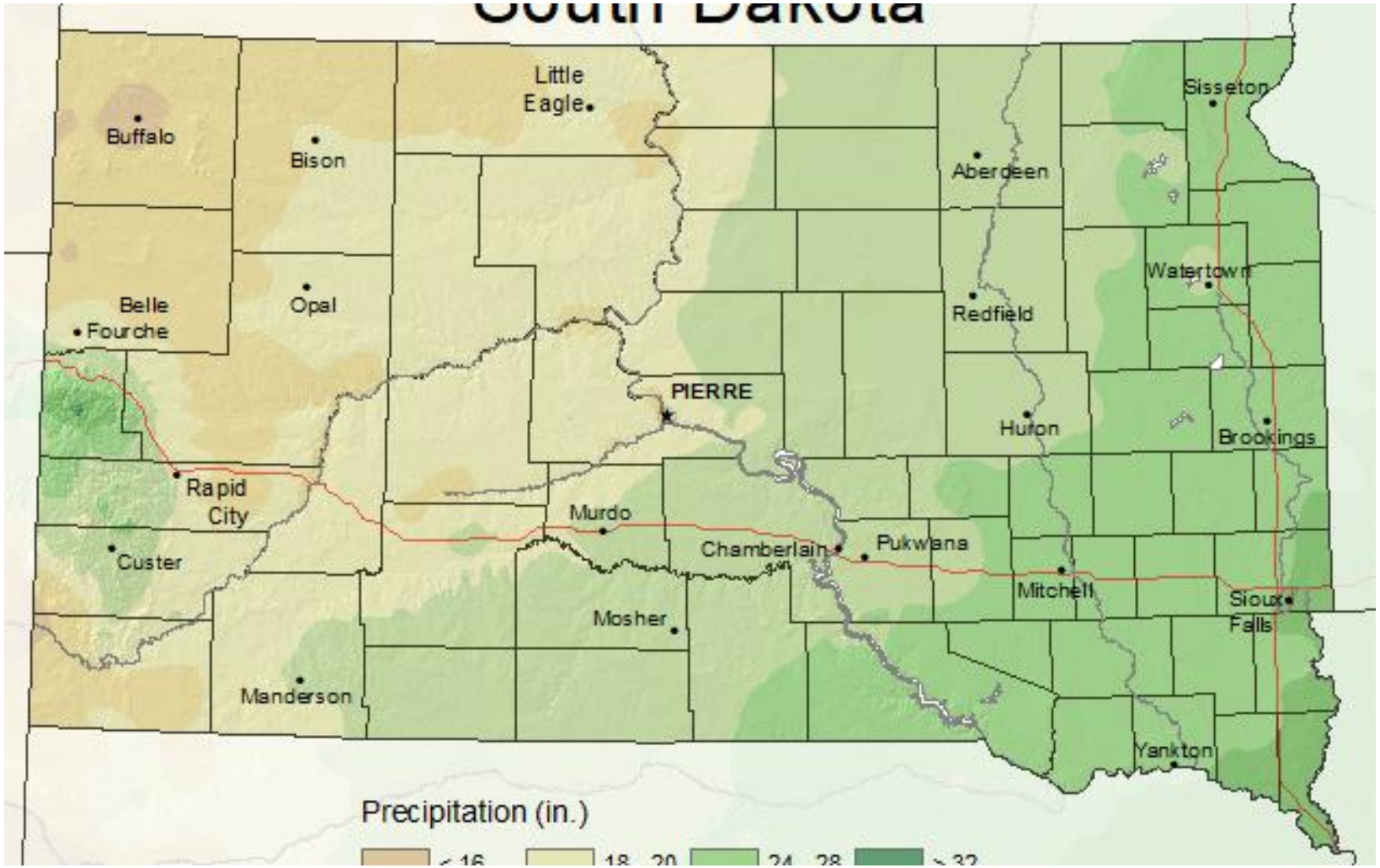
Nutrient Banding in Corn

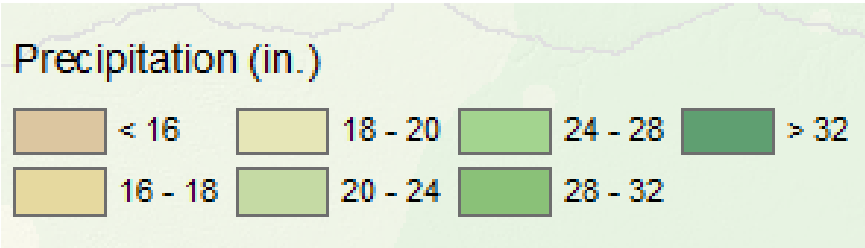
Péter Kovács

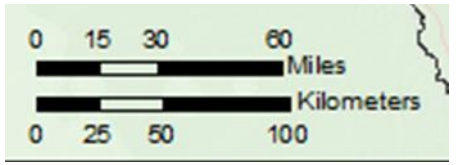
South Dakota State Univ.

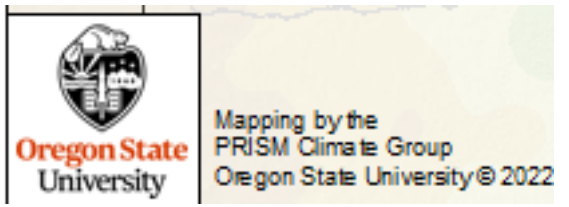
December 18, 2023

Mean Annual Precipitation (1991-2020)

