Variable Rate Starter Fertilization Based on Soil Attributes

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Fluid Fertilizer Forum,

Scottsdale, AZ

February, 15 and 16, 2016

Funding provided by the Fluid Fertilizer Foundation

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Justification

- A fluid starter fertilizer, like ammonium poly phosphate (APP), applied in-furrow may be an efficient and economic alternative to a traditional broadcast application. Especially:
  - on short-term rented land, where the farmer is not necessarily interested in building soil test levels,
  - when commodity prices are lower and input cost reductions are desired and
  - on high pH soils that have the potential to fix P.

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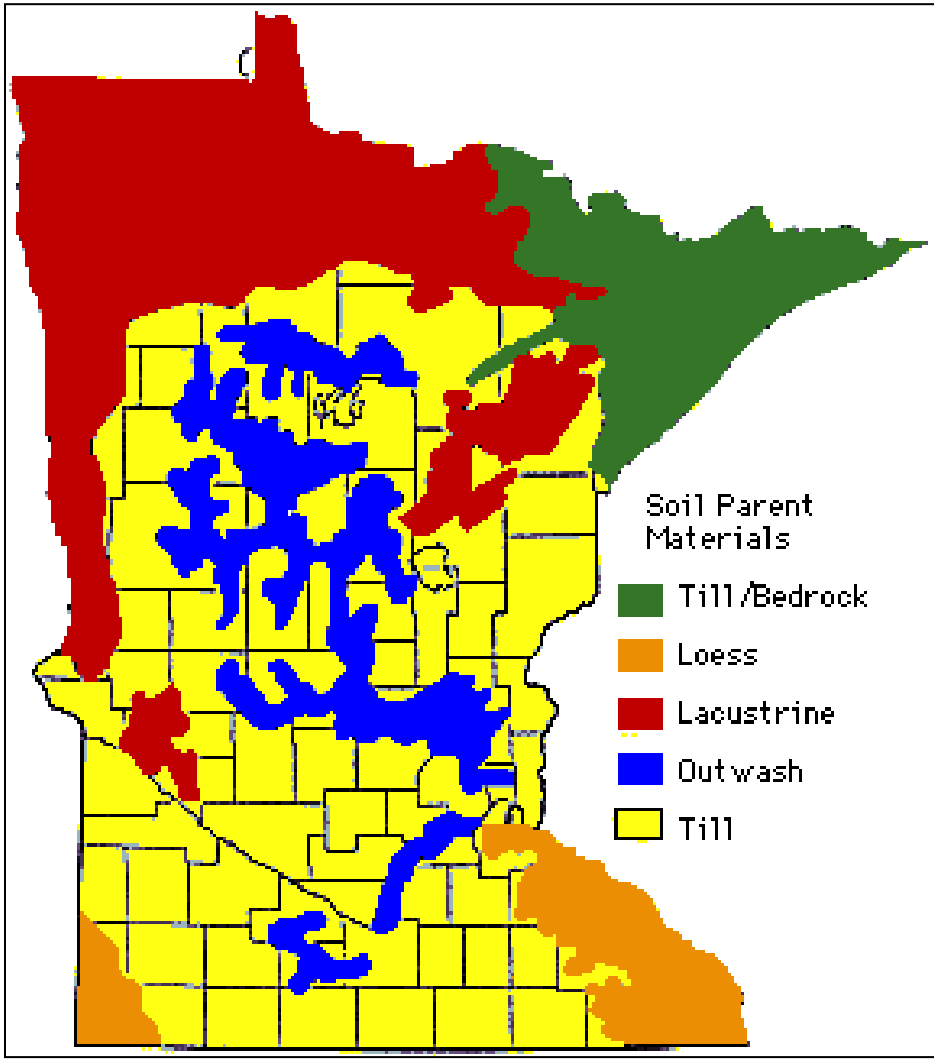
Soil parent materials of Minnesota

- Glacial till / bedrock
- Loess
- Outwash
- Glacial till
- Lacustrine



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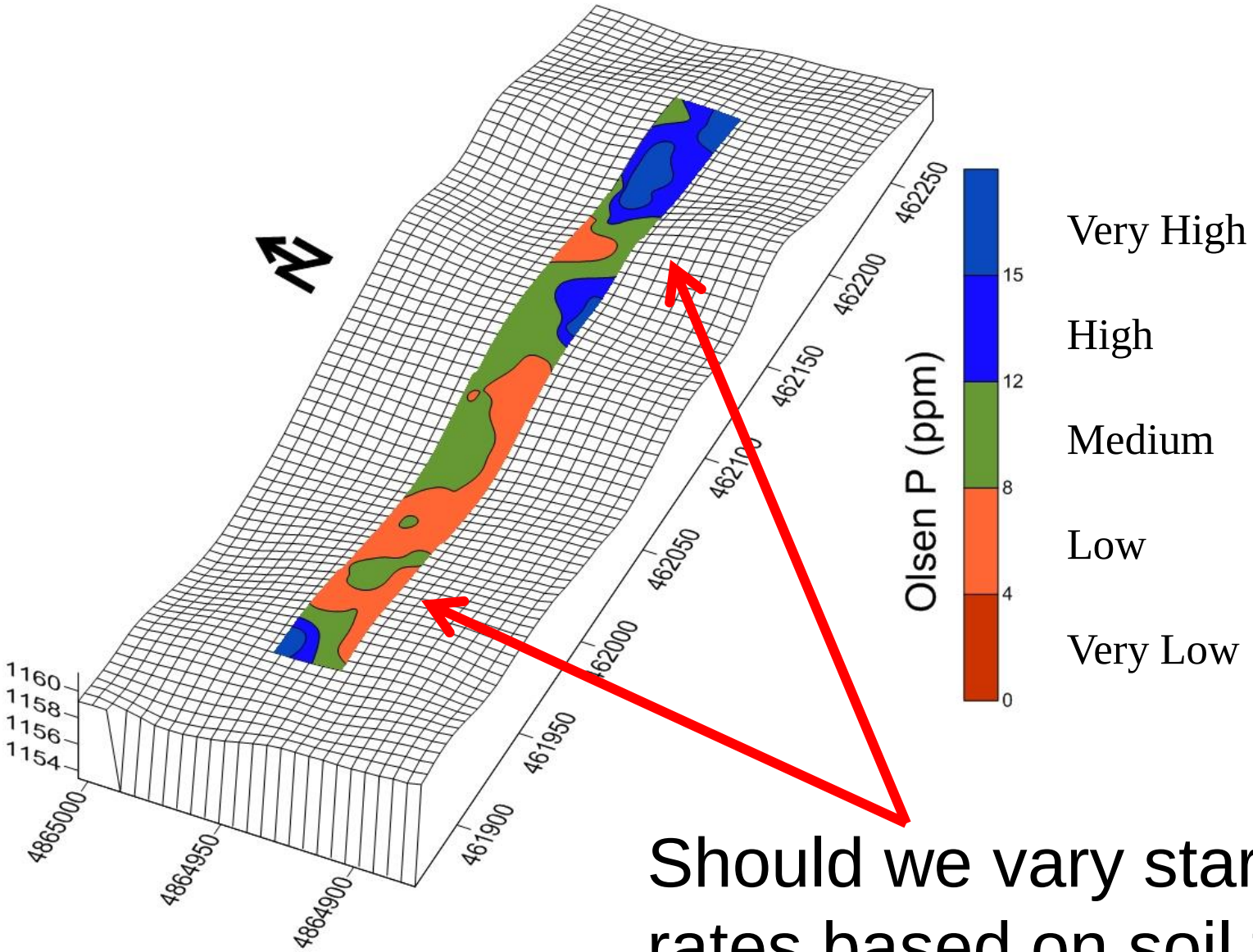
VR Starter New Richland 2013



