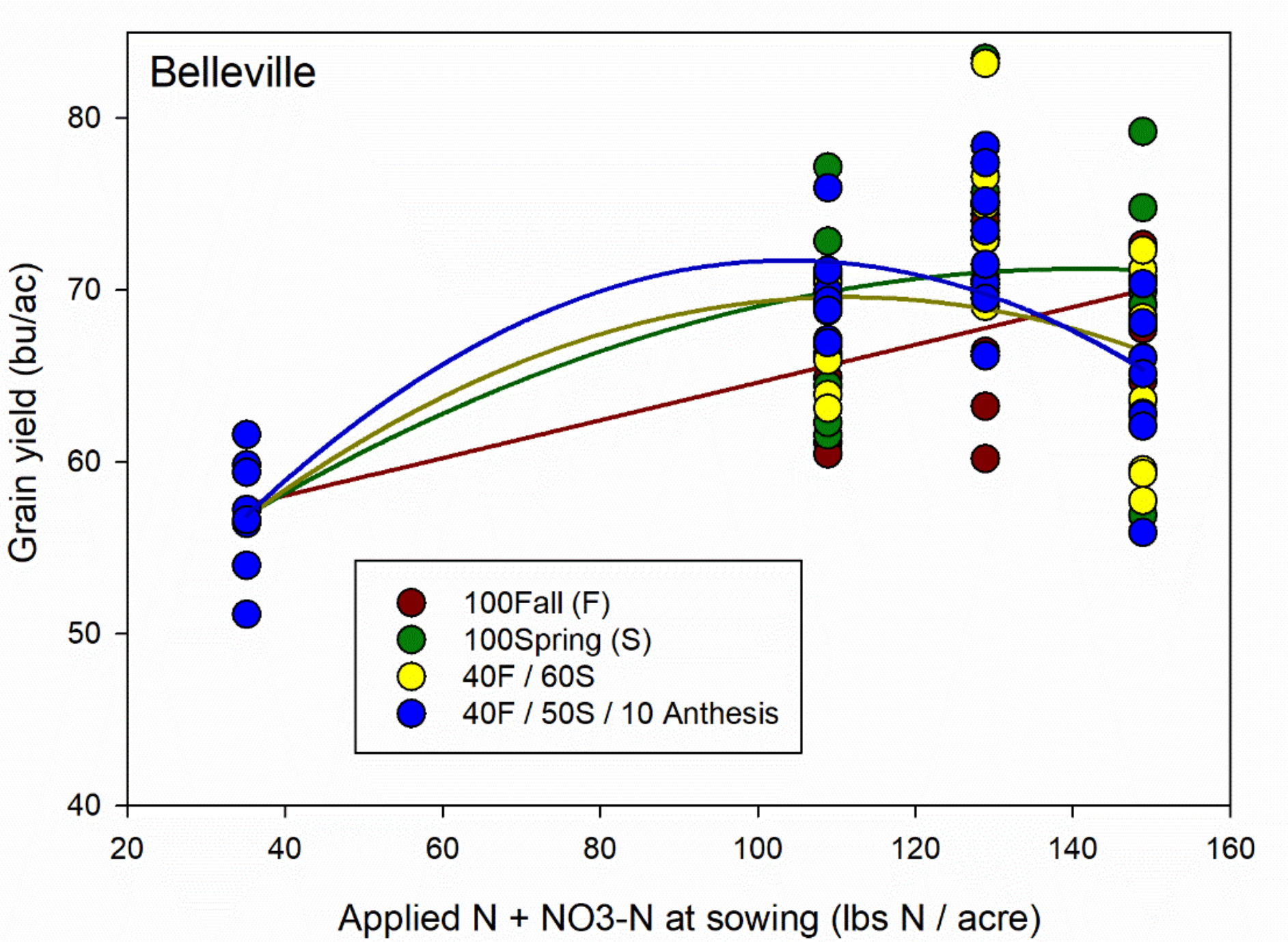
WINFIELD® UNITED

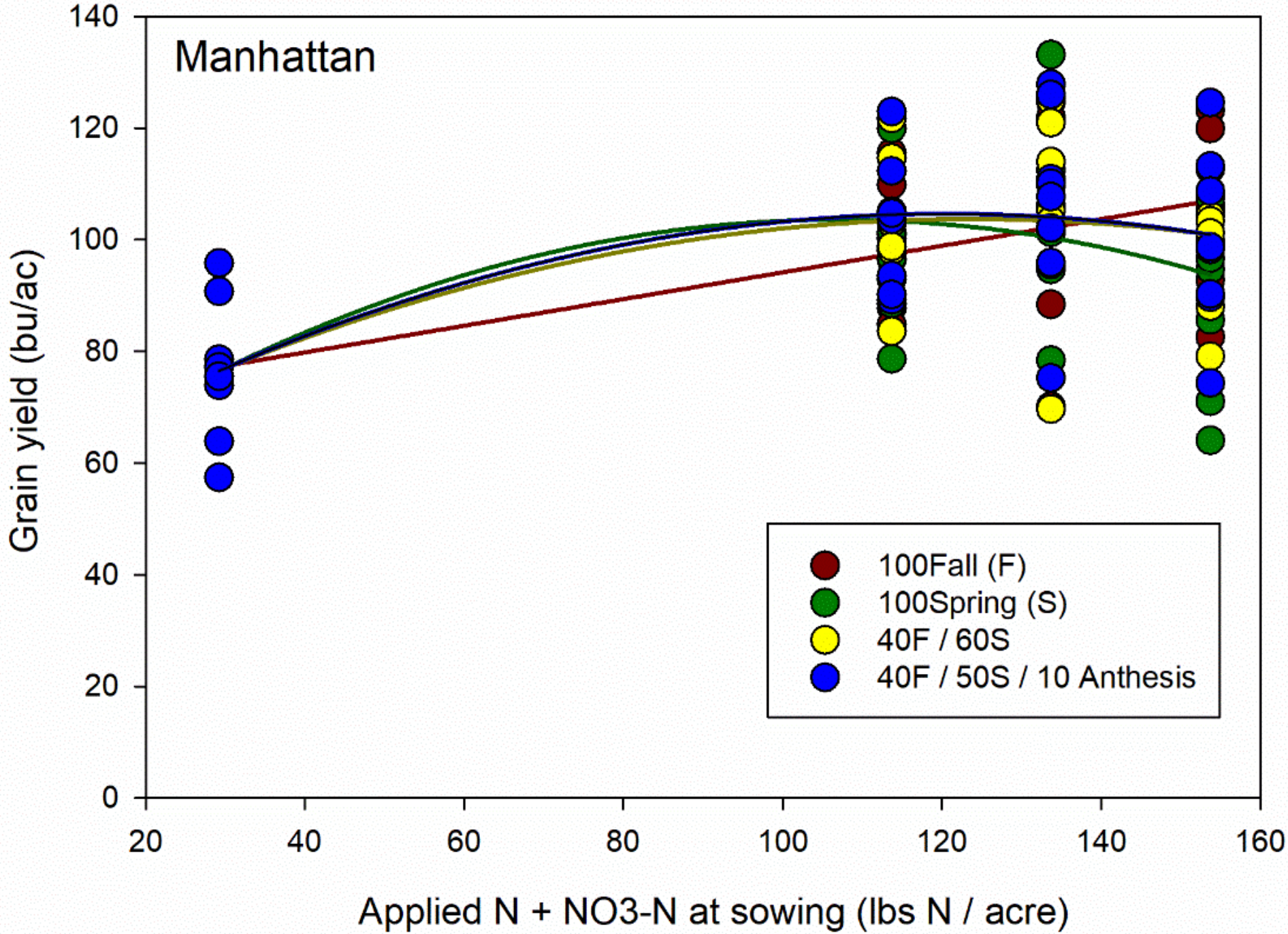
Fluid Fertilizer Foundation

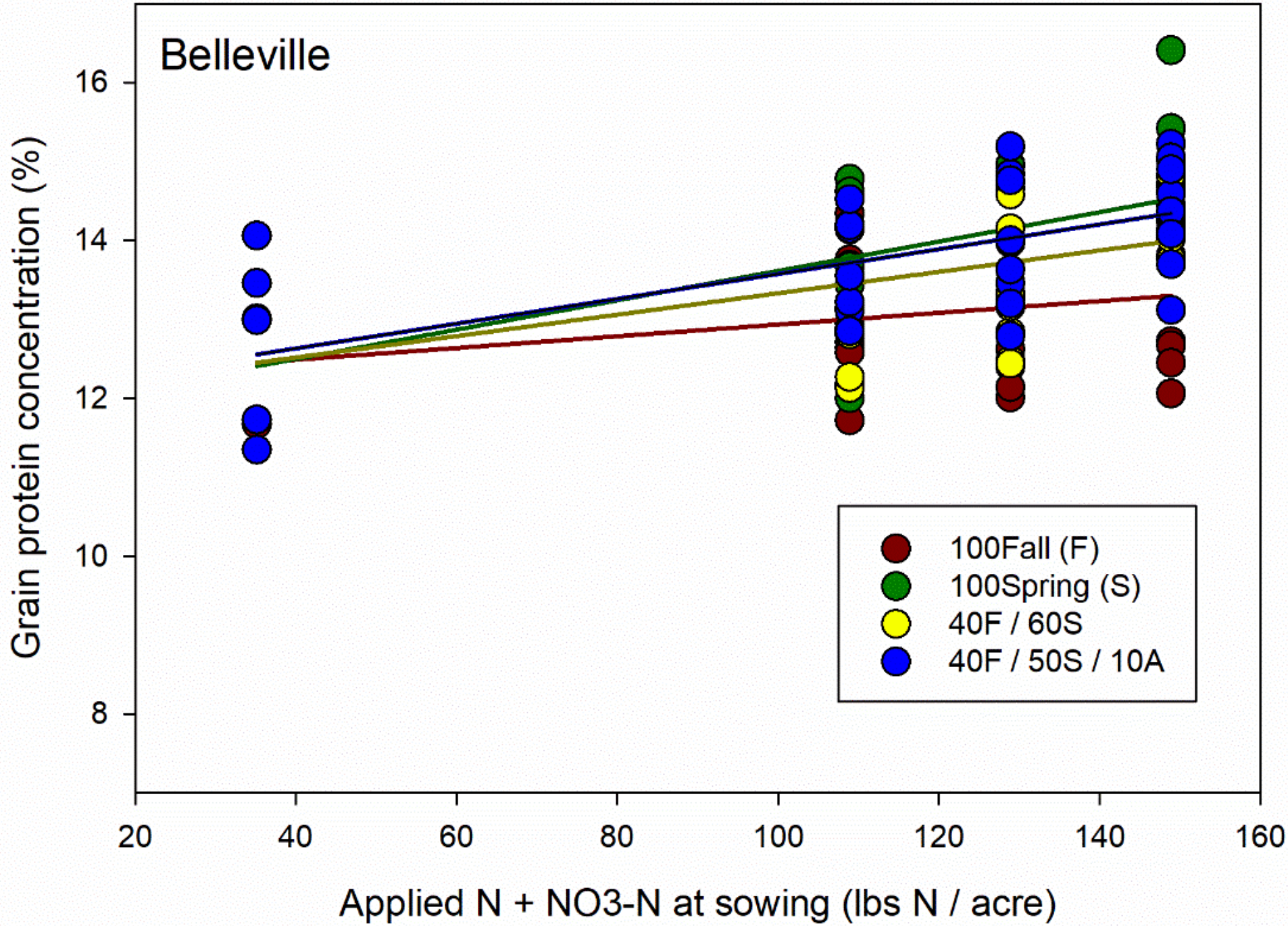
PRELIMINARY RESULTS

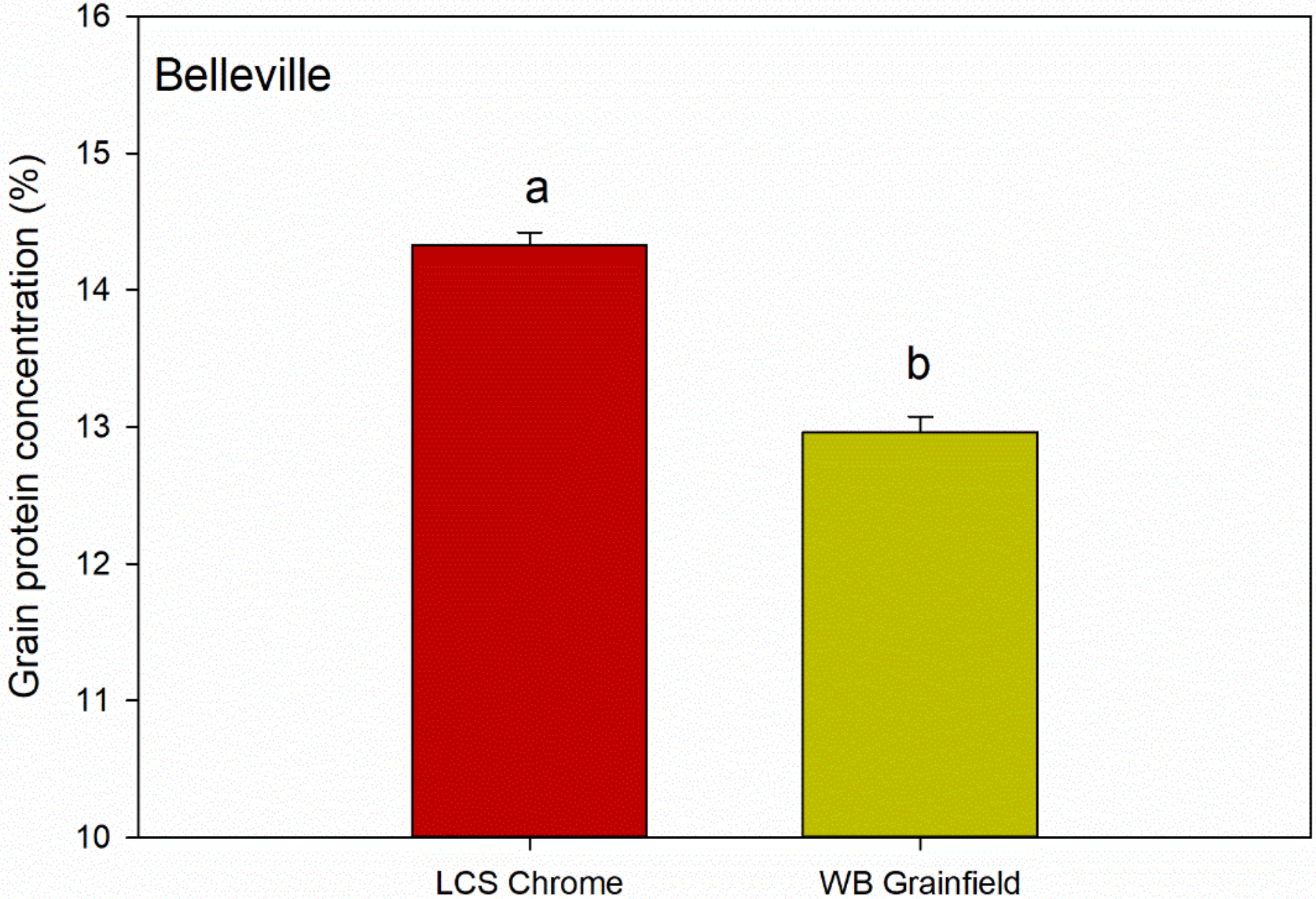
Photo: Brian FitzGerald