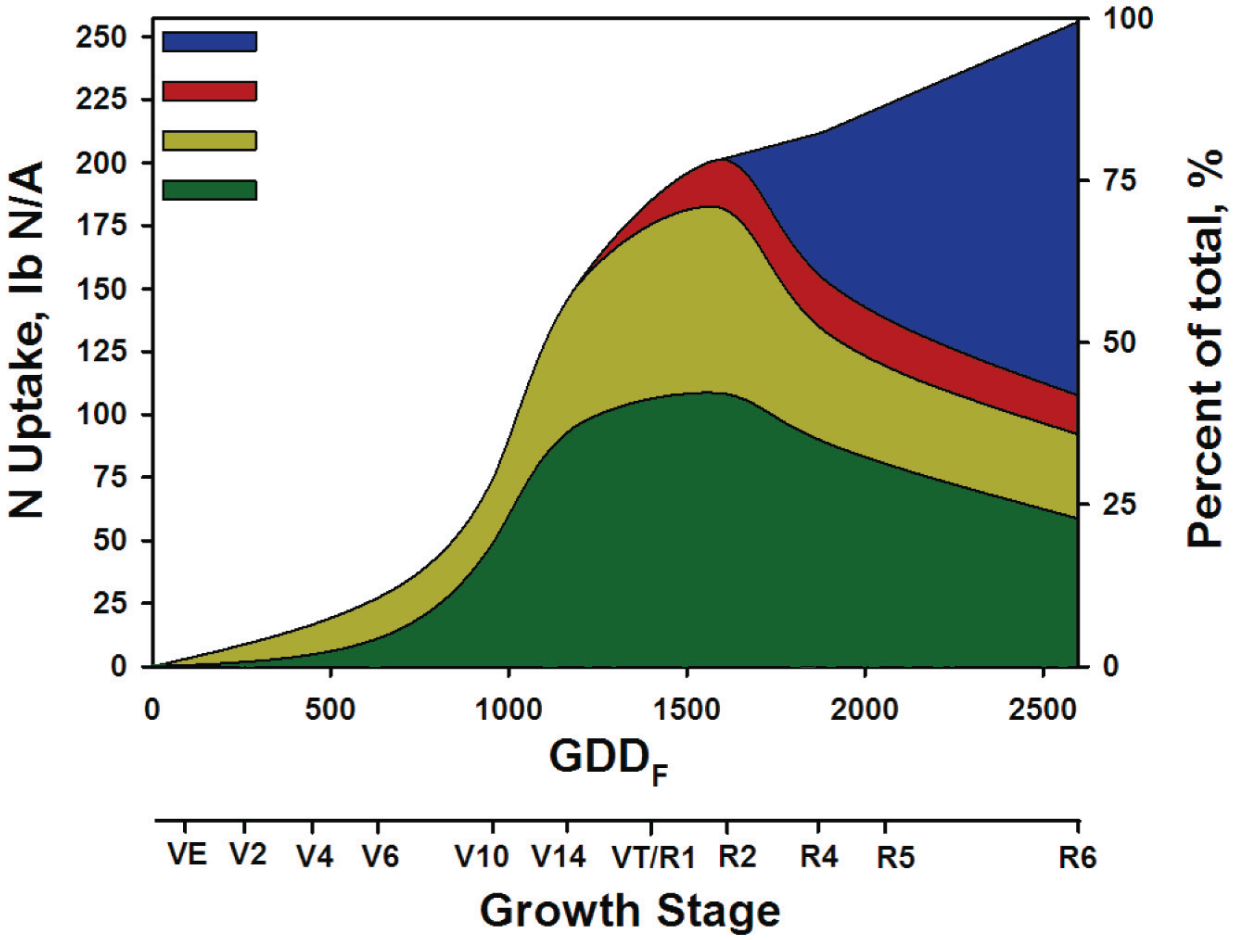


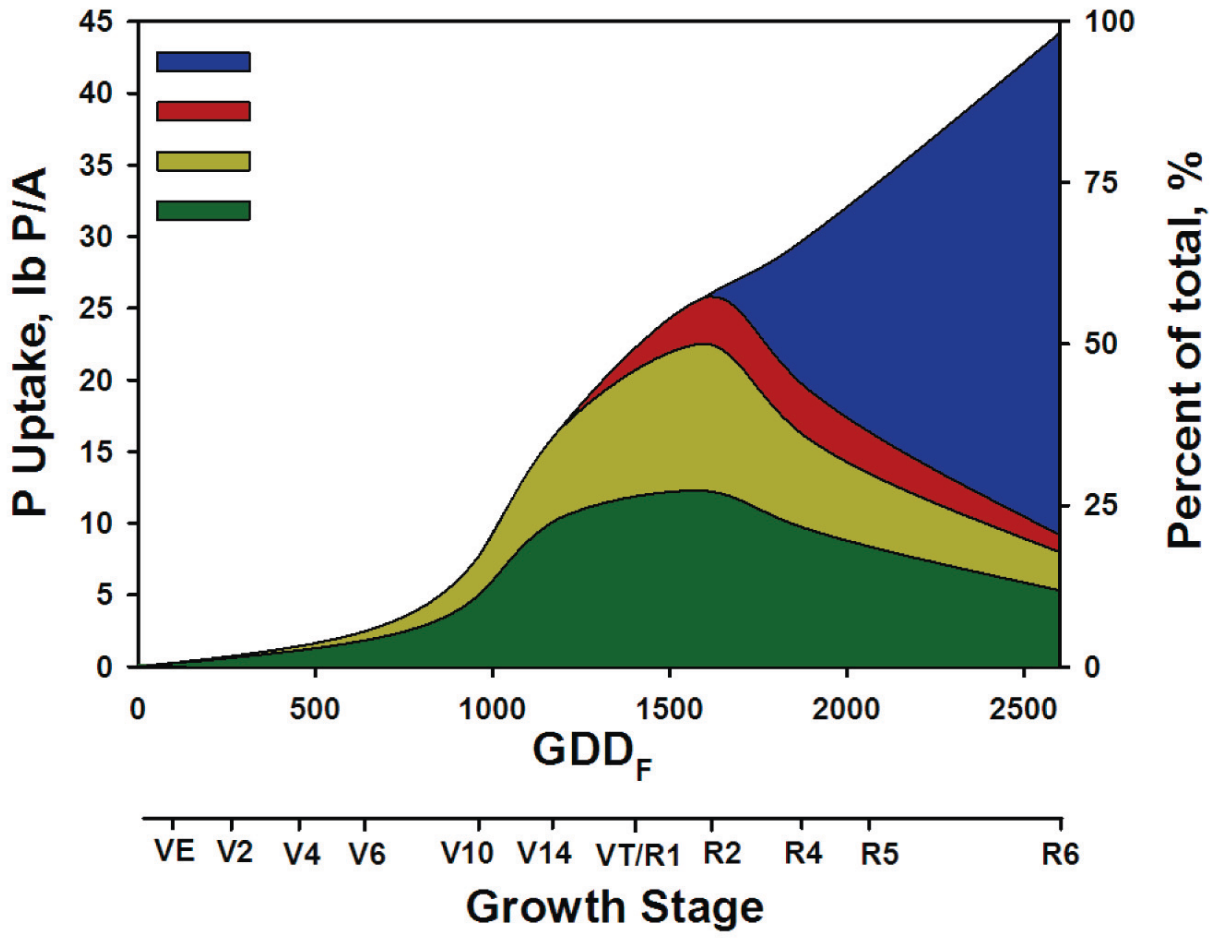






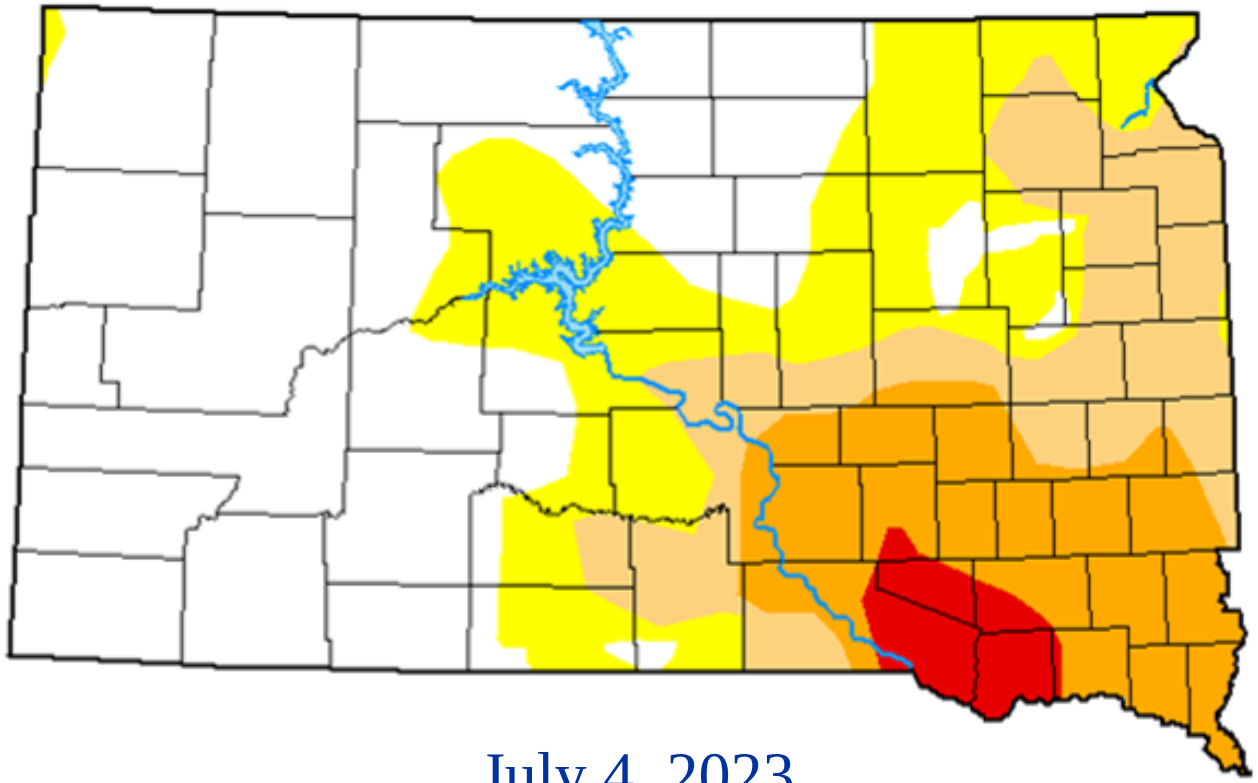
Nutrient Uptake in Corn



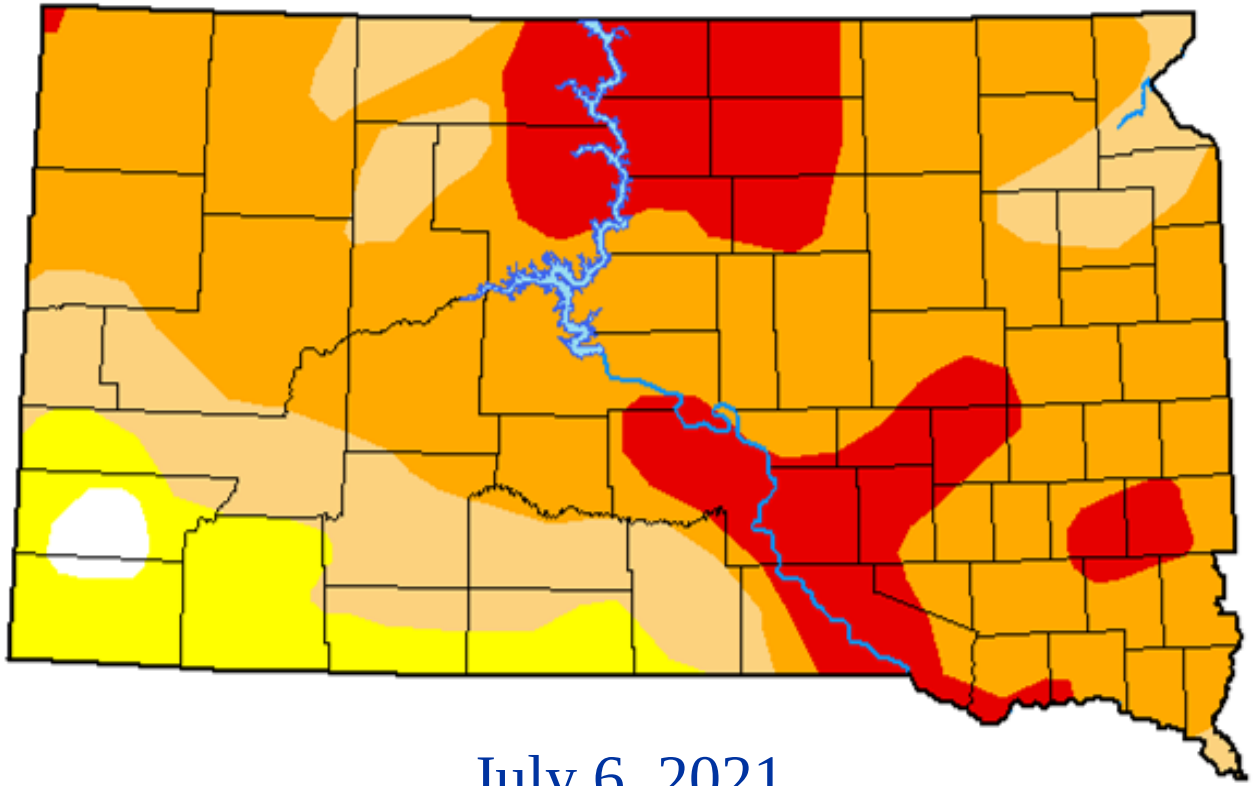


(Bender et al., 2013)

Weather Challenges During Growing Season



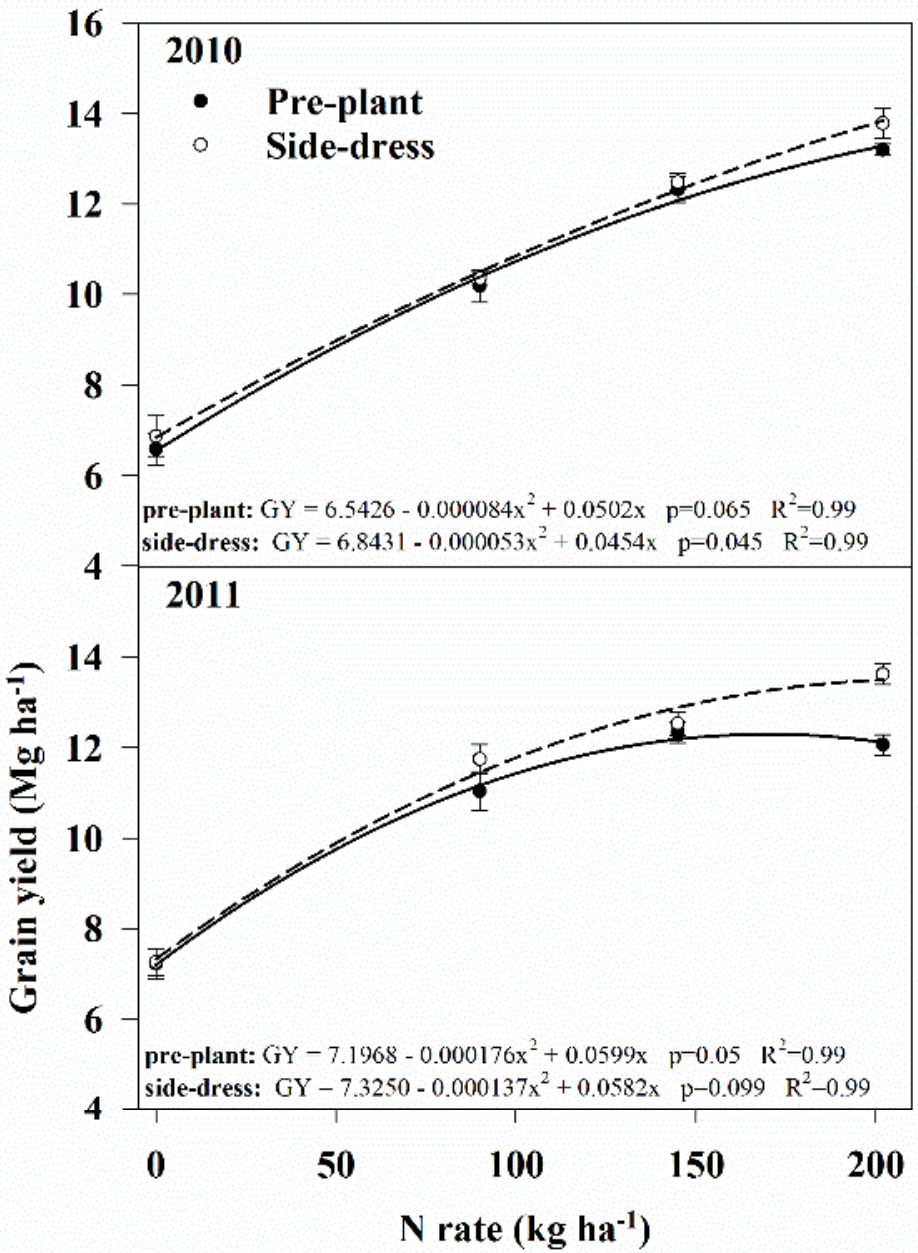
July 4, 2023

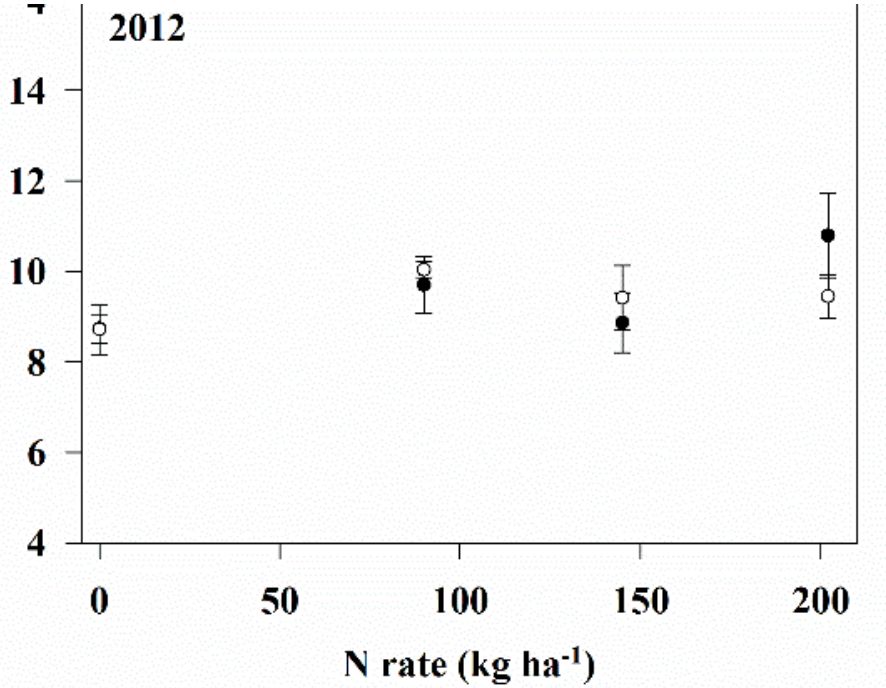


July 6, 2021

(Source: UNL Drought Monitor)