Should we vary starter rates based on soil test P or pH?

Additional questions

- What is the benefit of starter fertilizer with and without broadcast P fertilizer?
- How do starter and broadcast P applications affect yield response across the landscape?

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- The objectives of this study were to:
  1) measure the effect of APP rate on early growth of corn and grain yield;
  2) determine if the optimum rate of APP varies within a typical Minnesota field;
  3) develop and calibrate an algorithm for making variable rate starter applications based on soil attributes; and
  4) compare and contrast the effects of a traditional broadcast P application on the response(s) observed in objectives 1, 2 and 3.

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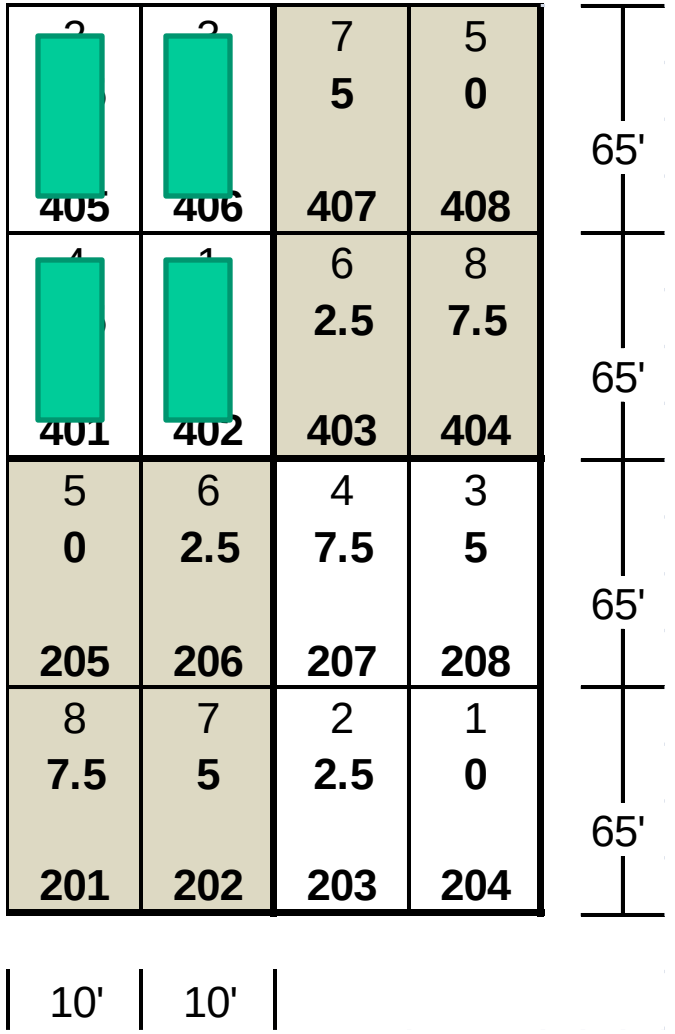
Experimental design

- Modified strip trial design
- Treatments randomized within replications in a split-plot arrangement
  - Main plot: Broadcast P rate (2)
  - Sub plot: APP starter rates (4)
- 16 replications per location
  - 16 reps × 8 treatments = 128 plots
- Response data from replications with similar soil attributes are pooled together



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Methods and measurements

- Ten field studies were conducted from 2012-2015 on fields with varying soil test P and pH.
- Broadcast P applied at 0 and 120 lb P_2O_5/ac (TSP).
- APP applied in-furrow at 0, 2.5, 5 and 7.5 gal/ac or about 0, 10, 20 and 30 lb P_2O_5/ac.
- At V5-6 harvest 8 whole plants measure: yield, P concentration and P uptake.
- Grain harvest measure: yield, moisture, P concentration and P removal in corn grain.

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Methods (continued)

- Soil samples analyzed for Bray P1, Olsen P, pH, $CaCO_3$ and exchangeable K
  - 0-6 inch samples: one composite (8 cores) sample from two neighboring plots or an area about 15 ft. by 35 ft.
  - 6-12 inch samples: one composite (16 cores) for each replication or an area 40 ft. by 130 ft (0.12 ac).