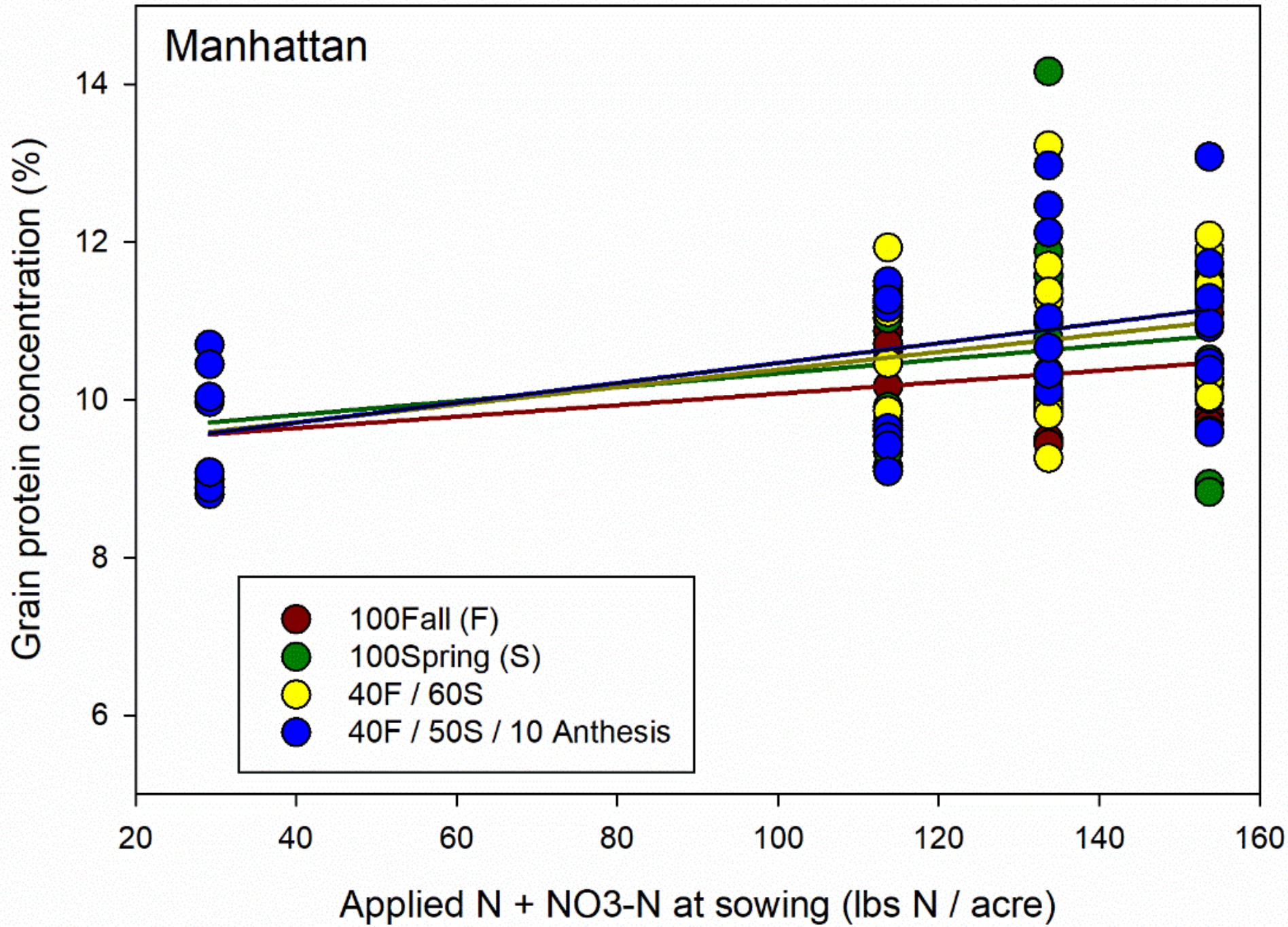
Effect	Yield			Protein		
	Bell	Hutch	Manh	Bell	Hutch	Manh
Variety (V)	NS	NS	NS	**	NS	NS
Rate (R)	**	NS	**	***	**	**
Time (T)	NS	NS	**	***	**	***
V x R	NS	NS	NS	NS	NS	NS
V x T	NS	NS	NS	NS	NS	NS
R x T	*	NS	***	**	NS	**
V x R x T	NS	NS	NS	NS	NS	NS

