# Variable Rate Starter Fertilization Based on Soil Attributes

Jeffrey Vetsch and Dr. Daniel Kaiser

Univ. of Minnesota

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# Background and Justification

- On calcareous (pH>7.4) P fixing soils 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 (if, pH>7.7 hard to build soil test).
  - When commodity prices are lower and input cost reductions are desired.

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# Justification continued

- Widespread adoption of variable rate fertilization and availability of variable rate controllers have raised additional questions.
  - Does the optimum rate of starter fertilizer vary enough within a field to require variable rate application of starter?
  - What soil or landscape attributes can be used to make variable starter rate application recommendations?

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- The objectives of this study were to:
  1) measure the effect of APP rate on early growth of corn, grain yield and fertilizer use efficiency;
  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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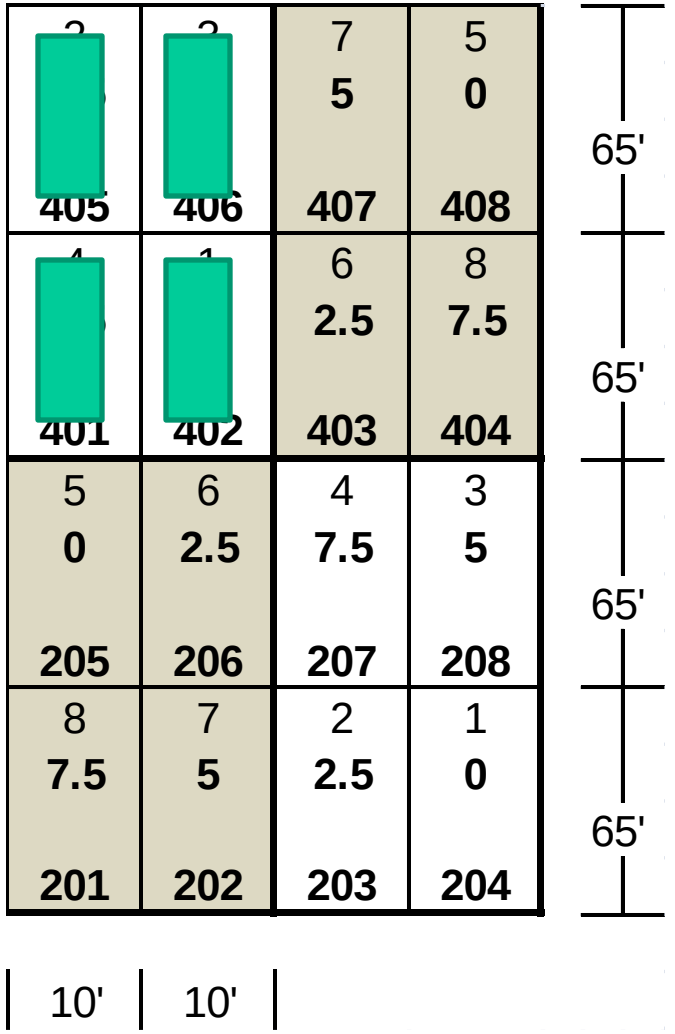
# Experimental design

- 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 timeline

- Study initiated by Dr. Daniel Kaiser in 2012 (two sites) in south-central Minnesota, 3 sites in 2013, 3 sites in 2014.
- 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).
- Broadcast-apply P at 0 and 120 lb $P_2O_5$/ac as TSP incorporate with preplant tillage.

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# Methods and timeline (continued)

- Plant corn and apply APP 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, harvest 8 whole plants for yield, P conc., P uptake; stand counts - calculate plant populations
- Combine harvest center two rows 45 ft long in two 22.5 ft segments; at harvest collect grain sample analyze for total P