Anhydrous Ammonia Timing and Placement Effects on Grain Yield





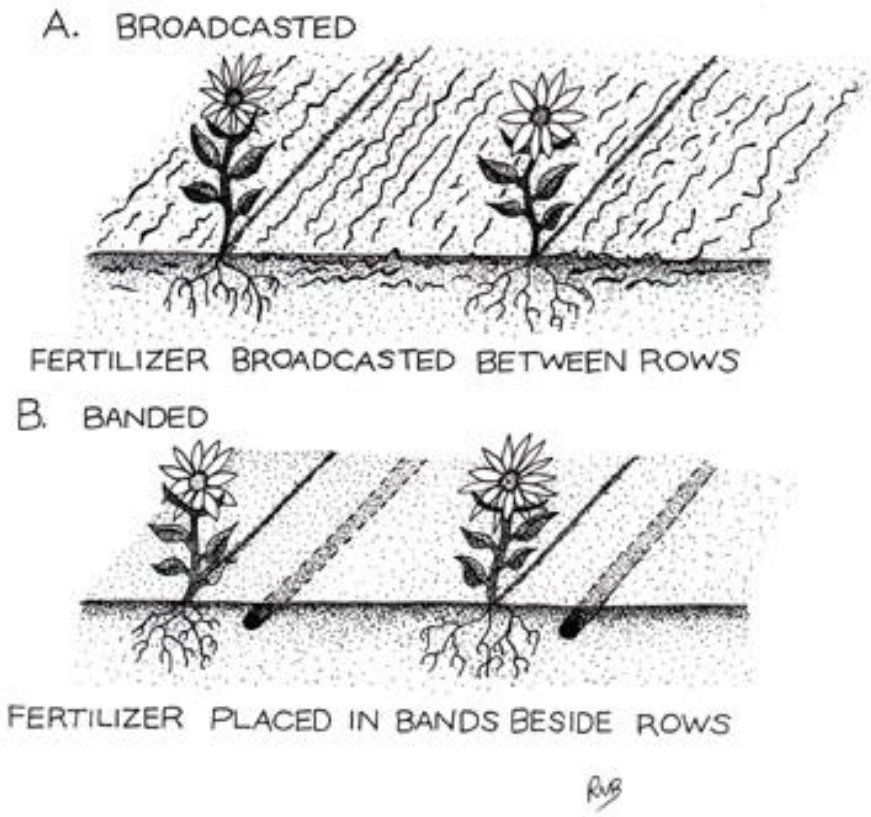
(Kovács et al. 2015.)

Nutrient application options

- Broadcast
  - Pre-plant
  - Top-dress
- Banding
  - Pre-plant
  - Planting
  - In-season
    - Side-dress
    - Y-Drop

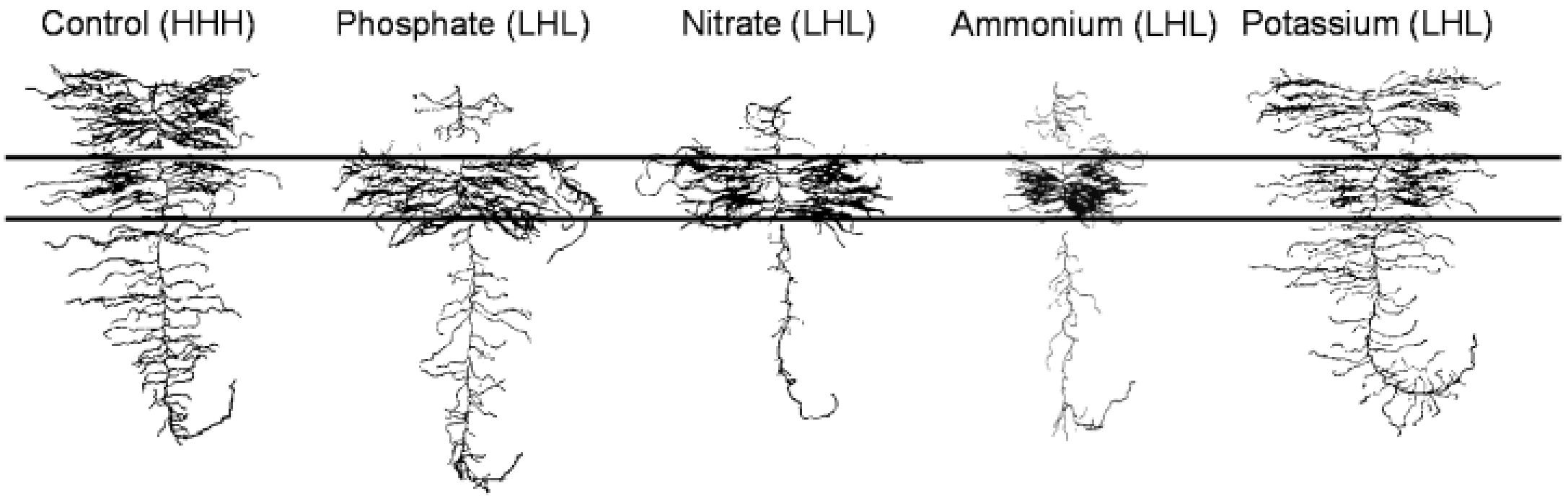
Nutrient application option

- Broadcast
  - Uniform nutrient distribution
  - Easy/Fast application
- Banding
  - Concentrated nutrient
  - Farmer's may need to apply
  - More efficiency
- When? How?



(UC ANR. 2017)

Root development in nutrient rich environment

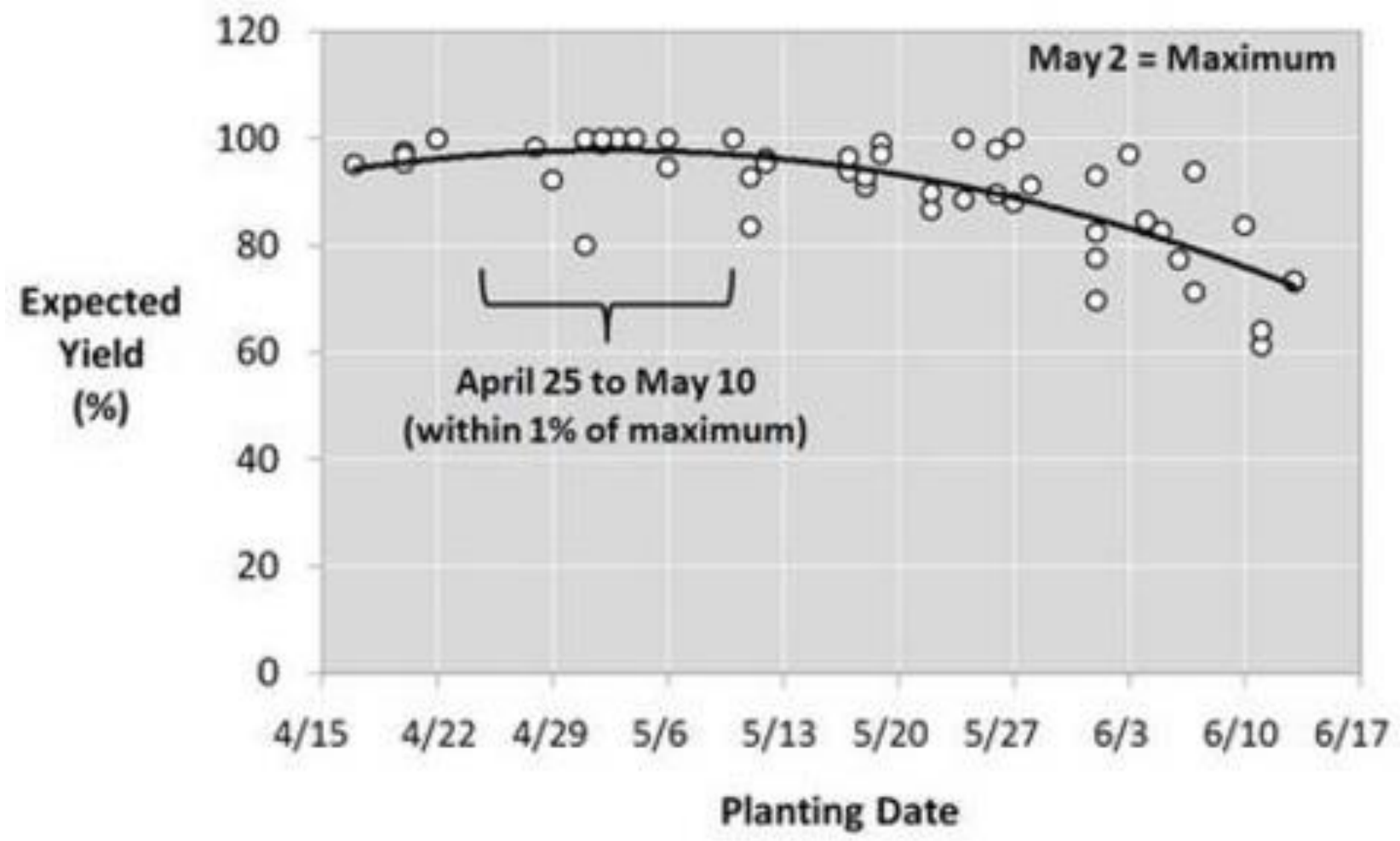


(Hodge, 2004, New Phytologist)