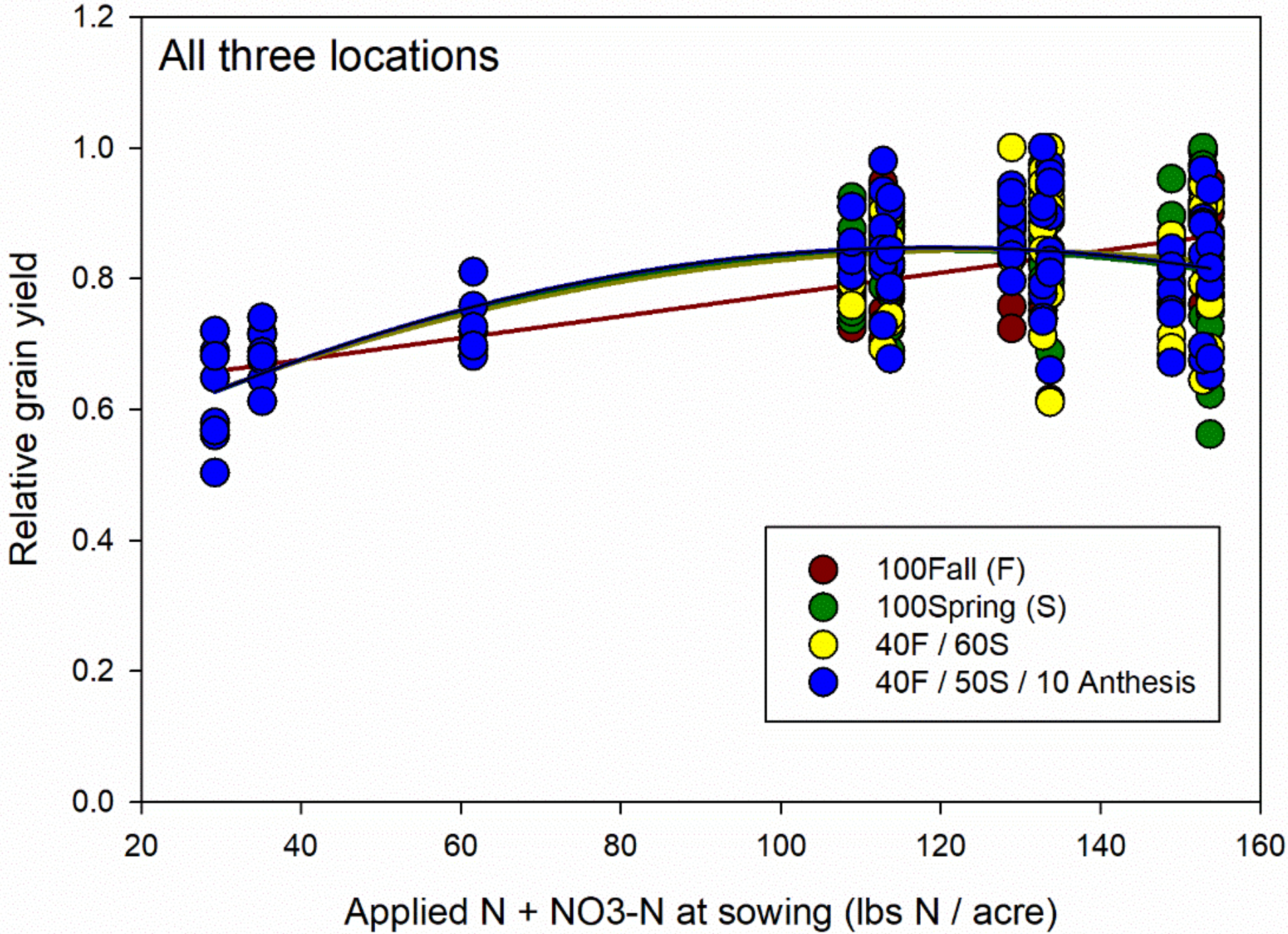

Belleville
Grain yield (bu/ac)
80
70
60
50
40
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis

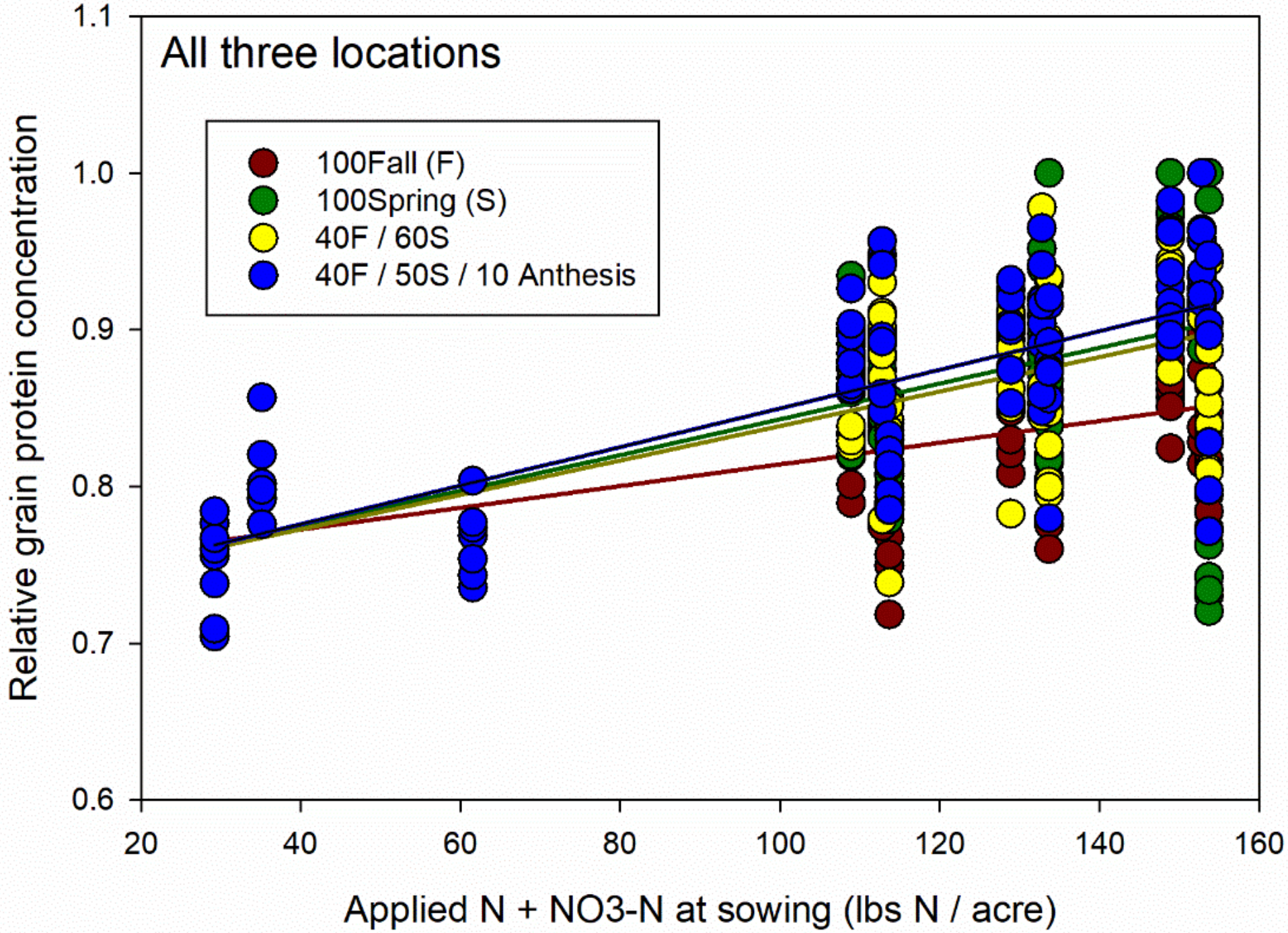

Manhattan
Grain yield (bu/ac)
0
20
40
60
80
100
120
140
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis

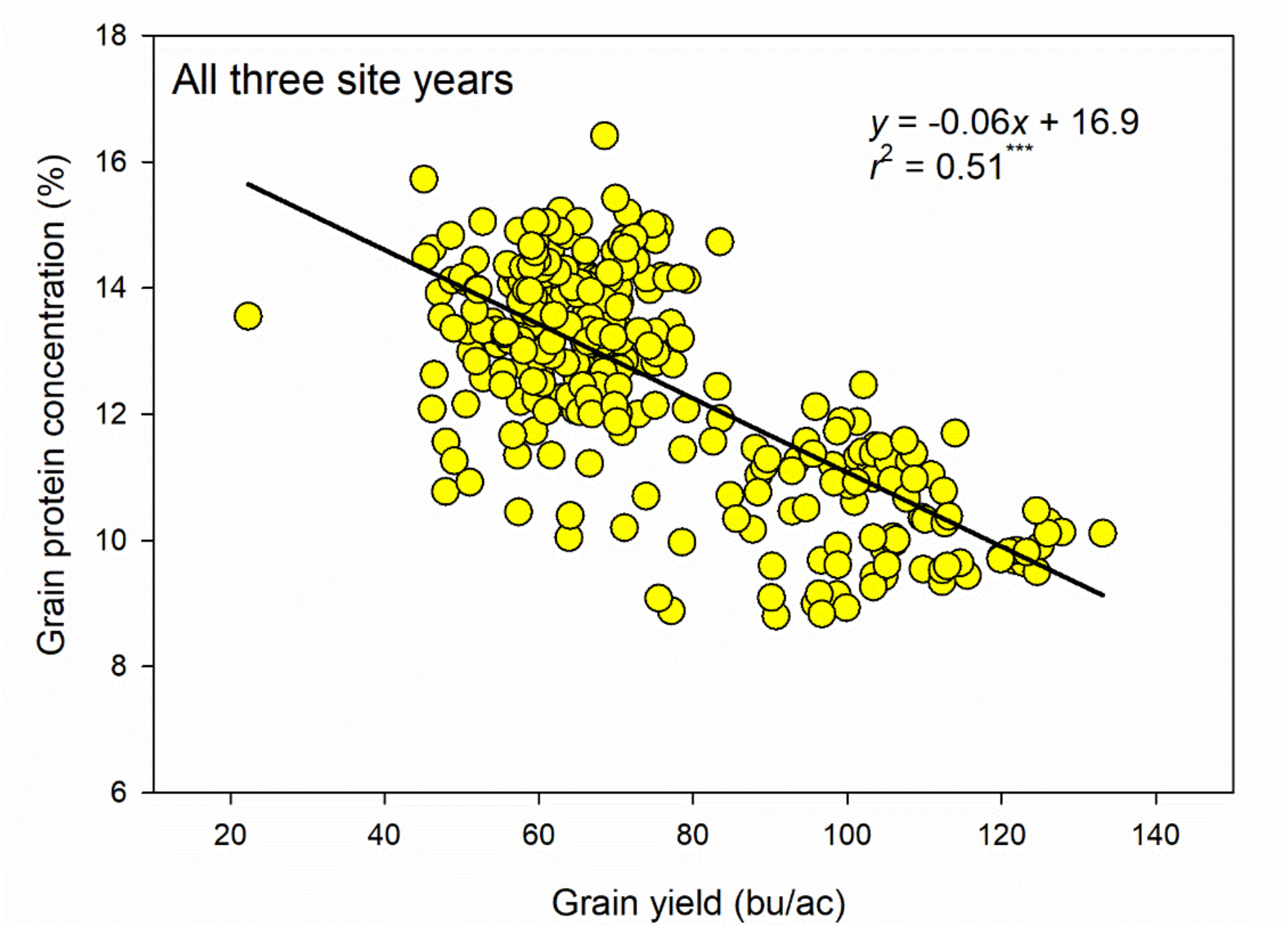

Belleville
Grain protein concentration (%)
16
14
12
10
8
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10A