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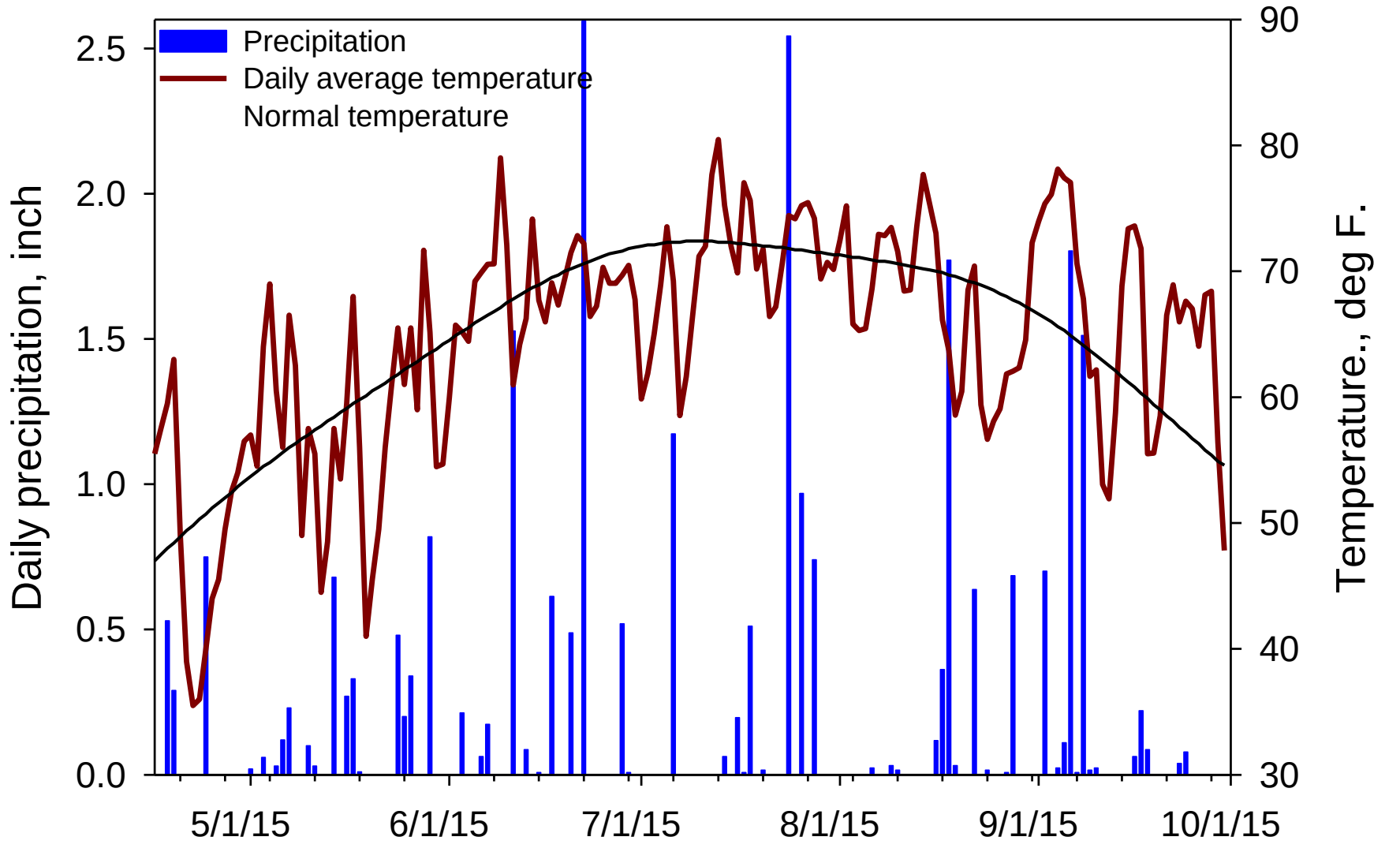
Precipitation and temperature at New Richland



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Weather summary: 2012–2015

- 2012: early spring (planting), very warm early, summer drought reduced yields
- 2013: cool and wet spring, snow delayed planting, late summer drought reduced yields
- 2014: awful growing season, record wet June, cool, summer drought, early frost
- 2015: early spring (planting) but cool, ample well distributed rainfall, EXCELLENT growing season

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Summary of soil test attributes (2015)

Location	Soil Depth	SOM	pH Avg.	pH Range	Olsen P Avg.	Olsen P Range
	inch	%			--- ppm ---	
New Rich.	0-6	5.6	7.6	7.0-7.9	9	3-17
	6-12	4.7	7.0	6.7-8.0	3	3-9
Clarkfield	0-6	4.2	7.8	6.8-8.0	9	4-20
	6-12	4.0	7.9	7.6-8.1	3	2-5