Benefit of Starter Fertilizer

- Early-season nutrient access
  - Cool and moist condition

Planting Date effect on Grain Yield

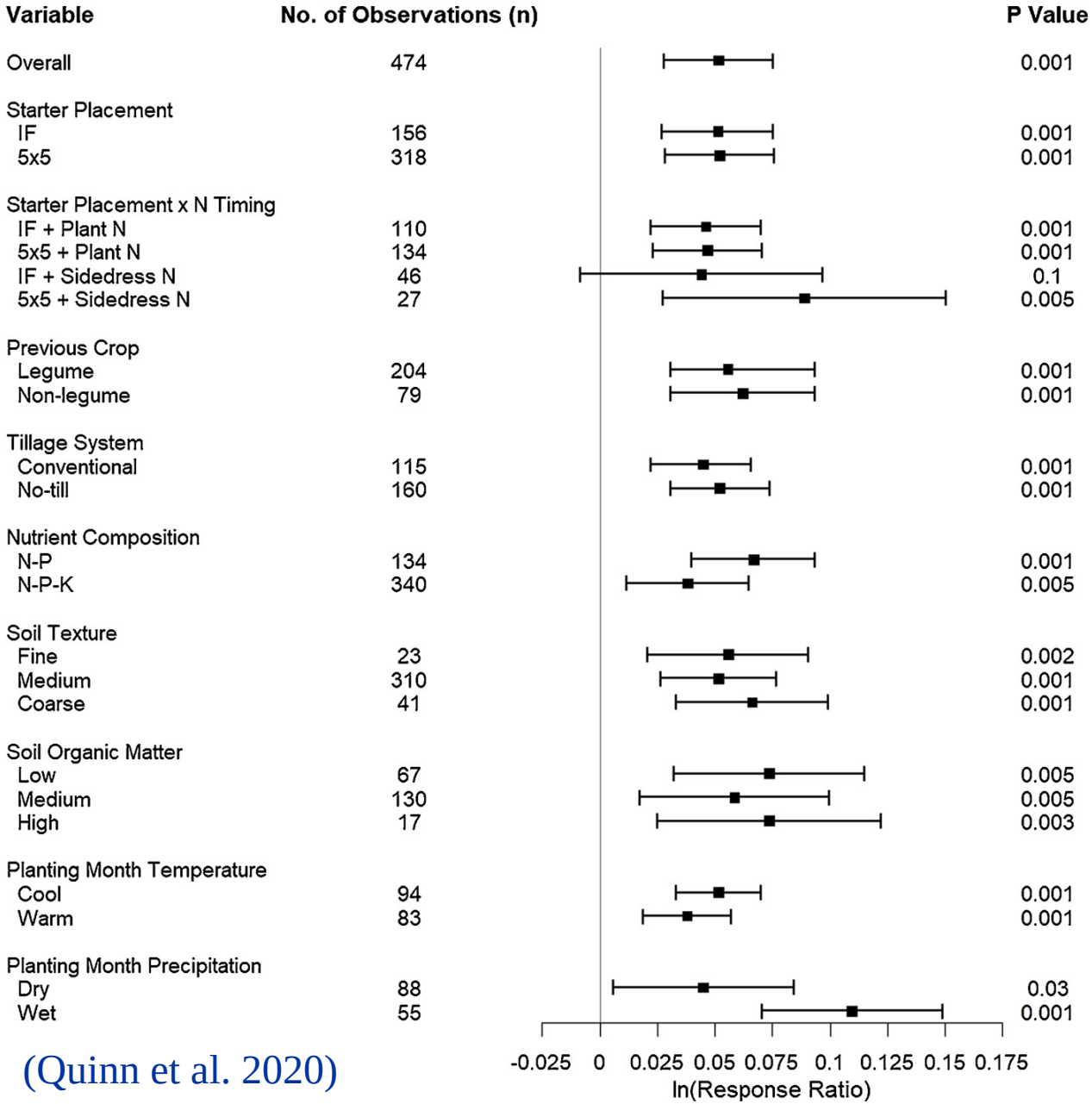


(Coulter et al. 2021)

Benefit of Starter Fertilizer

- Early-season nutrient access
  - Cool and moist condition
- Increased seedling uniformity
- Increased biomass production, nutrient uptake
- Increased plant height
- Shorten vegetative growth period

Starter Fertilizer Impact



(Quinn et al. 2020)

Treatment	Grain yield
Planting Date	**(bu ac^{-1})**
Early	**184.8 a**
+ 2 wks	**181.6 a**
+ 4 wks	**173.6 b**
Starter Fertilizer	
5 GPA 10-34-0	**180.0**
No	**181.6**

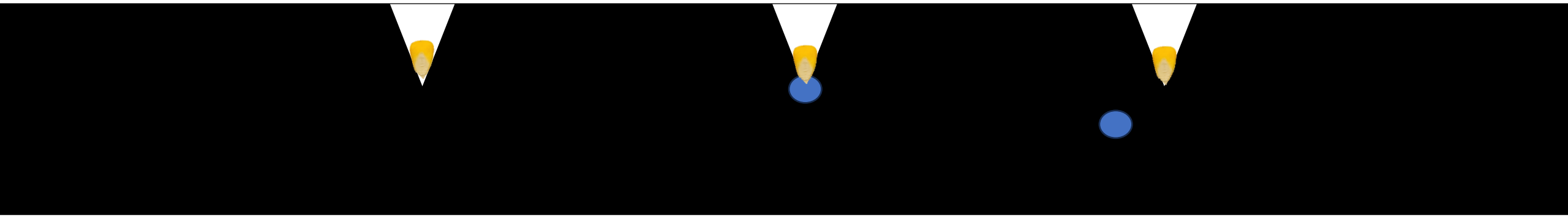
(Kaiser et al. 2016)

Benefit of Starter Fertilizer

- Yield response is variable
  - Hybrids planted
  - Tillage system - No till
  - Starter Fertilizer
    - Nutrient composition
    - Application rate
    - Placement
  - Soil
    - Nutrient levels - Low STP/STK
    - Moisture
    - Temperature
    - Texture

Use of Starter Fertilizer

- ~60% of SD producers use



No starter fertilizer **In-furrow/pop-up** **2 X 2**

(Source: SD Producer Survey)

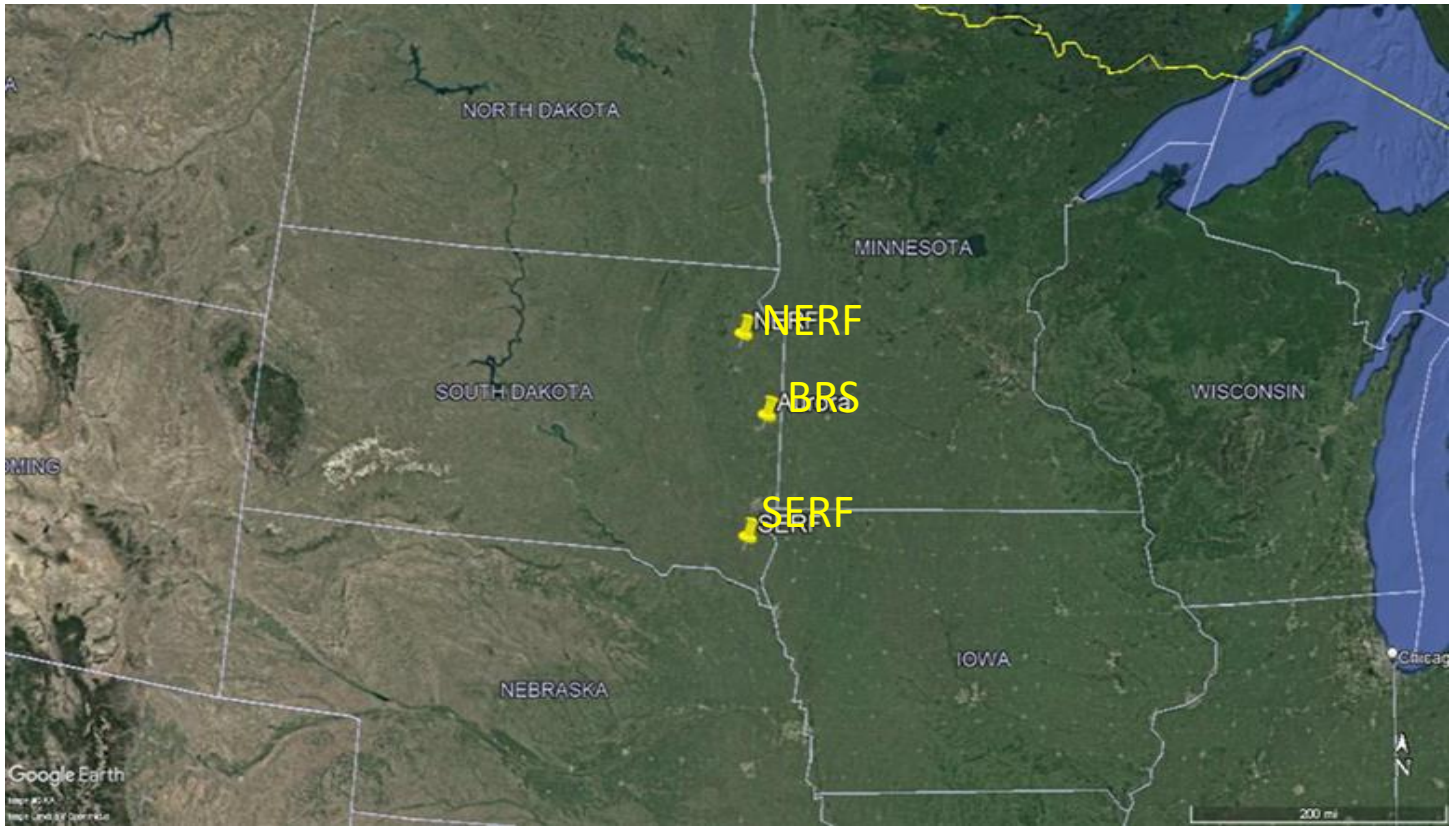
Starter Fertilizer Placement Effect on Corn

- Planting Dates
  - Early
  - Normal/Late
- Fertilizer Source
  - 10-34-0
  - 8-21-5

  } With and without Zn
- Fertilizer Placement
  - Control
  - In-furrow (low) – IFL (~9 lbs P_2O_5 ac^{-1})
  - In-furrow (high) – IFH (~14 lbs P_2O_5 ac^{-1})
  - 2 x 2 (~23 lbs P_2O_5 ac^{-1})
  - 2 x 2 + in-furrow low

Study Locations

- 2021 - 2023



Early Season Plant Response to Starter Fertilizer

Treatment	Growth stage	Plant height	Growth stage	Plant height
		(“)		(“)
PDate1	2.1 b	1.26 b	N/A	N/A
PDate2	2.6 a	1.69 a	N/A	N/A
Control	2.3	1.42	7.2	11.1
IF-L	2.4	1.54	7.3	11.6
IF-H	2.4	1.54	7.4	12.1
2X2	2.3	1.46	7.2	11.2
2X2 + IF-L	2.4	1.54	7.3	11.5

South Shore, 2023

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Early Season Plant Response to Starter Fertilizer

Treatment	Growth stage	Plant height	Growth stage	Plant height
		(“)		(“)
PDate1	3.2 a	1.69 b	7.2 b	11.0 b
PDate2	3.1 b	2.20 a	7.8 a	14.7 b
Control	3.1	1.77 c	7.6	12.6 ab
IF-L	3.2	1.97 b	7.6	12.8 ab
IF-H	3.2	2.05 ab	7.6	13.0 ab
2X2	3.1	1.77 c	7.5	12.3 b
2X2 + IF-L	3.2	2.13 a	7.7	13.6 a

Brookings, 2023

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Early Season Plant Response to Starter Fertilizer

Treatment	Growth stage	Plant height	Growth stage	Plant height
		(“)		(“)
PDate1	2.3 b	1.10 b	6.7 b	8.6 b
PDate2	3.1 a	1.73 a	7.6 a	10.3 a
Control	2.7 ab	1.42 ab	7.2	9.4
IF-L	2.8 a	1.50 a	7.2	9.4
IF-H	2.7 ab	1.42 ab	7.2	9.4
2X2	2.6 b	1.34 b	7.2	9.2
2X2 + IF-L	2.7 ab	1.46 ab	7.3	9.6