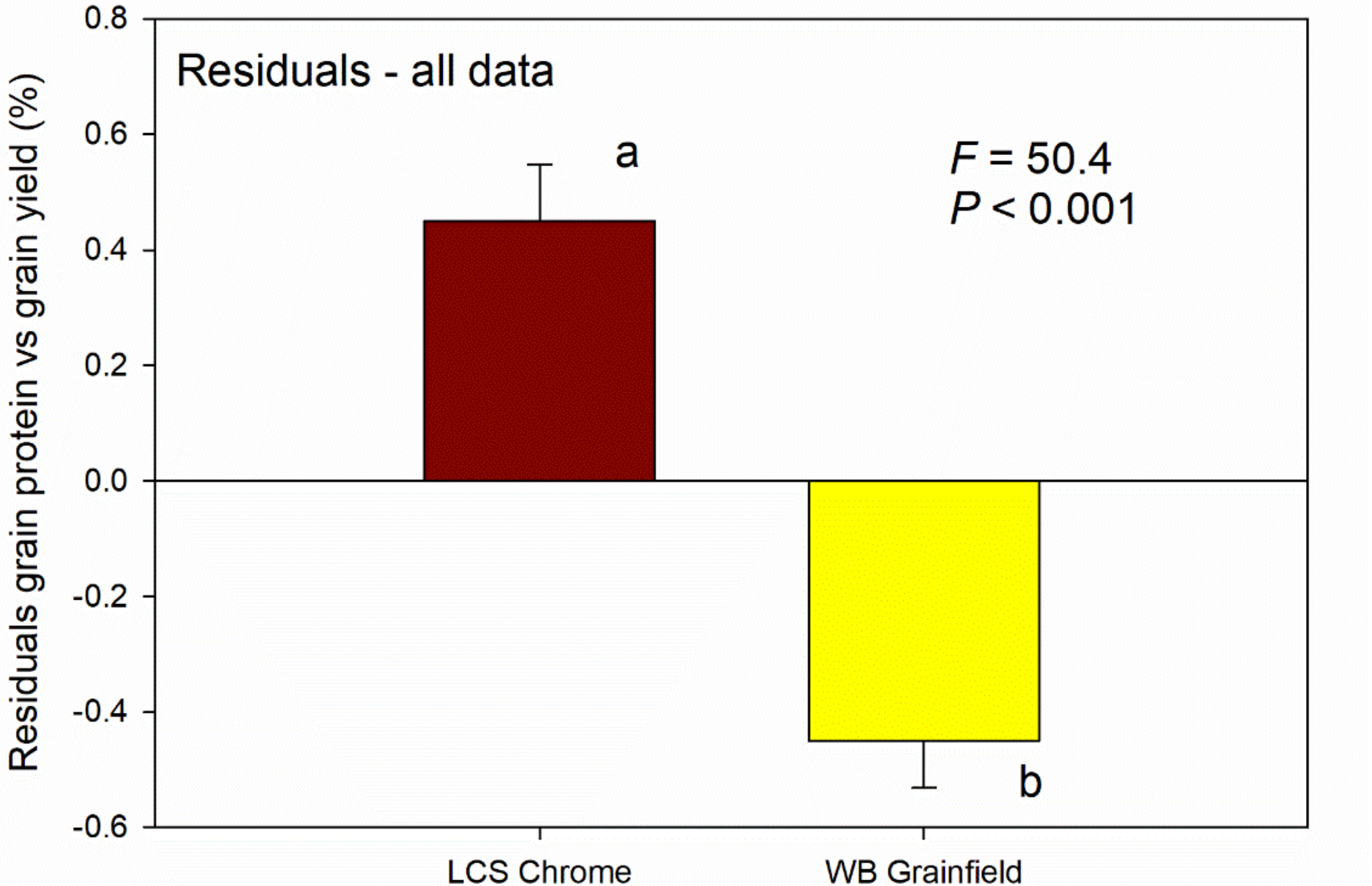

Belleville
Grain protein concentration (%)
16
15
14
13
12
11
10
a
b
LCS Chrome
WB Grainfield

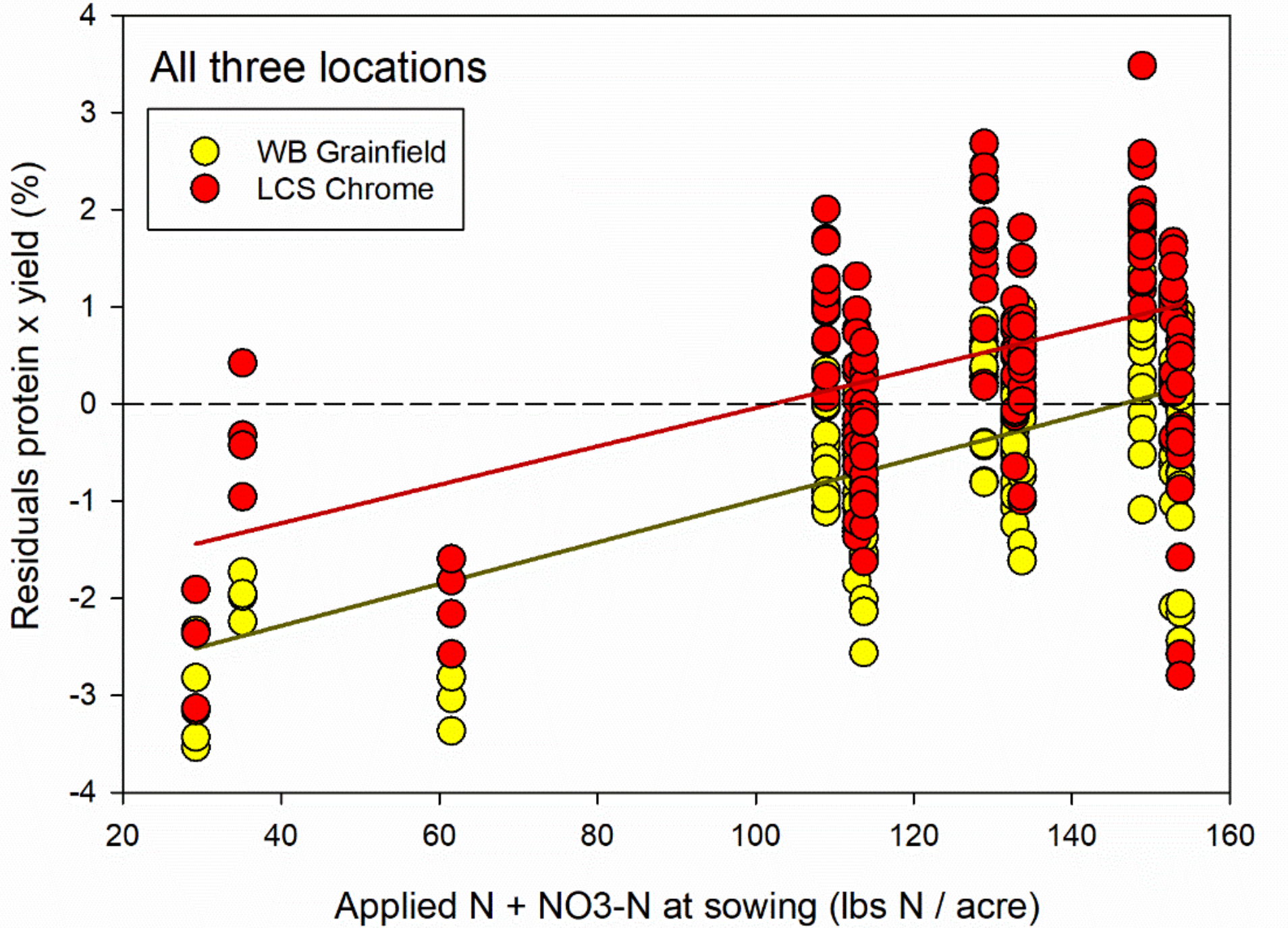

Manhattan
Grain protein concentration (%)
14
12
10
8
6
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis