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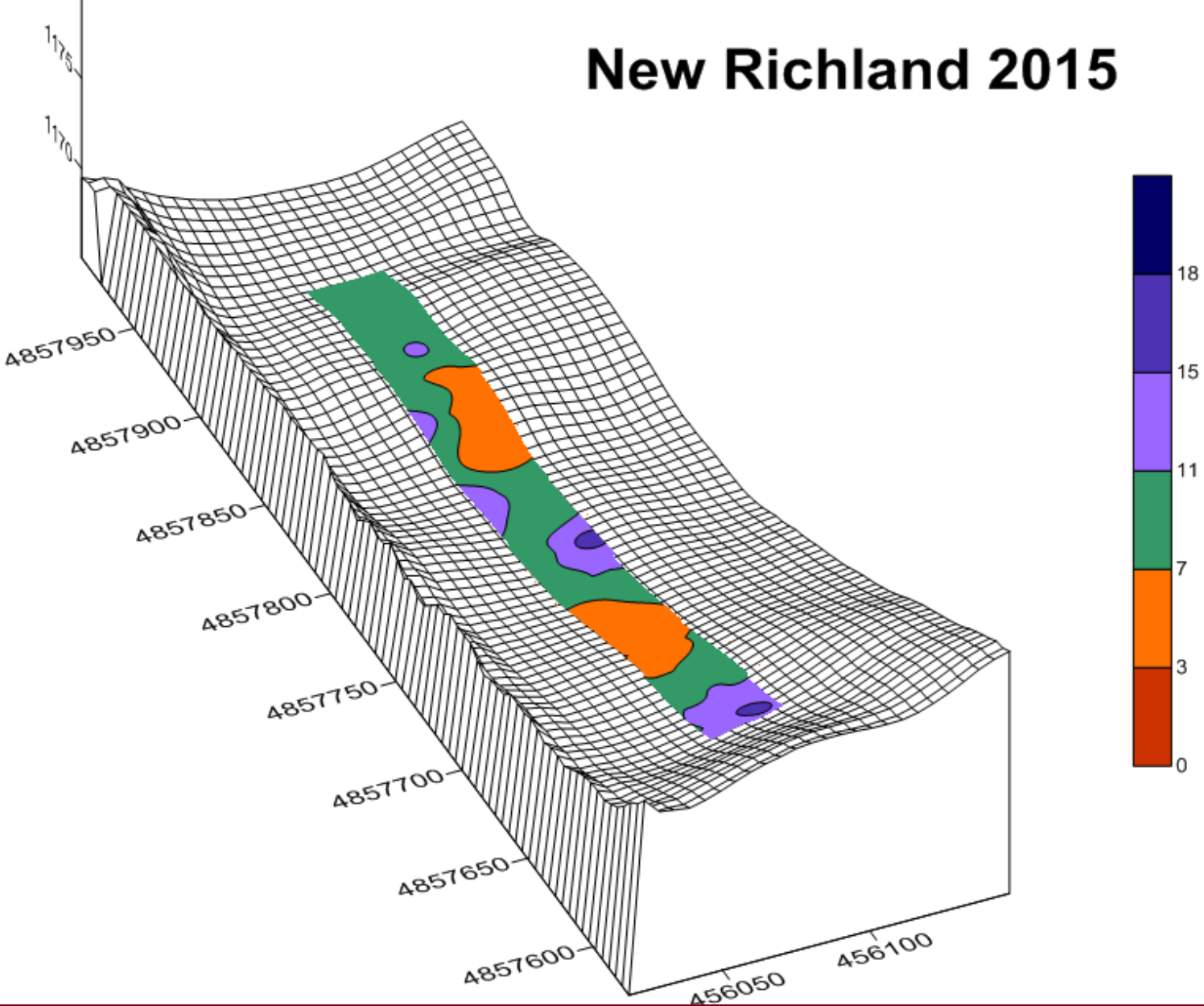
New Richland 2015