Beresford, 2023

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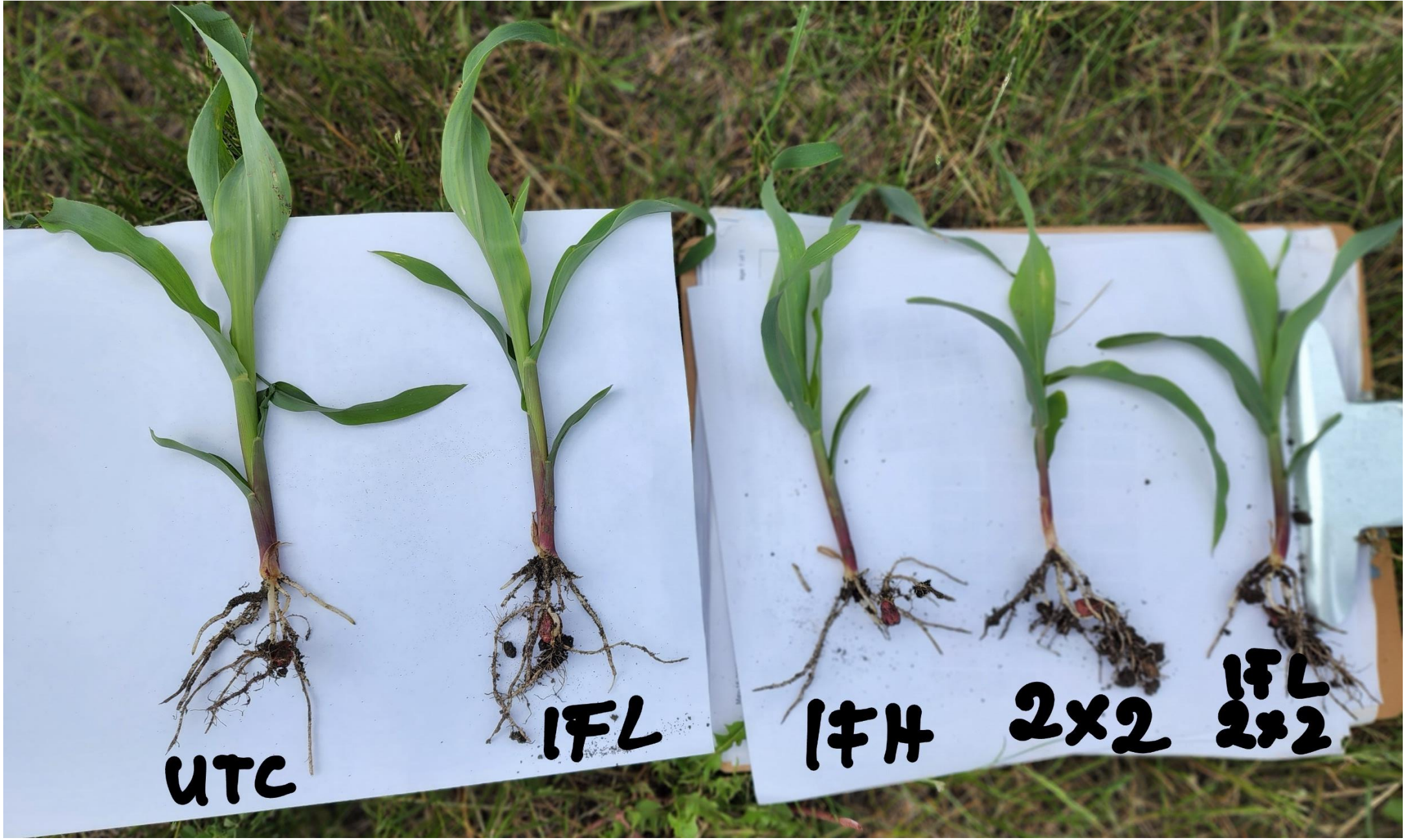

V6 Biomass and Nutrient Uptake

Treatment	DM	N	P		DM ('23)
PDate1	469 b	21.1 b	2.3 b		310 b
PDate2	726 a	29.8 a	3.7 a		410 a
Control	570 b	24.3 b	2.9		354
IF-L	567 b	24.9 ab	2.9		365
IF-H	596 ab	25.1 ab	3.0		381
2X2	598 ab	23.0 ab	2.9		342
2X2 + IF-L	656 a	27.7 a	3.2		361

(lbs ac^{-1})

South Shore, 2021, 23

V6 Biomass and Nutrient Uptake

Treatment	DM	N	P		DM ('23)
PDate1	413 b	14.2 b	1.4 b		313 b
PDate2	756 a	26.6 a	2.5 a		612 a
Control	502 d	17.2 b	1.8 b		434 b
IF-L	591 bc	20.3 ab	1.9 ab		449 ab
IF-H	630 ab	22.3 a	2.0 ab		465 ab
2X2	537 cd	19.9 ab	1.9 b		460 ab
2X2 + IF-L	663 a	22.9 a	2.2 a		499 a

(lbs ac^{-1})

Brookings, 2021, 23

V6 Biomass and Nutrient Uptake

Treatment	DM	N	P		DM ('23)
PDate1	359 b	12.2 b	1.4 b		267 b
PDate2	585 a	21.8 a	2.0 a		1151 a*
Control	412 b	15.4 b	1.5 b		675
IF-L	494 a	17.6 ab	1.8 ab		724
IF-H	457 ab	16.3 ab	1.6 ab		728
2X2	483 a	17.7 ab	1.8 ab		671
2X2 + IF-L	513 a	18.4 a	1.9 a		744

(lbs ac^{-1})

Beresford, 2021, 23

Beresford, July 10, 23

Starter Fertilizer Placement effect on Grain Yield

Treatment	2021	2022	2023
PDate1	226.7 b	208.8 a	188.8
PDate2	235.0 a	191.5 b	184.9
Control	232.4	203.0 ab	186.0
IF-L	234.2	204.4 a	185.7
IF-H	231.6	200.7 ab	186.1
2X2	227.0	195.6 b	186.8
2X2 + IF-L	229.1	197.1 ab	189.5

(bu ac^{-1})

South Shore, 2023

Starter Fertilizer Placement effect on Grain Yield

Treatment	2021	2022	2023
PDate1	177.3	179.9 a	171.4
PDate2	174.6	169.1 b	164.9
Control	185.4 a	171.5	170.6
IF-L	183.4 ab	173.8	168.9
IF-H	170.0 bc	178.3	167.4
2X2	173.8 abc	174.1	168.6
2X2 + IF-L	166.6 c	174.7	165.3

(bu ac^{-1})

Brookings, 2023

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South Dakota State University
Precision Ag Cropping System

Starter Fertilizer Placement effect on Grain Yield

Treatment	2021	2022	2023
PDate1	165.5 a	109.4	182.8 a
PDate2	156.8 b	115.3	171.5 b
Control	158.4	117.9	176.1
IF-L	164.9	106.2	175.6
IF-H	155.0	113.4	176.7
2X2	163.9	108.1	181.4
2X2 + IF-L	163.5	115.8	175.9

(bu ac^{-1})

Beresford, 2023

Starter Fertilizer Placement Effect on Corn

- Planting Dates
  - Early
  - Normal/Late
- Fertilizer Source
  - 10-34-0
  - 8-21-5

  } With and without Zn
- Fertilizer Placement
  - Control
  - In-furrow (low) – IFL (~9 lbs P_2O_5 ac^{-1})
  - In-furrow (high) – IFH (~14 lbs P_2O_5 ac^{-1})
  - 2 x 2 (~23 lbs P_2O_5 ac^{-1})
  - 2 x 2 + in-furrow low

Starter Fertilizer Placement Effect on Corn

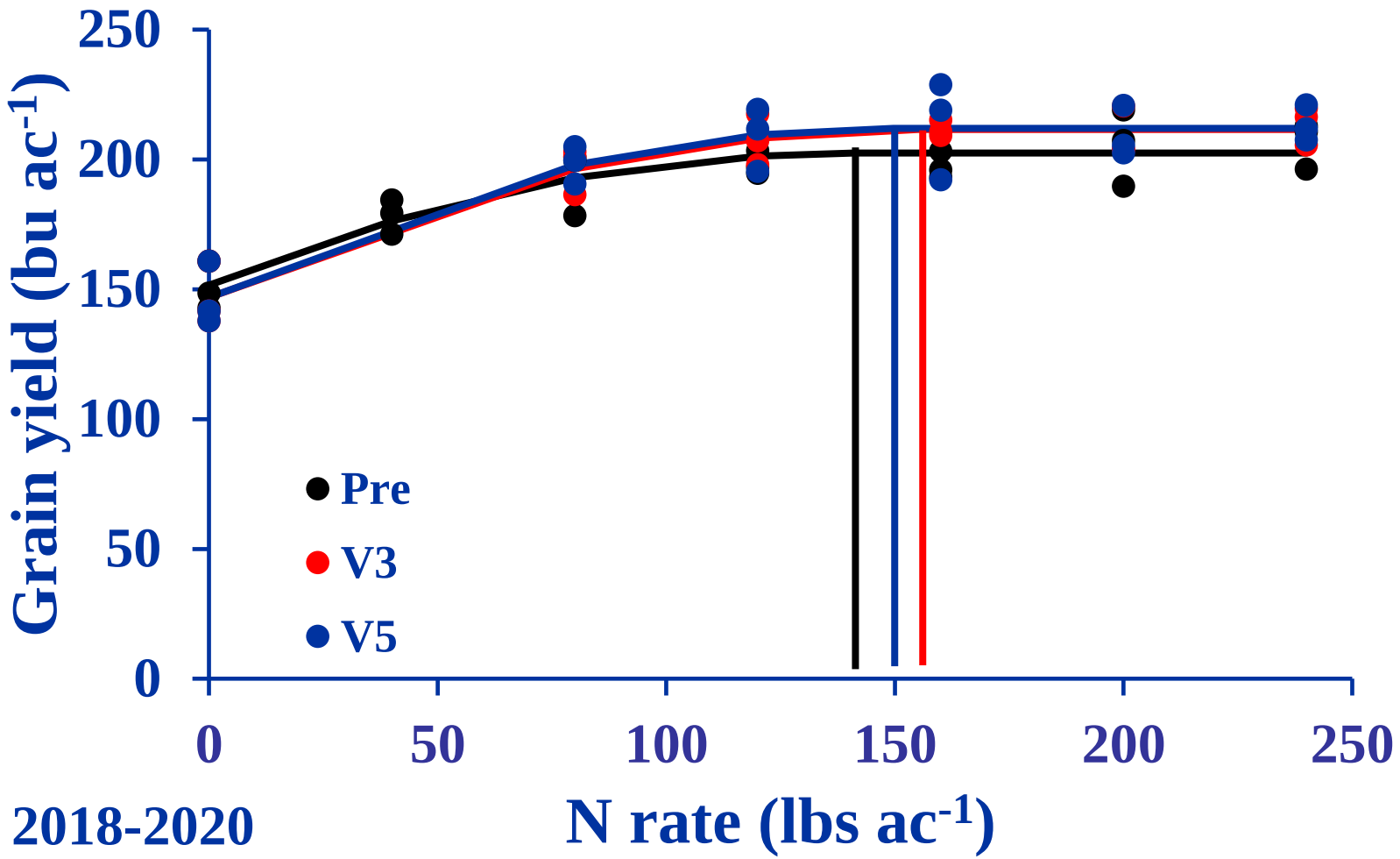
- Planting Dates
  - Early
  - Normal/Late
- Fertilizer Source
  - 10-34-0
- Fertilizer Placement
  - Control
  - In-furrow (low) – IFL 2.5 GPA (~9 lbs P_2O_5 ac^{-1})
  - In-furrow (high) – IFH 3.5 GPA (~14 lbs P_2O_5 ac^{-1})
  - In-furrow (VH) 5 GPA (~20 lbs P_2O_5 ac^{-1}) (± 12 GPA UAN – 2X2)
  - In-furrow (UH) 8 GPA (~32 lbs P_2O_5 ac^{-1}) (± 12 GPA UAN – 2X2)

In-furrow Fertilizer Rate effect on Grain Yield

Treatment	NERF	BRS	SERF
Control	184.9	164.5	174.8
2.5 GPA 10-34-0 IF	189.9	162.9	174.8
3.5 GPA 10-34-0 IF	180.9	172.3	183.0
5 GPA 10-34-0 IF	177.8	160.0	180.9
5 GPA 10-34-0 IF + 2X2 UAN	186.9	168.0	178.6
8 GPA 10-34-0 IF	188.3	161.1	187.1
8 GPA 10-34-0 IF + 2X2 UAN	179.7	174.3	188.1