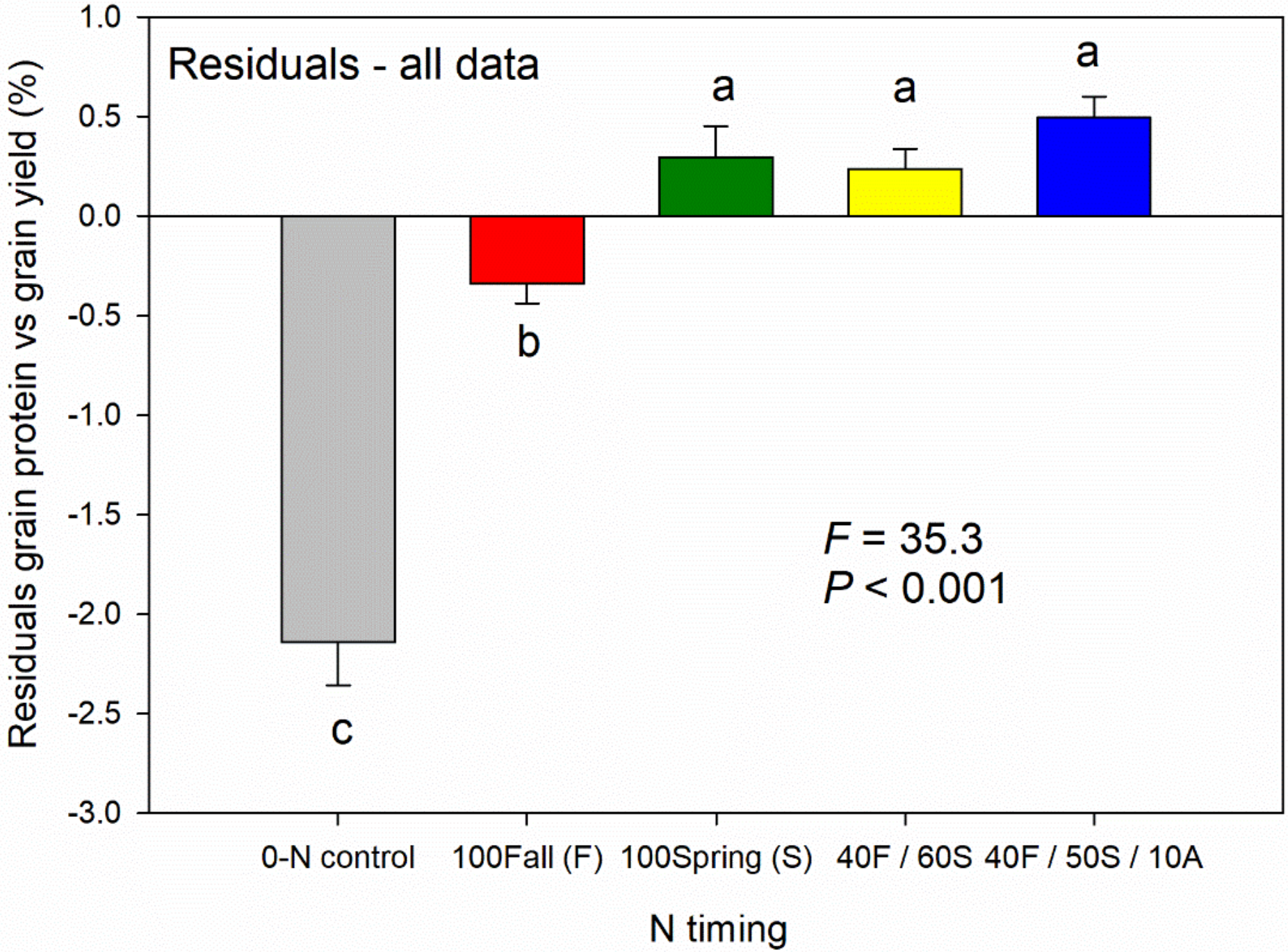

All three locations
Relative grain yield
1.2
1.0
0.8
0.6
0.4
0.2
0.0
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis

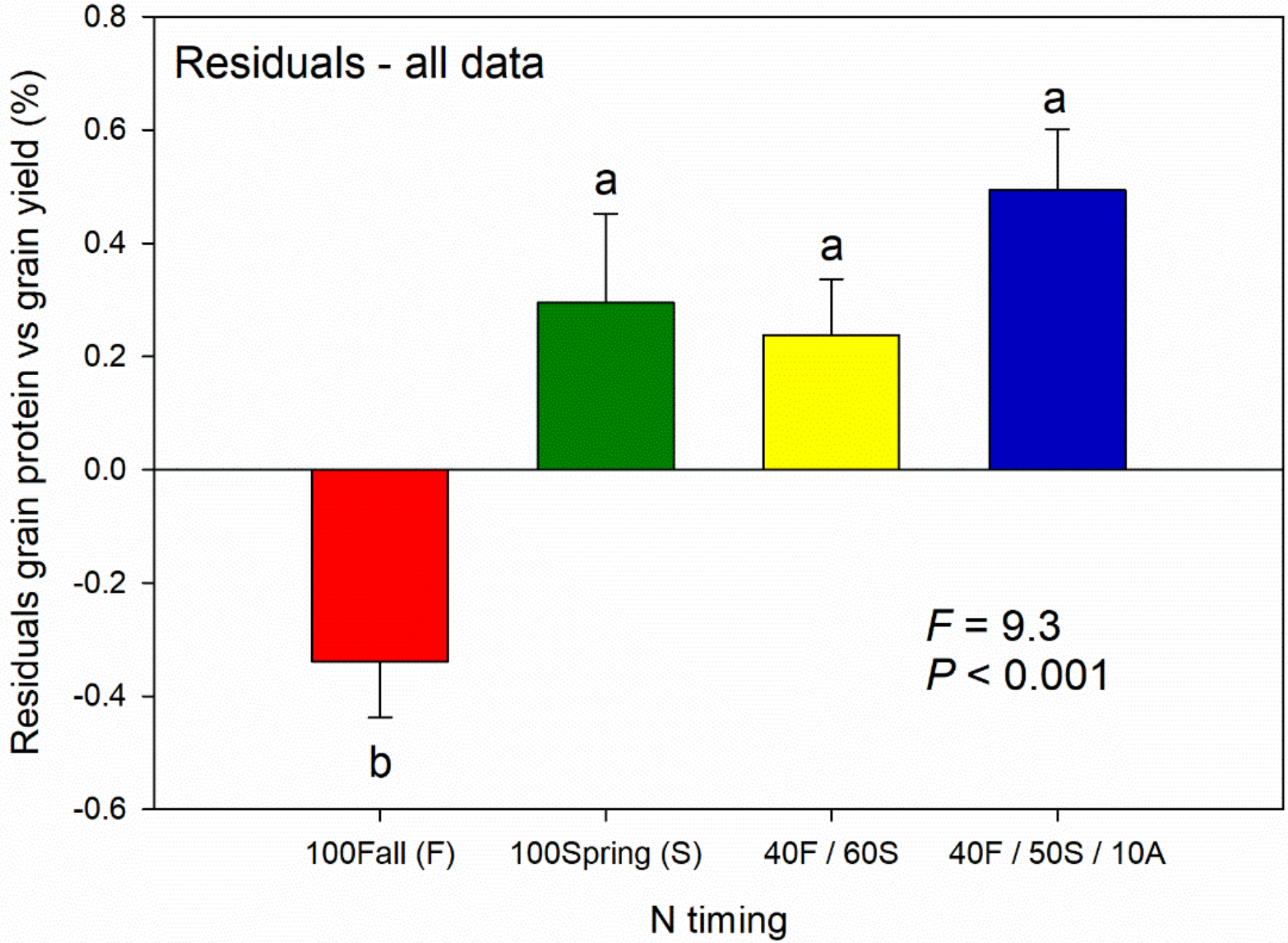

All three locations
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis
Relative grain protein concentration
1.1
1.0
0.9
0.8
0.7
0.6
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)

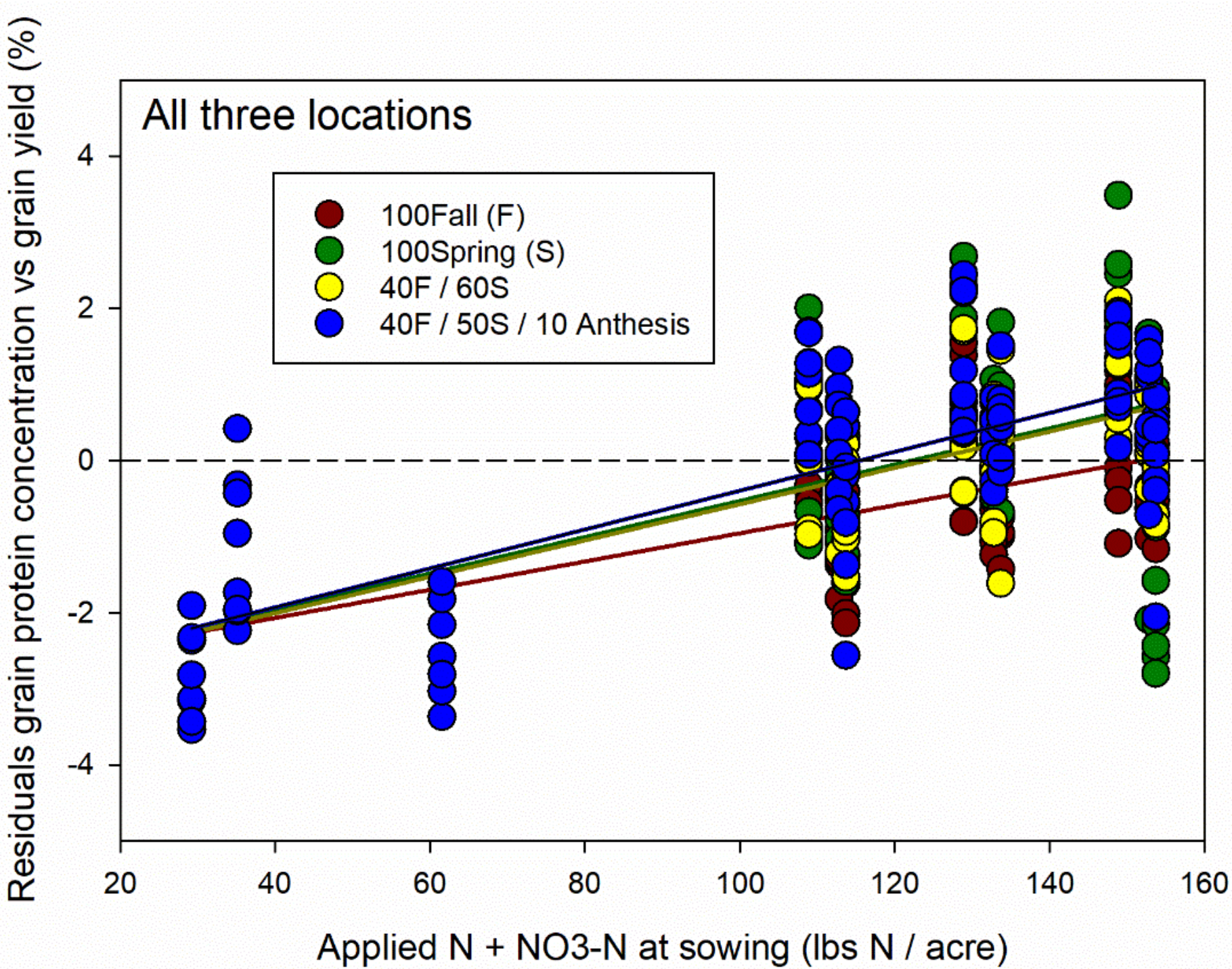

All three site years
y = -0.06x + 16.9
r2 = 0.51***
Grain protein concentration (%)
18
16
14
12
10
8
6
20
40
60
80
100
120
140
Grain yield (bu/ac)