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Clarkfield 2015

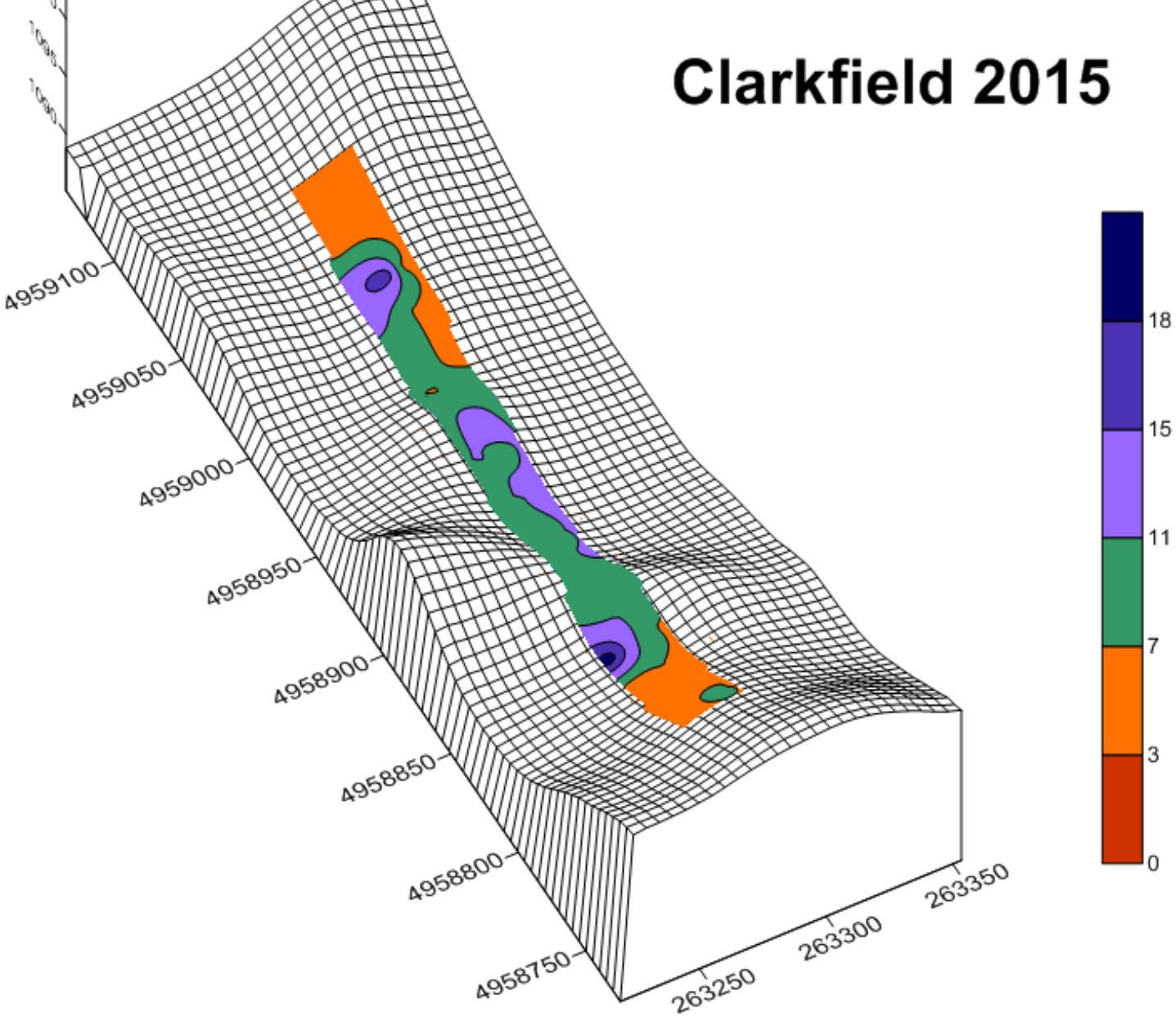

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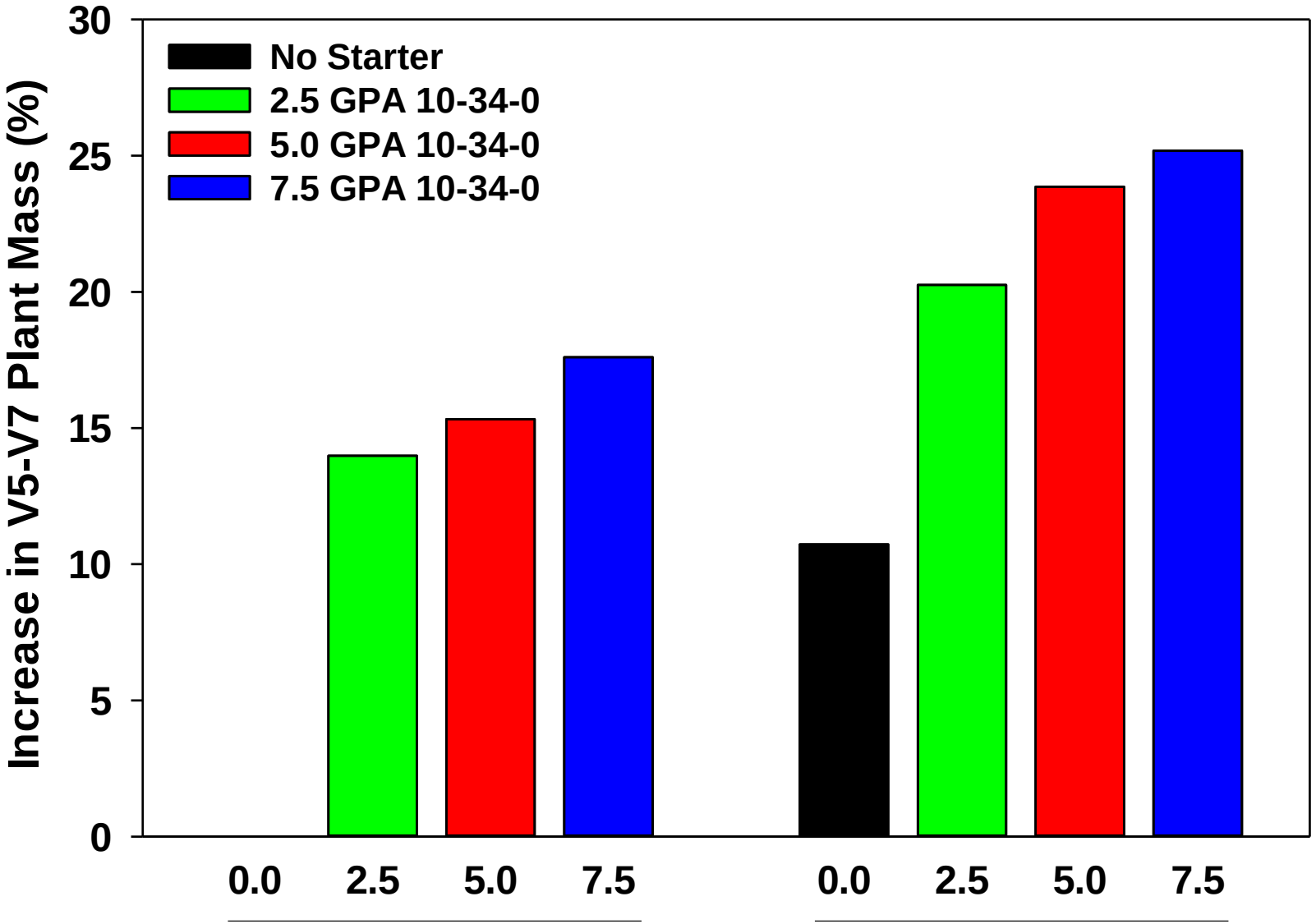
Figure 1. Increase in early plant growth over the control (no starter or broadcast P) averaged across eight southern Minnesota field locations.



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Summary: V5-6 whole plants

- When averaged across sites:
  - Starter as APP applied in-furrow increased V5 corn plant mass.
  - Broadcast P increased plant mass but not as much as starter
  - Plant mass increased slightly with increasing APP rate.

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Significance of treatment main effects for grain yield and moisture by location (2015).