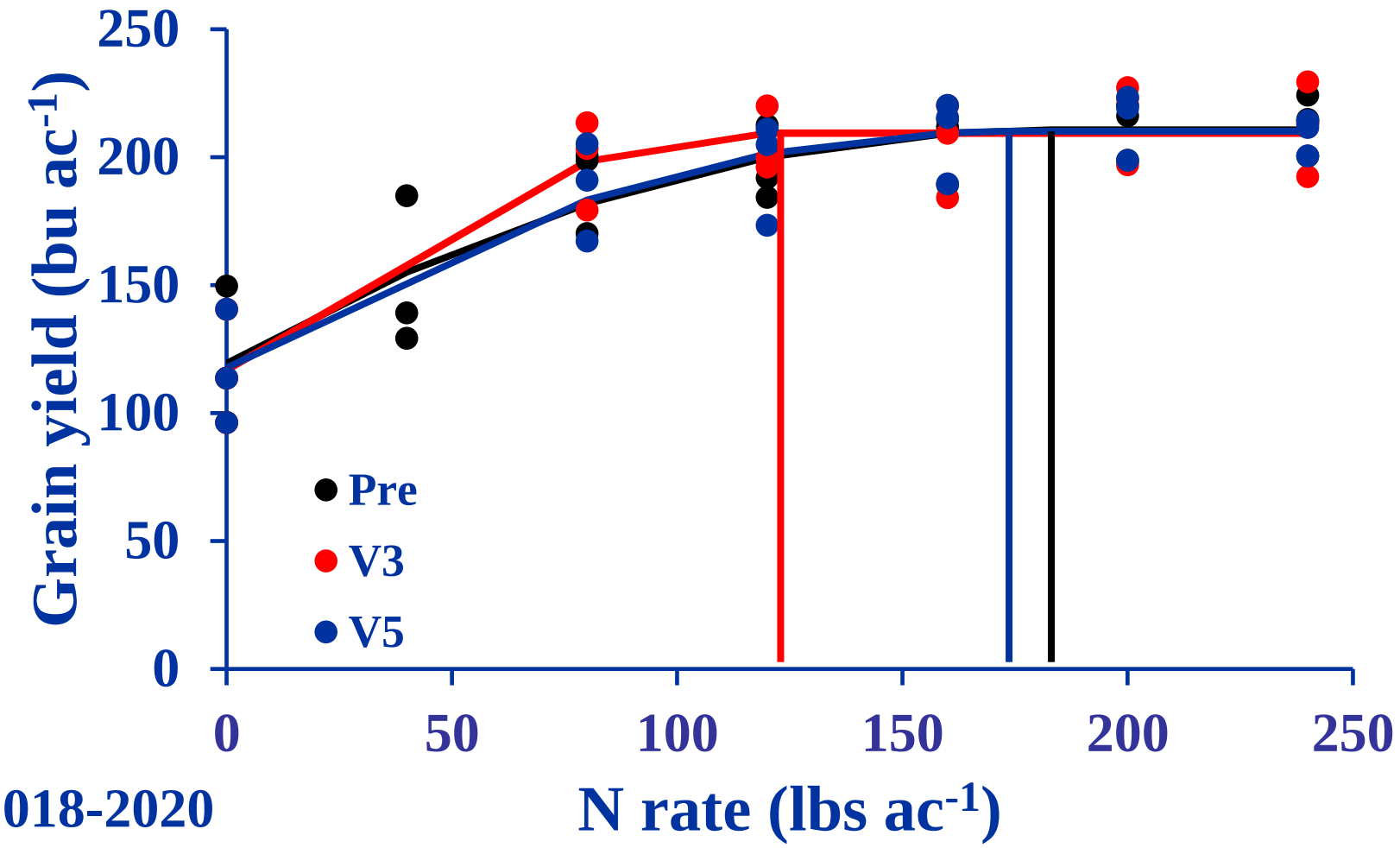
(bu ac^{-1})

Early-season split N application



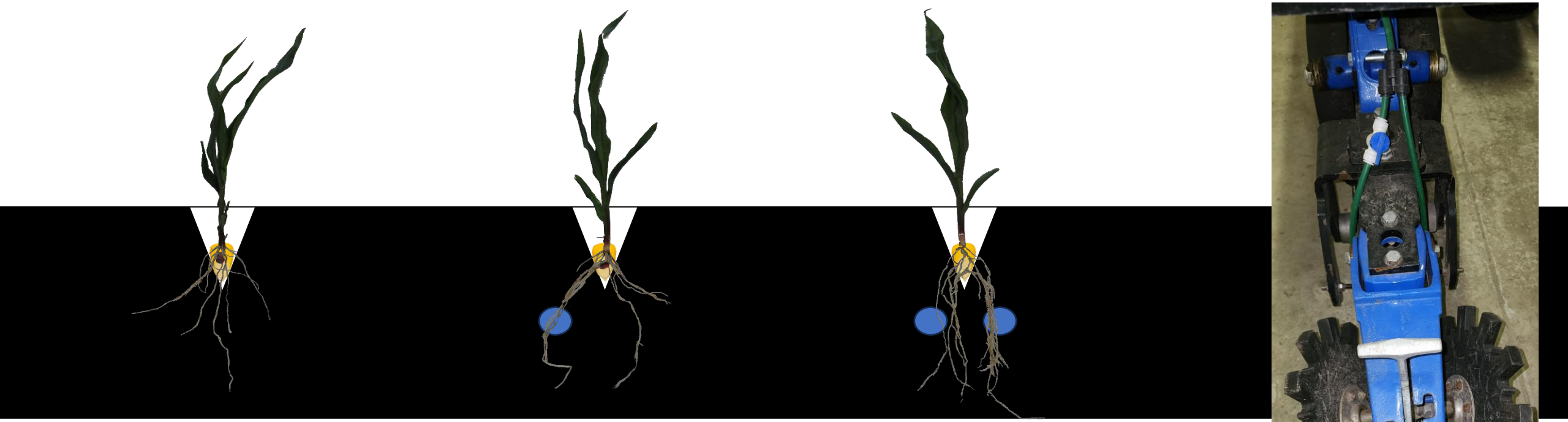
South Shore, 2018-2020

Early-season split N application



Beresford, 2018-2020

Optimizing N fertilizer placement?