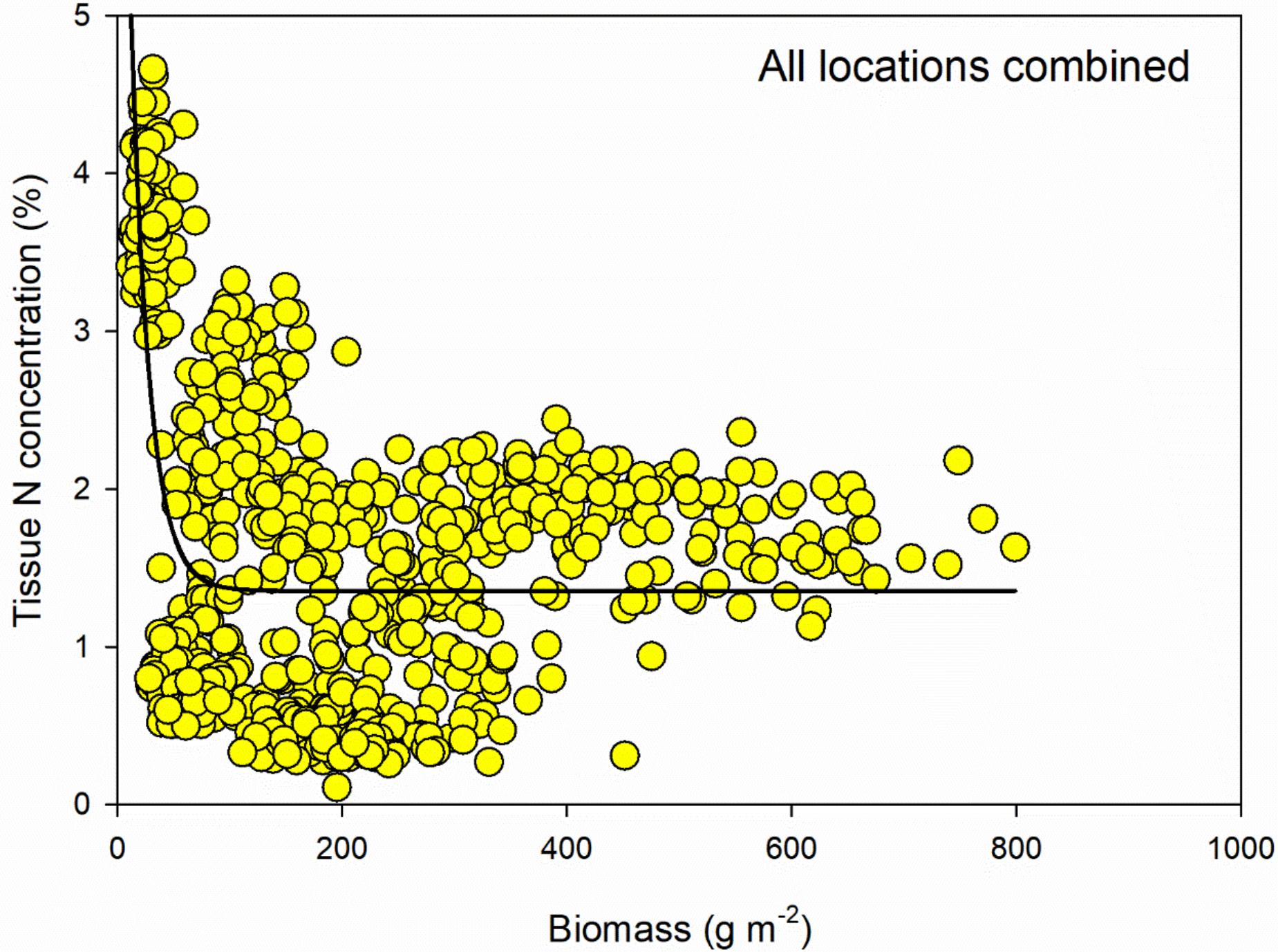

Residuals - all data
Residuals grain protein vs grain yield (%)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
a
b
F = 50.4
P < 0.001
LCS Chrome
WB Grainfield

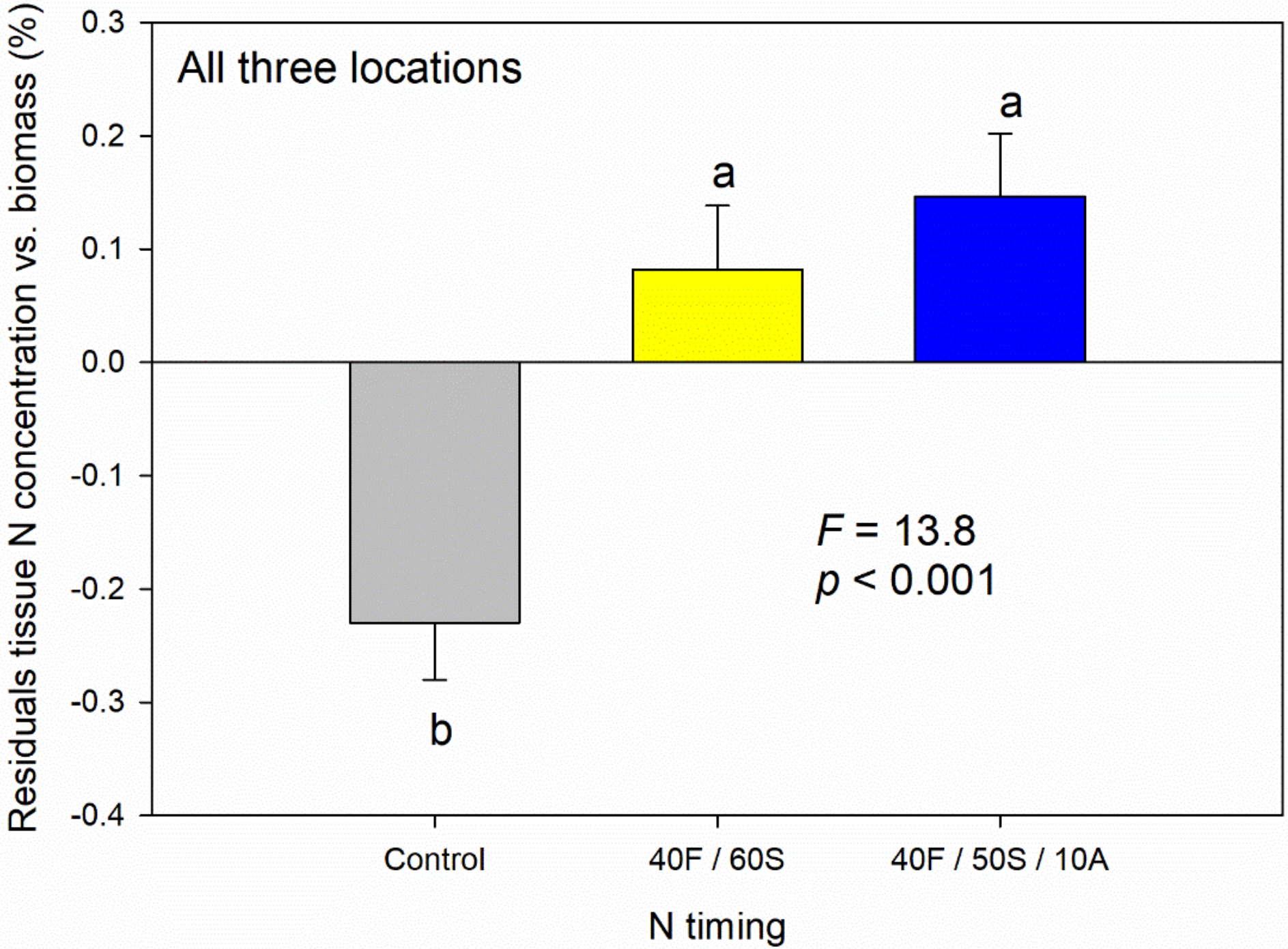

All three locations
WB Grainfield
LCS Chrome
Residuals protein x yield (%)
4
3
2
1
0
-1
-2
-3
-4
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)