Parameter	Location	Broadcast P	Starter P	Bdct*Starter
		----------P > F----------		
Grain Yield	New Richland	0.644	0.253	0.954
	Clarkfield	**<0.001**	0.498	0.156
Grain Moisture	New Richland	0.614	0.927	0.691
	Clarkfield	0.320	0.698	0.410

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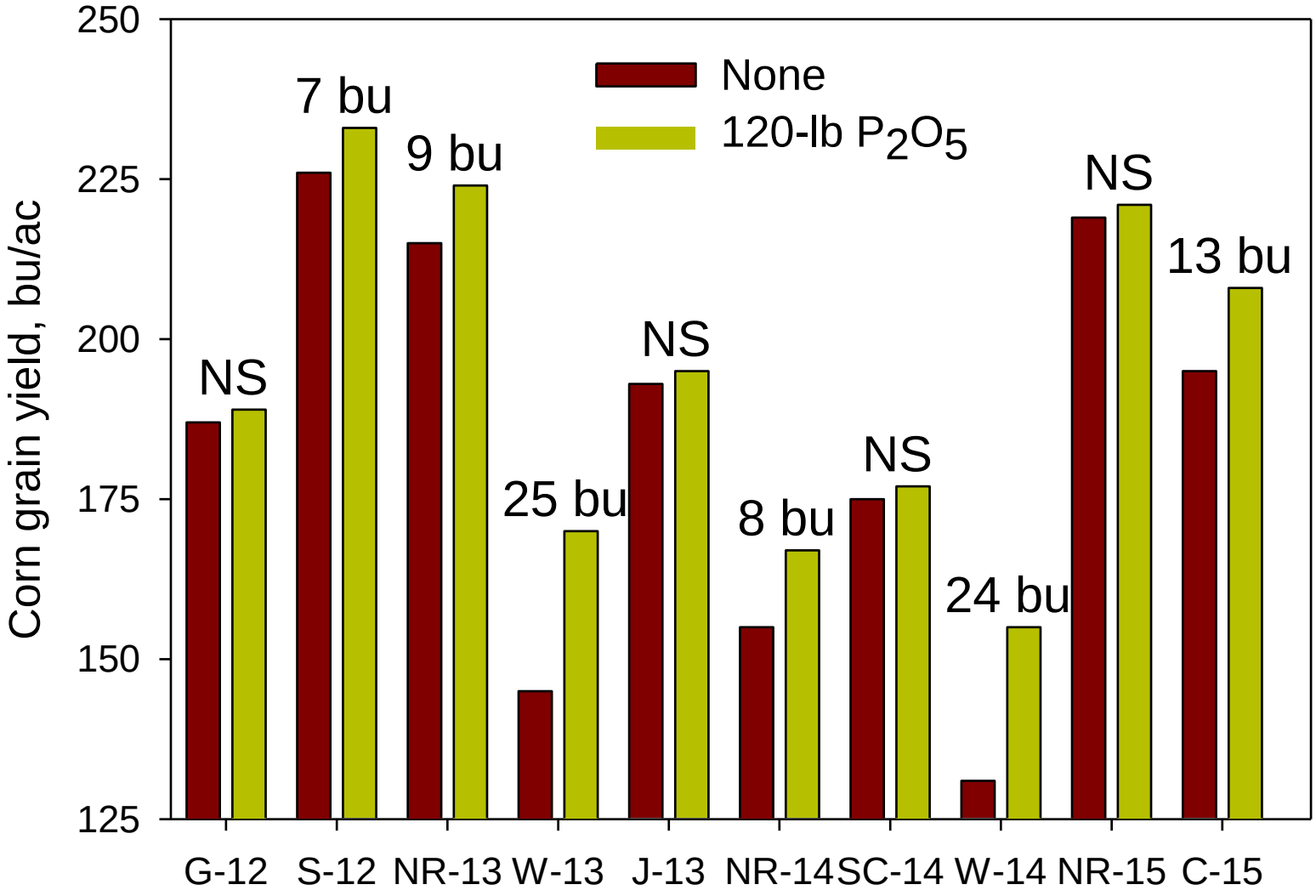
Corn yield as affected by broadcast P



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Main effects summary for grain yield

- Broadcast P increased grain yields at 1 of 2 sites in 2015 and 6 of 10 sites overall.
  - Yield response ranged from 7 – 25 bu/ac.
- Starter fertilizer increased grain yields in 3 of 10 sites overall, none in 2015.

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Relative yield as affected by treatment main effects across locations.

Treatment Effects	Relative yield
Olsen P Level or Class	**%**
Very Low (0-3 ppm Olsen)	83.2 c
Low (4-7 ppm Olsen)	96.6 b
Medium (8-11 ppm)	99.0 a
High (12-15 ppm)	100.9 a
Very High (16+ ppm)	100.1 a
Broadcast Rate	
0 lb P_2O_5/ac	92.7 b
120 lb	99.3 a
Starter (APP, 10-34-0) Rate	
0 gal/ac	93.5 b
2.5 gal	94.8 b
5.0 gal	98.0 a
7.5 gal	97.6 a

Relative yield as affected by treatment main effects across locations.

Treatment Effects	Relative yield
Interactions, (*P* > *F*)	
Olsen Level×Broadcast Rate	**<0.001**
Olsen Level×Starter Rate	0.103
Broadcast Rate×Starter Rate	**0.001**
Olsen Level×Broadcast×Starter	0.124