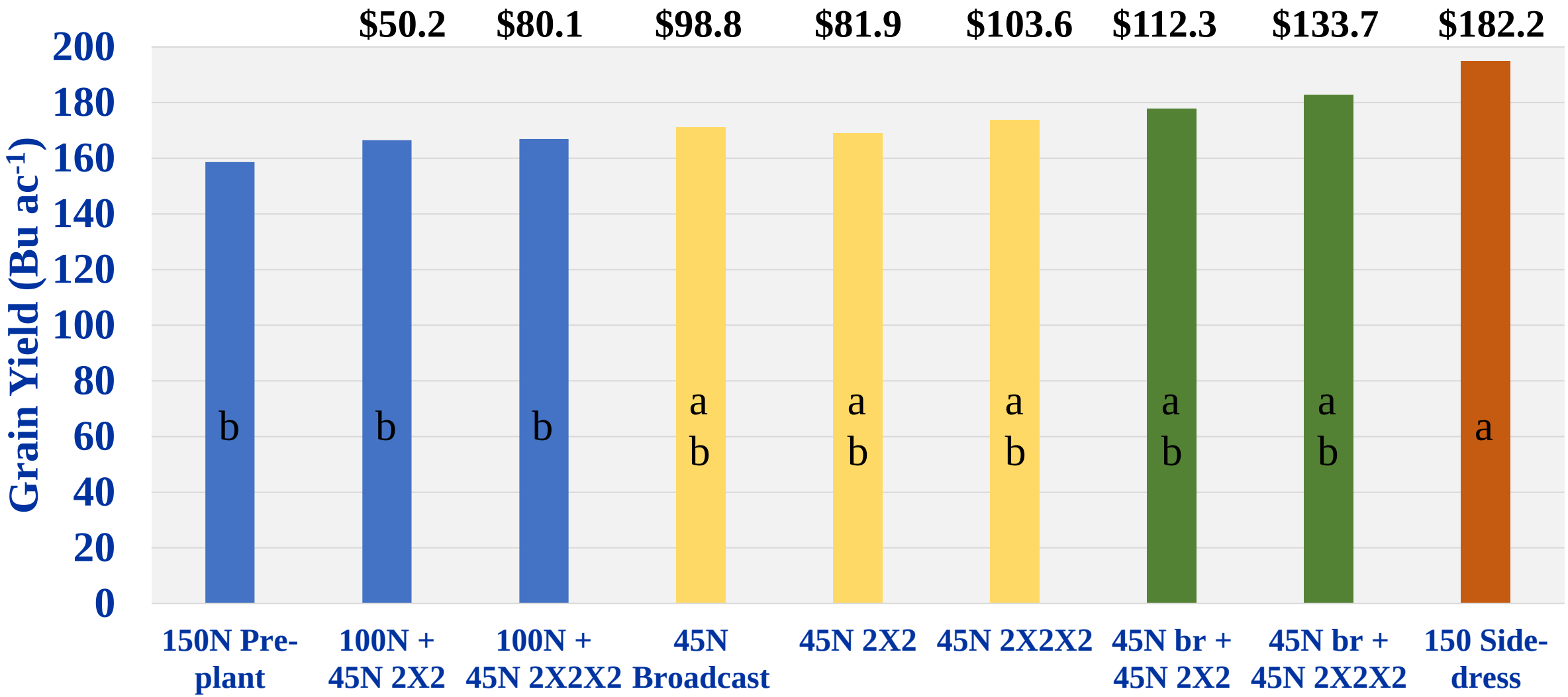


No starter fertilizer **2 X 2** **2 X 2 X 2**

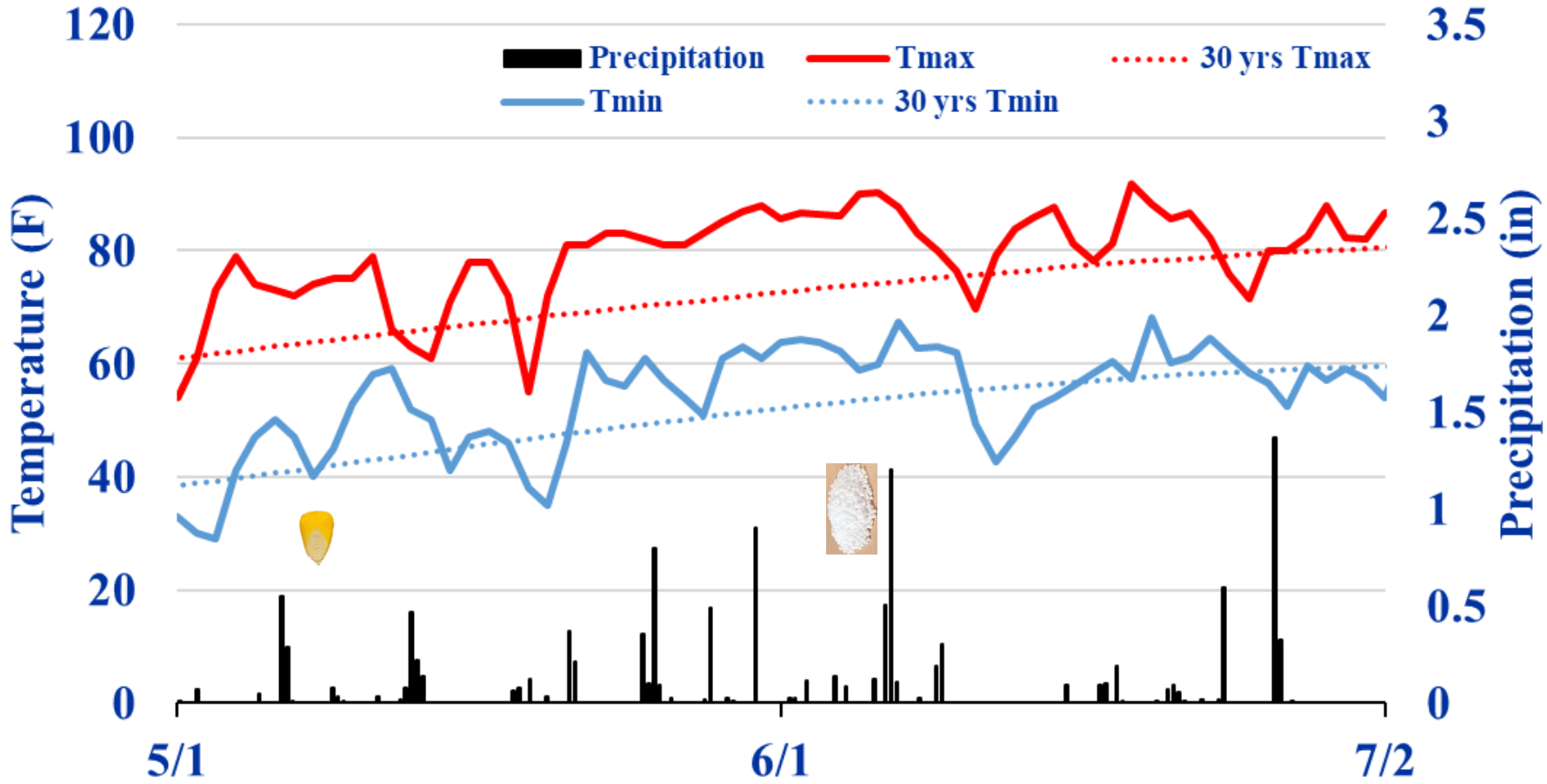
Optimizing N Placement at Planting

	Pre-plant	Starter		Side-dress
Treatment	Broadcast N	2 X 2	2 x 2 x 2	Broadcast N
	(lbs ac^{-1})	(lbs ac^{-1})	(lbs ac^{-1})	(lbs ac^{-1})
1	150			
2	105	45		
3	105		45	
5	45			105
5		45		105
6			45	105
7	45	45		60
8	45		45	60
9				150