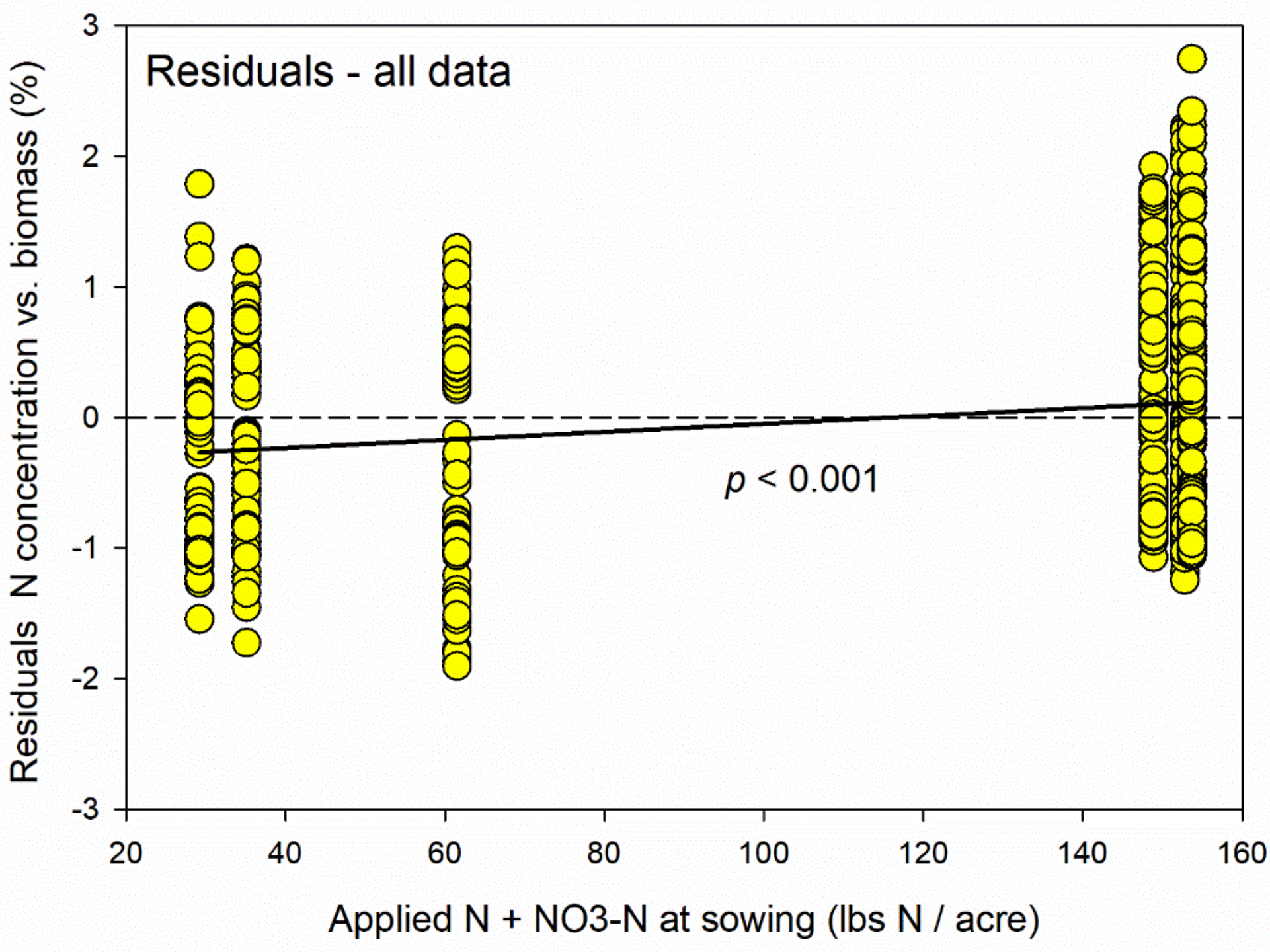

Residuals - all data
Residuals grain protein vs grain yield (%)
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
a
a
a
b
c
F = 35.3
P < 0.001
0-N control
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10A
N timing

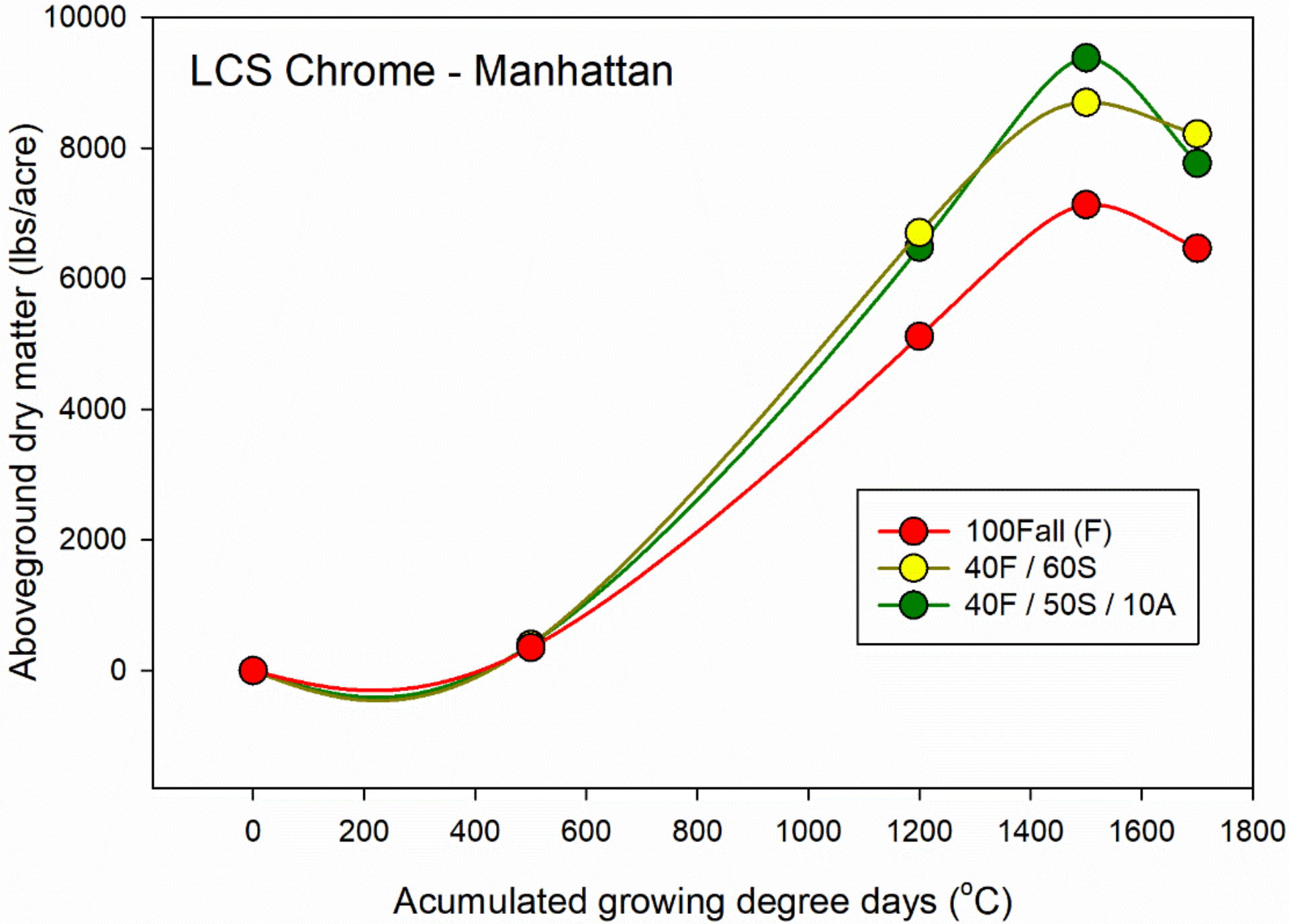

Residuals - all data
Residuals grain protein vs grain yield (%)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
a
a
a
b
F = 9.3
P < 0.001
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10A
N timing

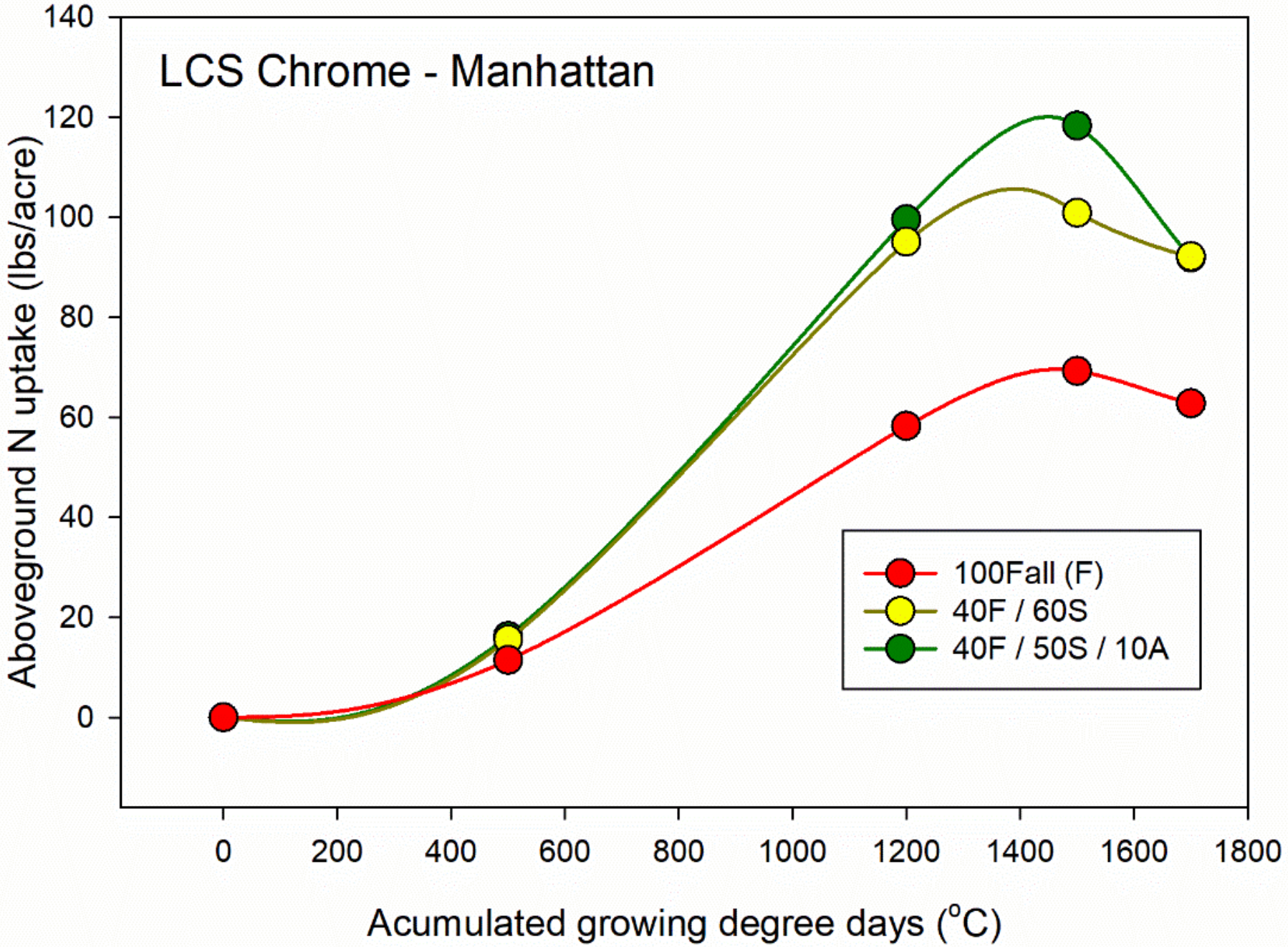

All three locations
100Fall (F)
100Spring (S)
40F / 60S
40F / 50S / 10 Anthesis
Residuals grain protein concentration vs grain yield (%)
4
2
0
-2
-4
20
40
60
80
100
120
140
160
Applied N + NO3-N at sowing (lbs N / acre)