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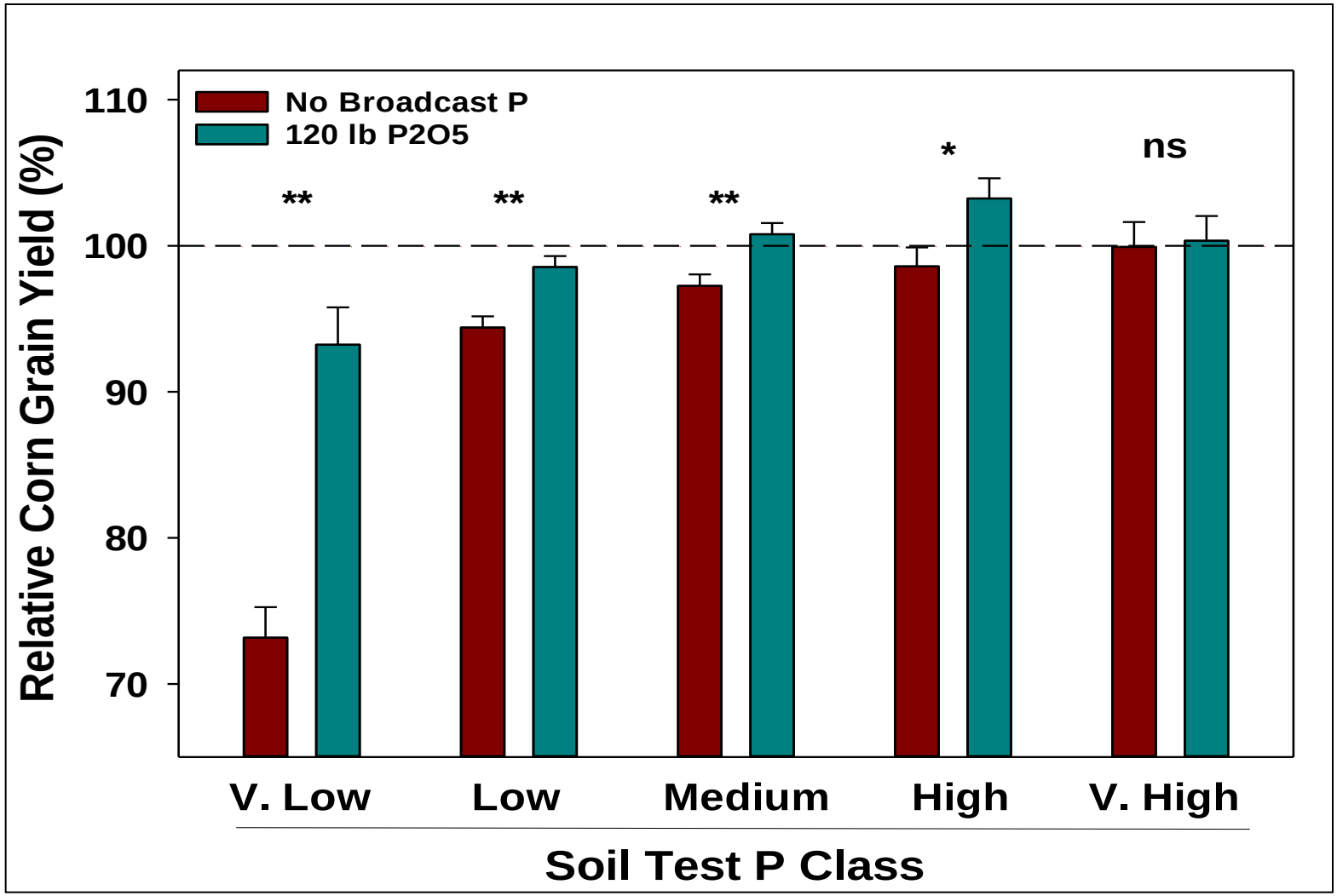
Relative yield as affected by the interaction between Olsen P level and broadcast P.



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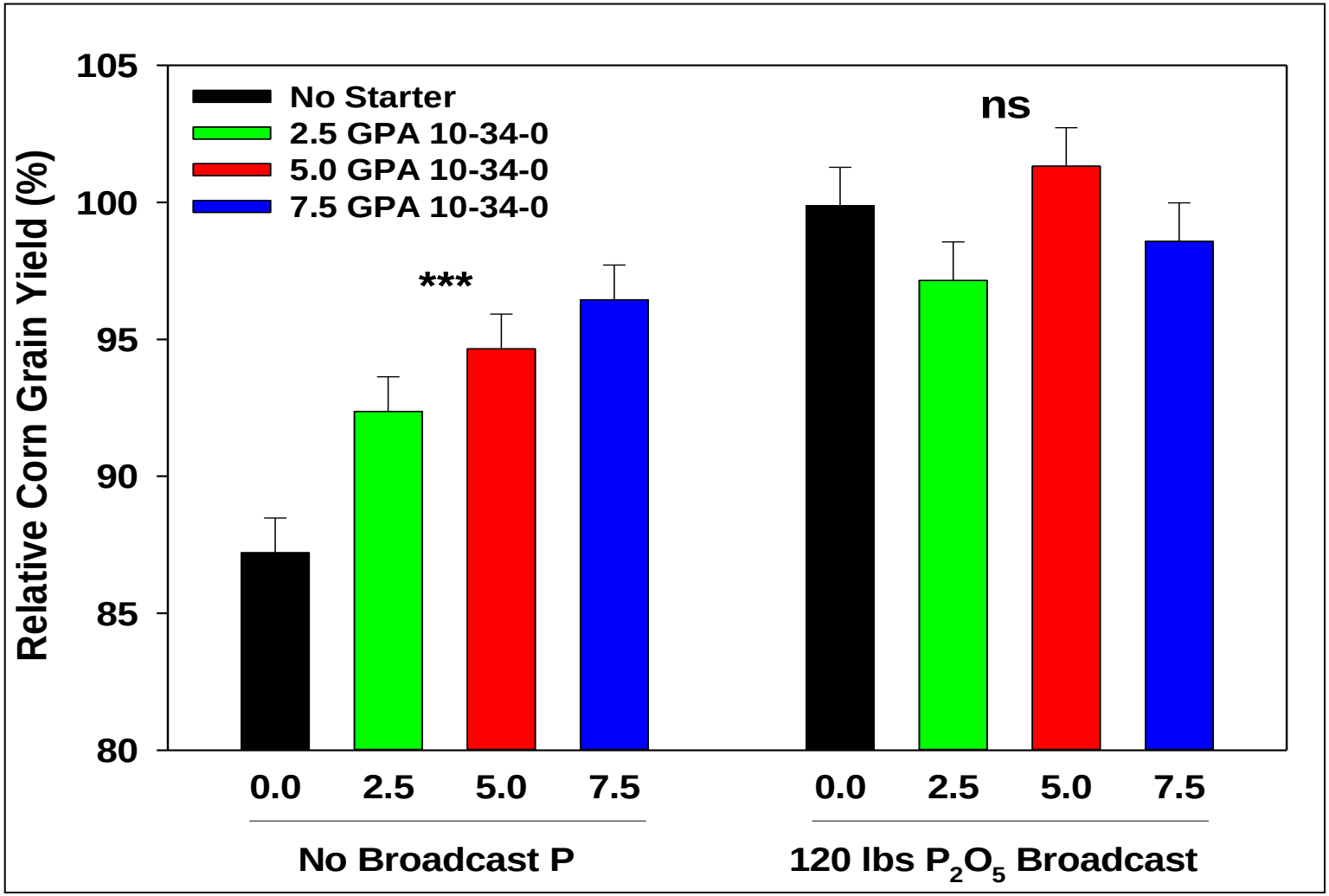
Relative yield as affected by the interaction between broadcast and starter P rates.