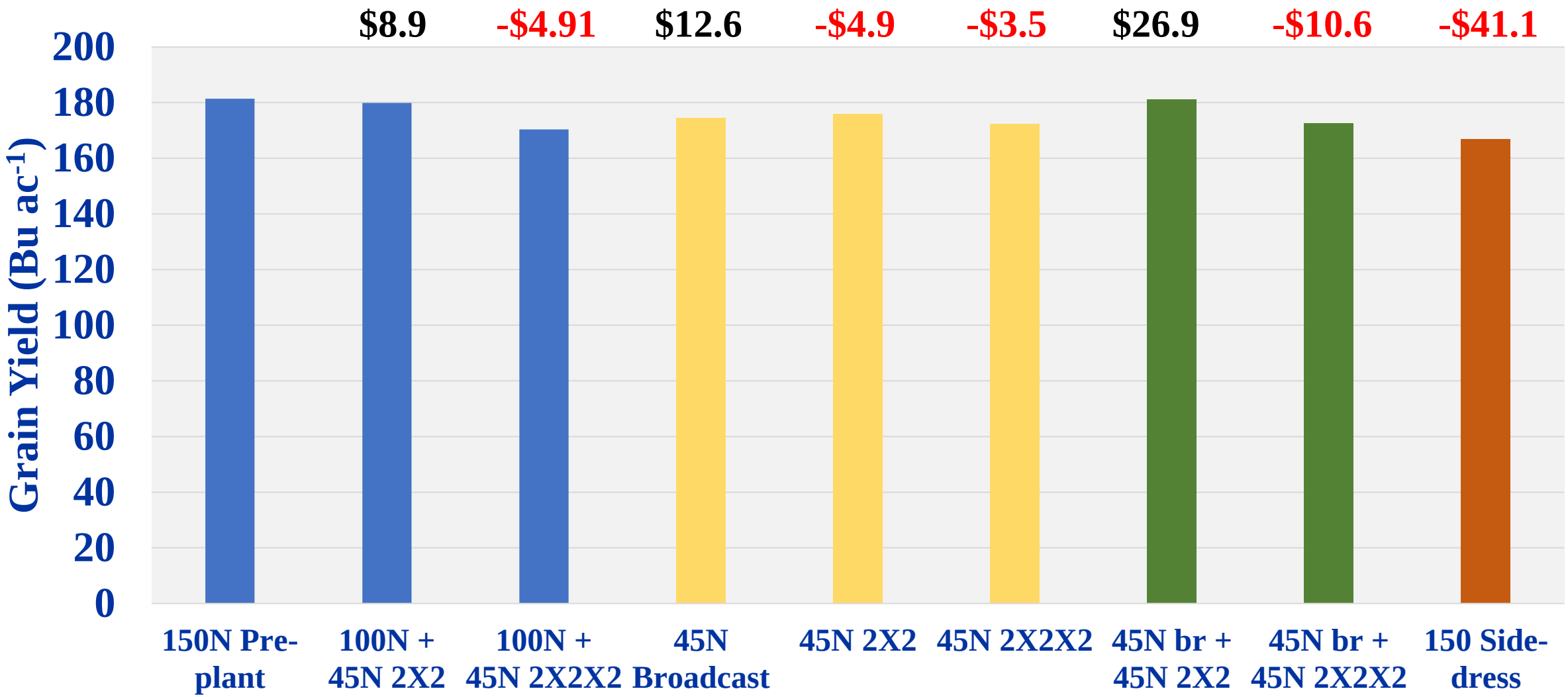
N Placement Effect on Grain Yield



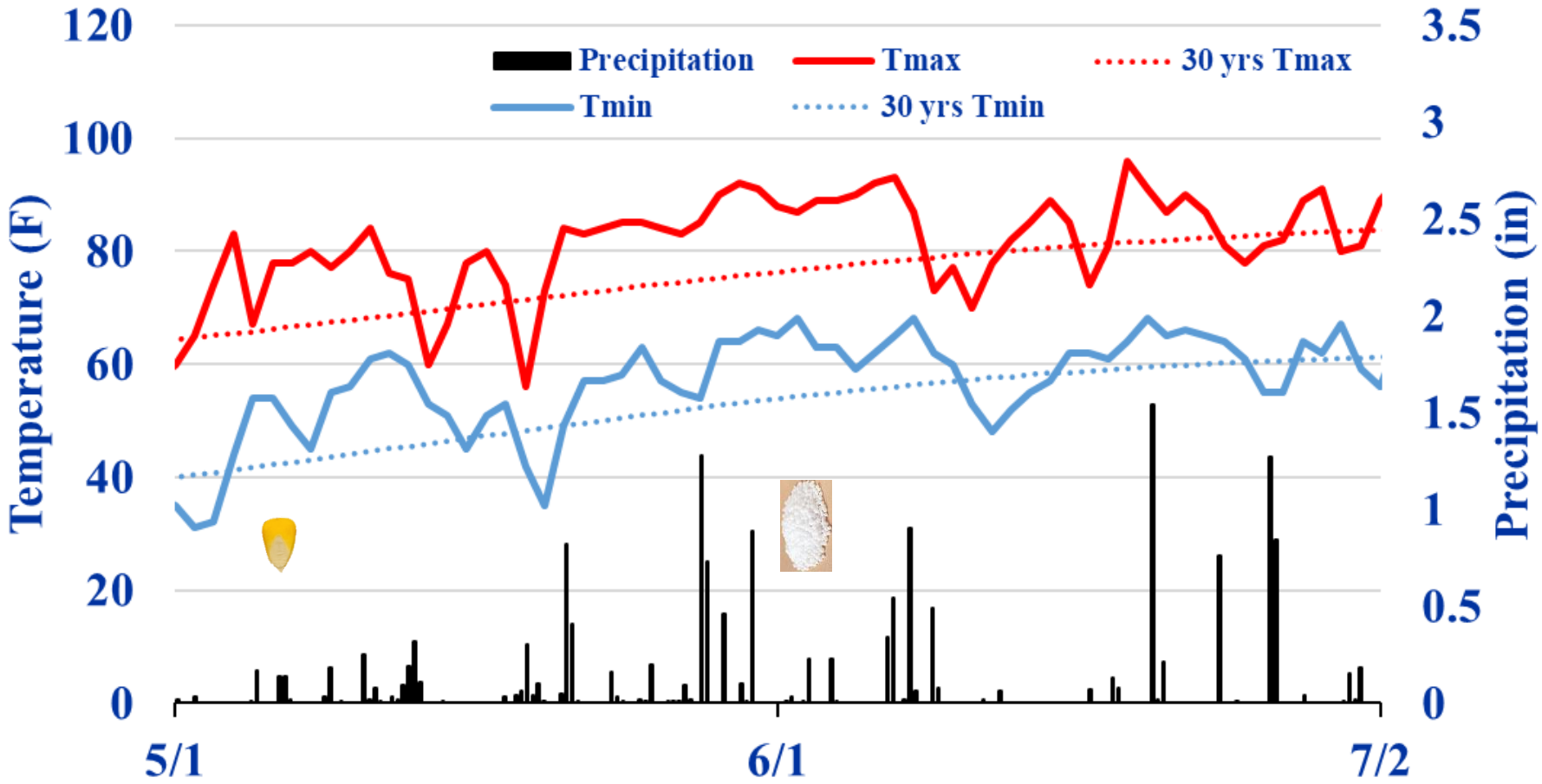
Weather around N application



N Placement Effect on Grain Yield



Weather around N application

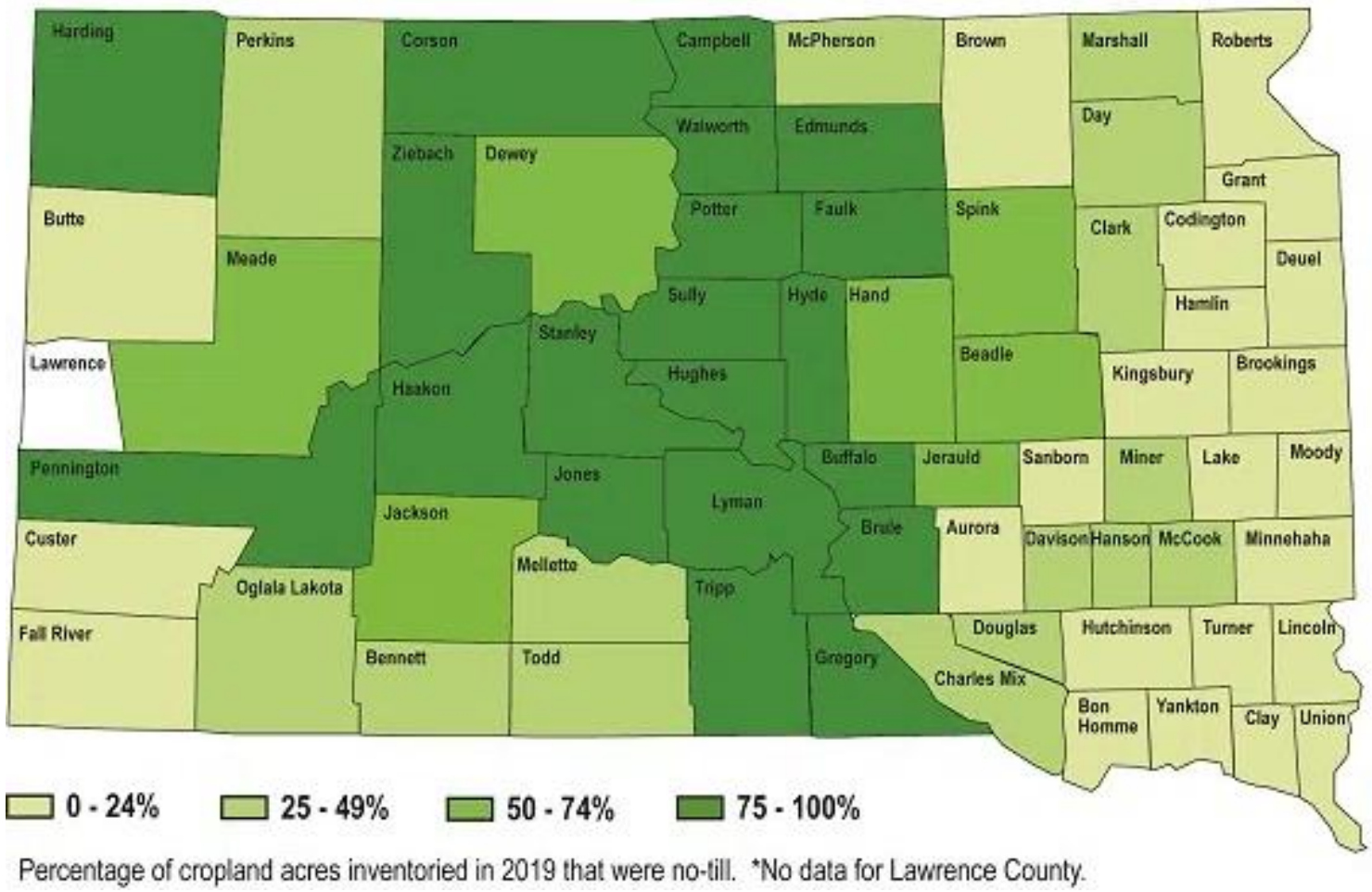


In-season N application options

Early-season N placement Effect on Grain Yield

N rate	Placement	2021	2022
(lbs ac^{-1})		(bu ac^{-1})	(bu ac^{-1})
140	Broadcast	161.8	162.9 ab
	Banding	161.3	164.3 ab
	Y-Drop	168.8	172.1 a
100	Broadcast	160.7	160.2 b
	Banding	163.0	173.2 a
	Y-Drop	162.5	158.1 b

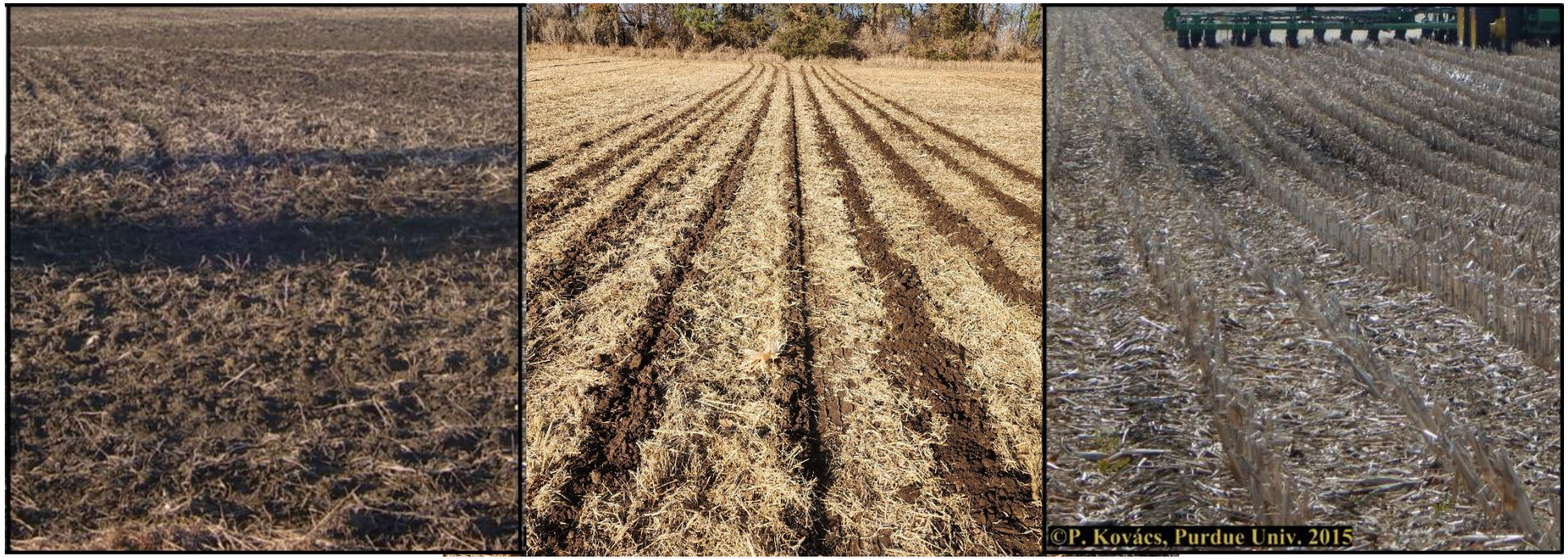
No-till practices in SD



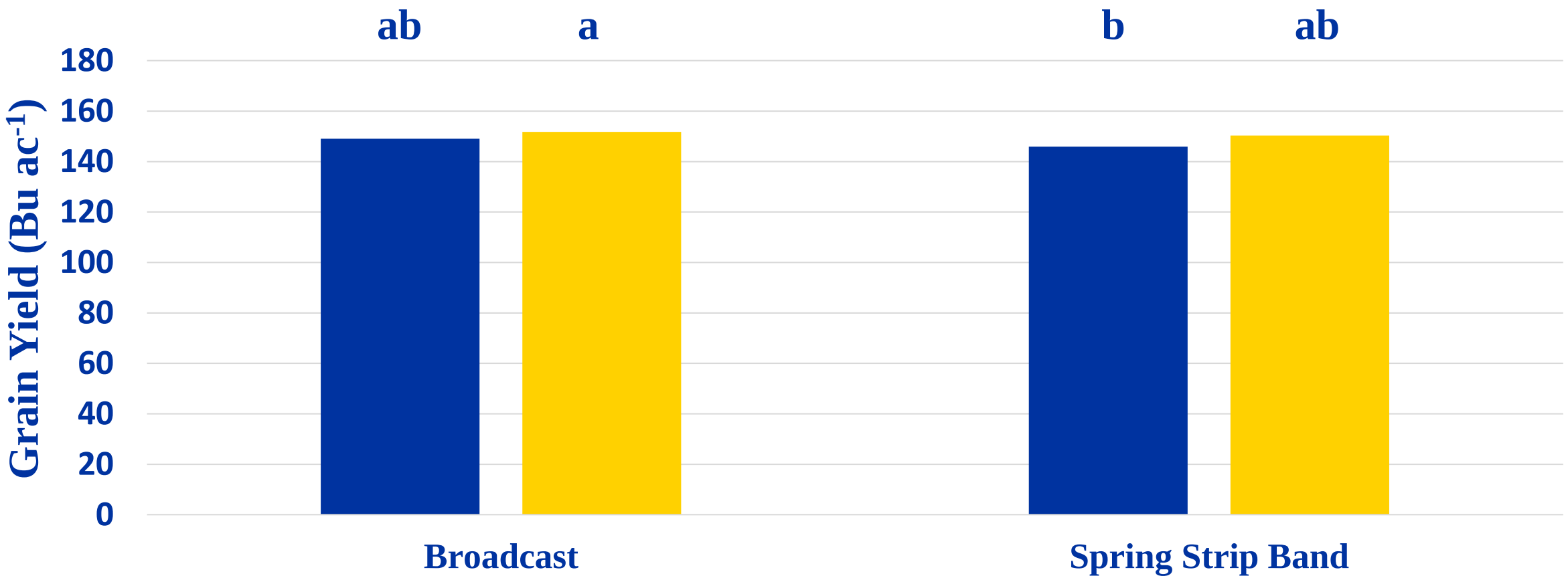
Percentage of cropland acres inventoried in 2019 that were no-till. *No data for Lawrence County.

(SD NRCS, 2019)

Is strip-tillage the gateway?



P and K banding on Grain Yield



3:2 Potash : MAP

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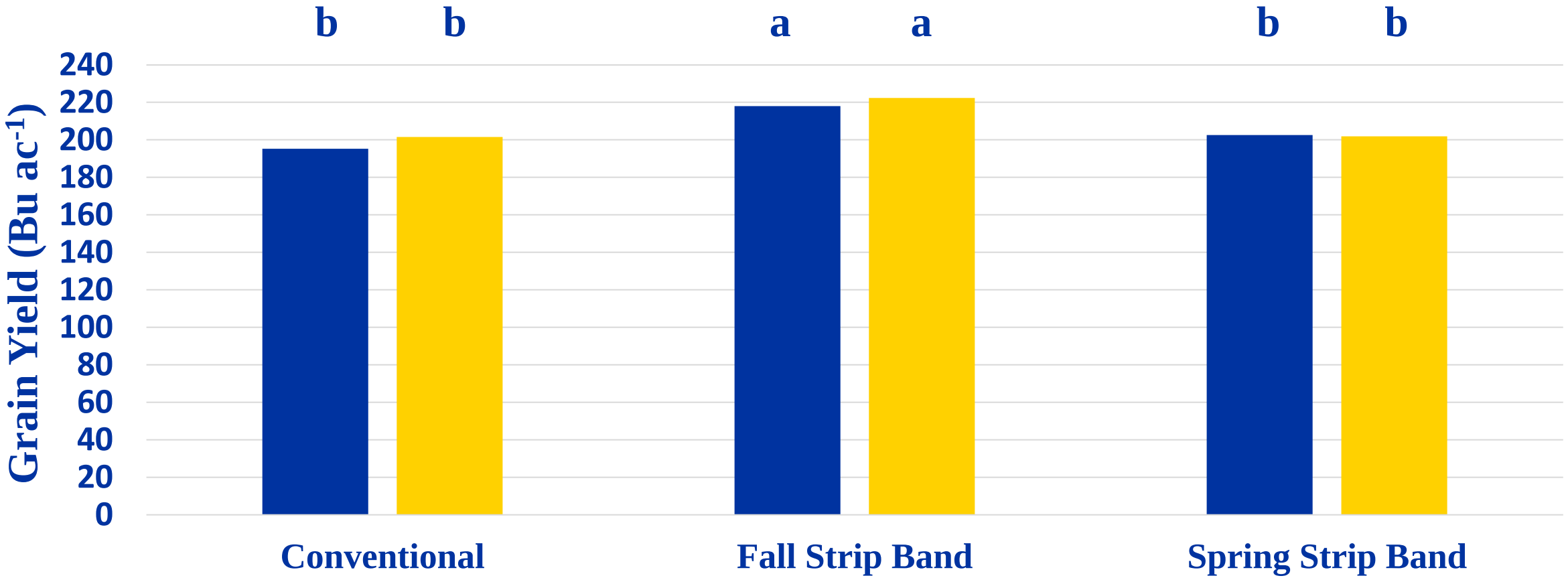
ver.2023. 12. 18.

Strip-till Effect on Grain Yield



3:2 Potash : MAP

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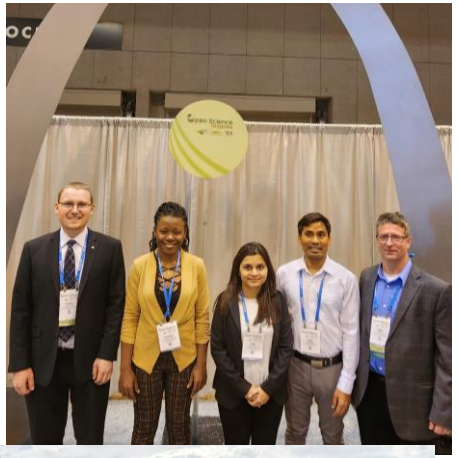
Acknowledgment



- SD Nutrient Research and Education Council
- Undergraduate and Graduate Students
- SD Ag Experimental Station
- USDA – NIFA
- Koch, NACHURS, Corteva, ETS

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USDA NIFA

SDSU Agricultural Experiment Station Research

KOCH FERTILIZER

ETS ENVIRONMENTAL TILLAGE SYSTEMS

soil WARRIOR

South Dakota State University
Precision Ag Cropping System

Thank you

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