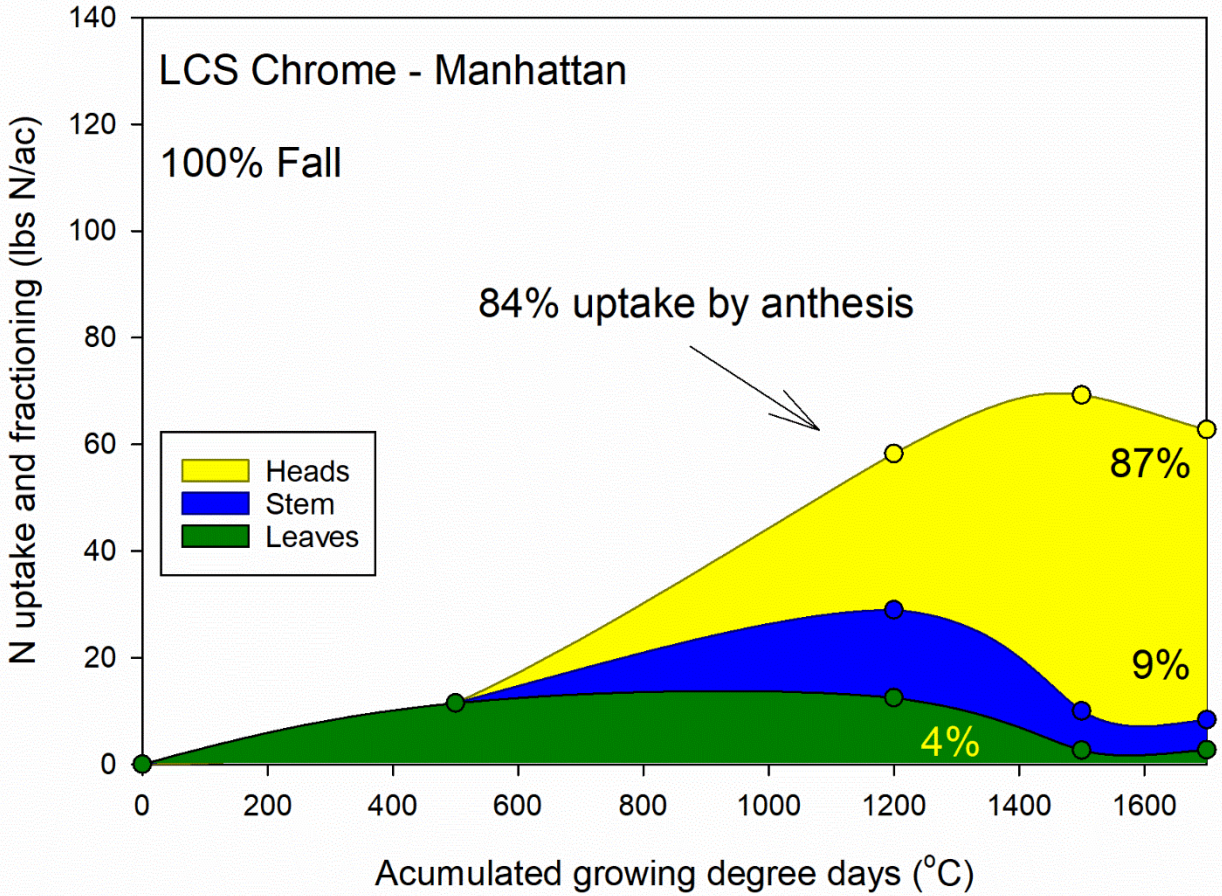

All locations combined
Tissue N concentration (%)
Biomass (g m-2)
0
1
2
3
4
5
0
200
400
600
800
1000

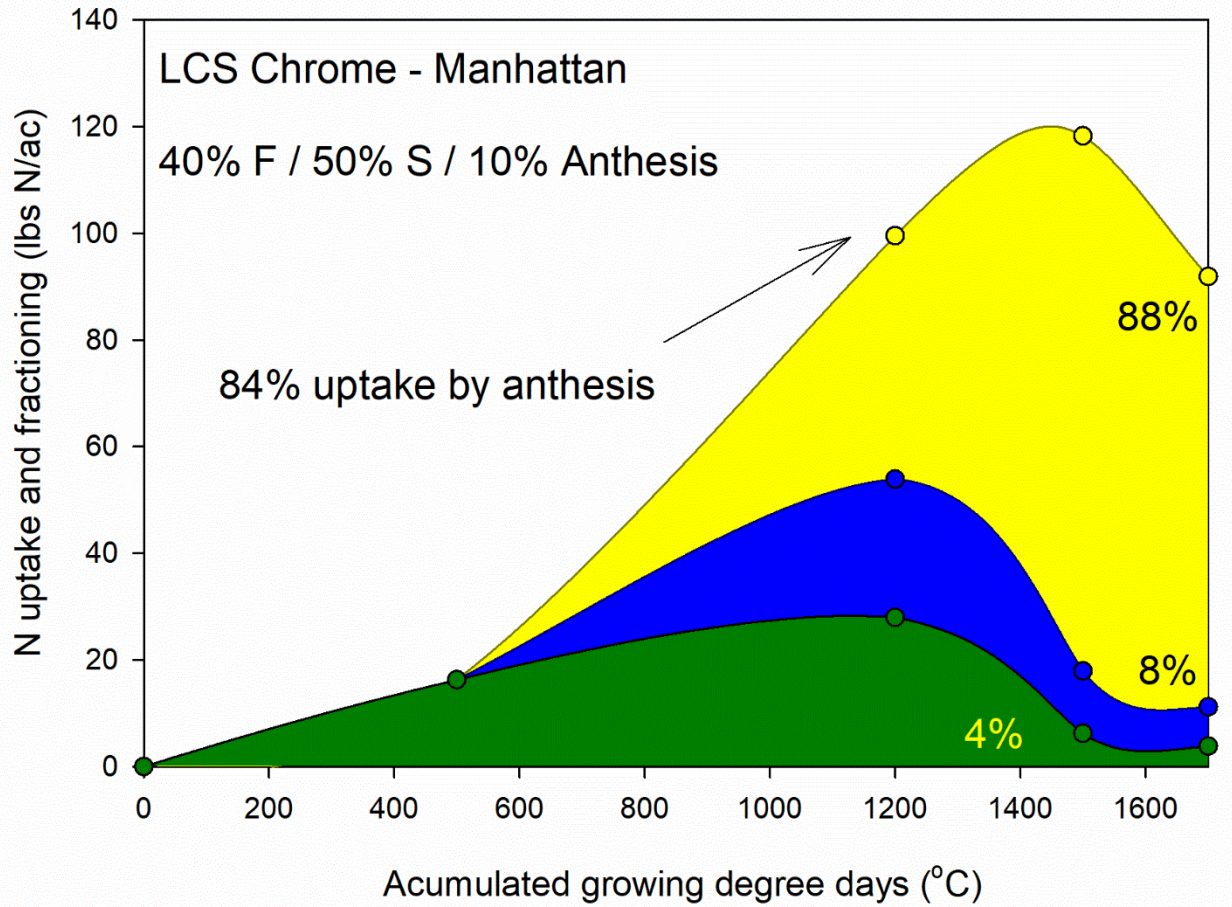

All three locations
Residuals tissue N concentration vs. biomass (%)
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
a
a
b
F = 13.8
p < 0.001
Control
40F / 60S
40F / 50S / 10A
N timing


Residuals - all data
Residuals N concentration vs. biomass (%)
3
2
1
0
-1
-2
-3
20
40
60
80
100
120
140
160
p < 0.001
Applied N + NO3-N at sowing (lbs N / acre)


LCS Chrome - Manhattan
Aboveground dry matter (lbs/acre)
10000
8000
6000
4000
2000
0
0
200
400
600
800
1000
1200
1400
1600
1800
Acumulated growing degree days (°C)
100Fall (F)
40F / 60S
40F / 50S / 10A


LCS Chrome - Manhattan
Aboveground N uptake (lbs/acre)
140
120
100
80
60
40
20
0
0
200
400
600
800
1000
1200
1400
1600
1800
Acumulated growing degree days (°C)
100Fall (F)
40F / 60S
40F / 50S / 10A





Fluid Fertilizer Foundation

WINFIELD UNITED

PRELIMINARY CONCLUSIONS

More N was needed to maximize protein as compared to yield

N rate x N timing: 100% fall required more N than 100% spring or split-applied

At same yield and biomass levels:

- Varietal differences in protein, not in tissue N%
- Higher N rates increased protein and N%
- Spring timing increased protein and N%

Applied N increased N uptake, but timing and partitioning were not changed

WINFIELD® UNITED

Fluid Fertilizer Foundation

ACKNOWLEDGMENTS

Fluid Fertilizer Foundation

WINFIELD® UNITED






Questions?

Romulo Lollato, Ph.D.
Assistant Professor, Extension Wheat and Forages Specialist
Kansas State University
lollato@ksu.edu

@KSUWheat

KSU Wheat

Kansas State University

WinField United

Fluid Fertilizer Foundation