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Summary for relative yield across sites.

- All main effects (Olsen P level, broadcast P and starter P) affected relative yields.
- A significant Olsen P level × broadcast P rate interaction showed: broadcast P increased yields at Very Low, Low, Medium and High Olsen P levels but not at Very High level (>16 ppm).
- A significant broadcast × starter P interaction showed starter P increased yields only when broadcast P was not applied.

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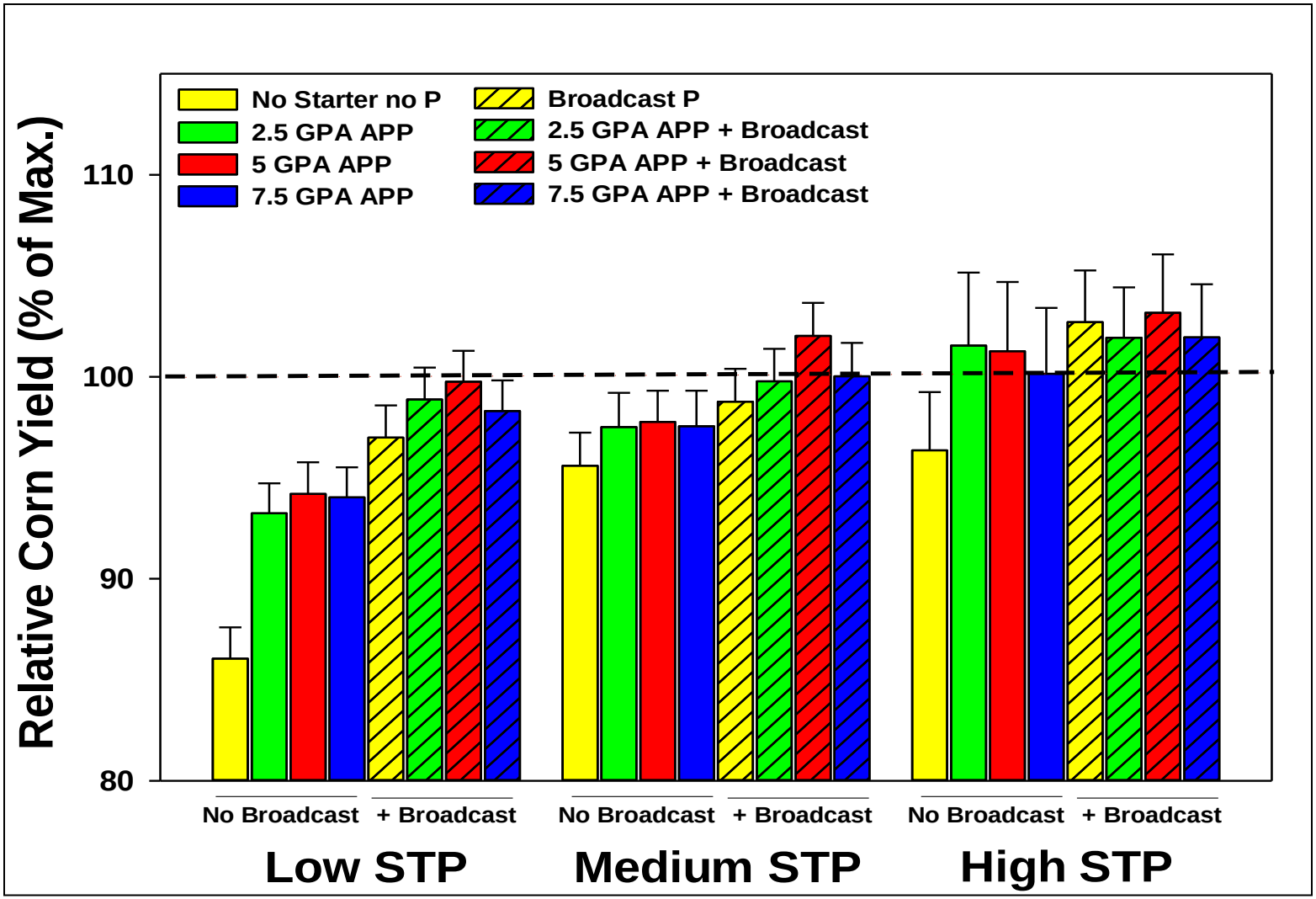
Relative yield as affected by broadcast and starter P rates across soil test P classes.



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Conclusions

- Should we vary starter rates based on soil attributes like soil test P or pH?
  - No.
- What is the benefit of starter fertilizer in addition to broadcast P fertilizer?
  - Small yield increase when STP low
  - Early growth and grain moisture.
- How do starter and broadcast P applications affect yield response across the landscape?
  - Response to broadcast P driven by STP, not so for starter. These data were not clear on the optimum rate of APP – likely about 5 gal/ac

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Acknowledgements

- The authors are most grateful to:
  - – the Fluid Fertilizer Foundation, Minnesota Corn Growers, Corn Research and Promotion Council for funding this project
  - – FFF partnering labs for “in-kind” support
  - – research crews at the Department of Soil, Water, and Climate and Southern Research and Outreach Center for their assistance
  - –farmer cooperators for their assistance and the use of land

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QUESTIONS

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