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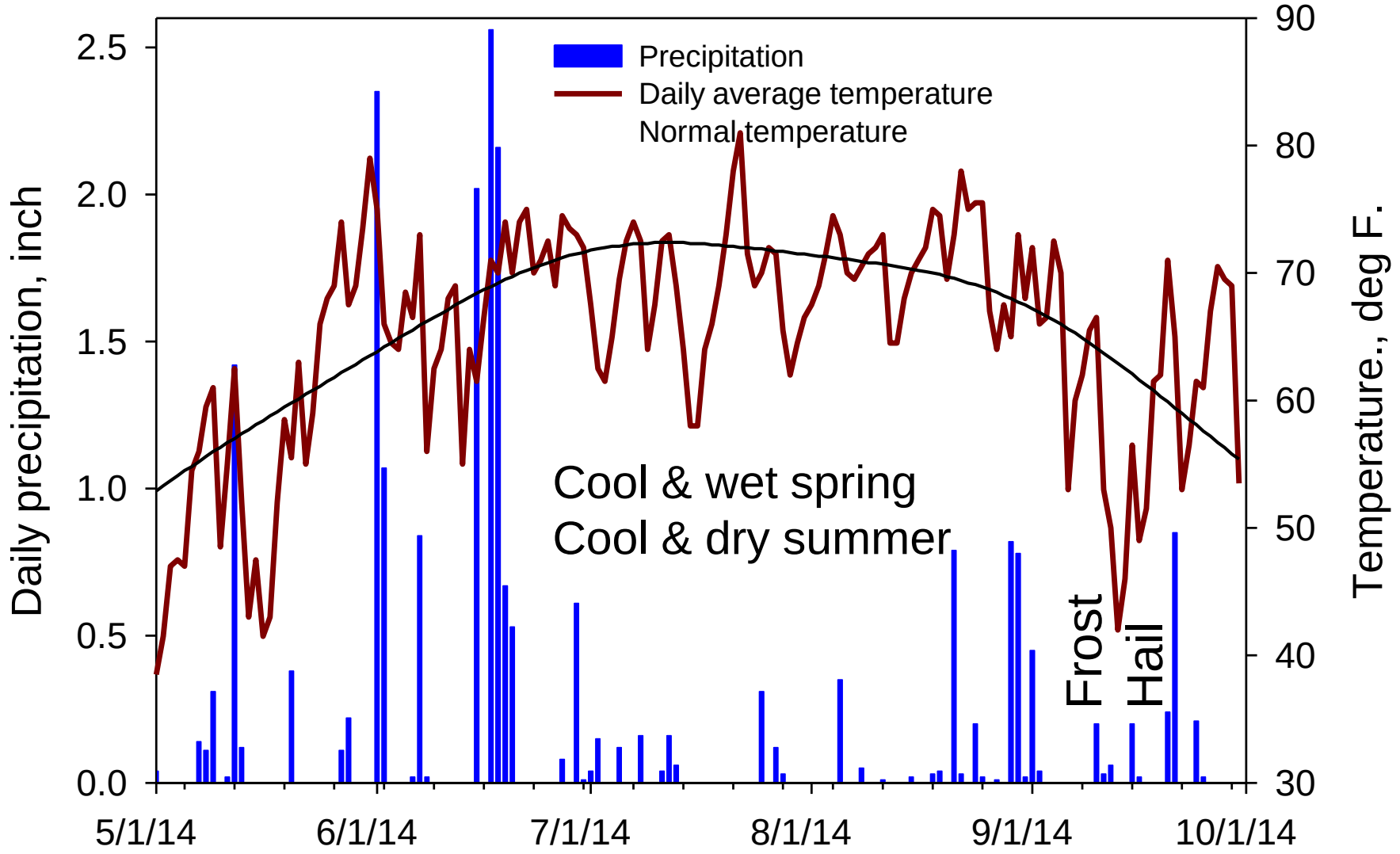
Wettest June in 100-*yrs. 12.94*”

# Precipitation and air temperature at Waseca.

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# Summary of soil test attributes (2014)

| Location | Dep. | SOM | Bray P | Exch. K | pH Avg. | pH Range | Olsen P Avg. | Olsen P Range |
|---|---|---|---|---|---|---|---|---|
| | inch | % | ------ ppm ------ | | | | ------ ppm ------ | |
| New Rich. | 0-6 | 4.7 | 13 | 135 | 7.0 | 5.8-8.0 | 8 | 3-24 |
| | 6-12 | 3.6 | 4 | 92 | 7.4 | 6.4-8.1 | 4 | 2-7 |
| St. Charles | 0-6 | 2.6 | 11 | 98 | 6.8 | 6.3-7.3 | 8 | 5-11 |
| | 6-12 | 2.1 | 11 | 91 | 6.7 | 6.3-7.1 | 8 | 5-12 |
| Waseca | 0-6 | 4.8 | 6 | 184 | 6.6 | 5.7-7.8 | 5 | 2-10 |
| | 6-12 | 4.0 | 5 | 116 | 6.9 | 5.7-7.9 | 4 | 2-6 |

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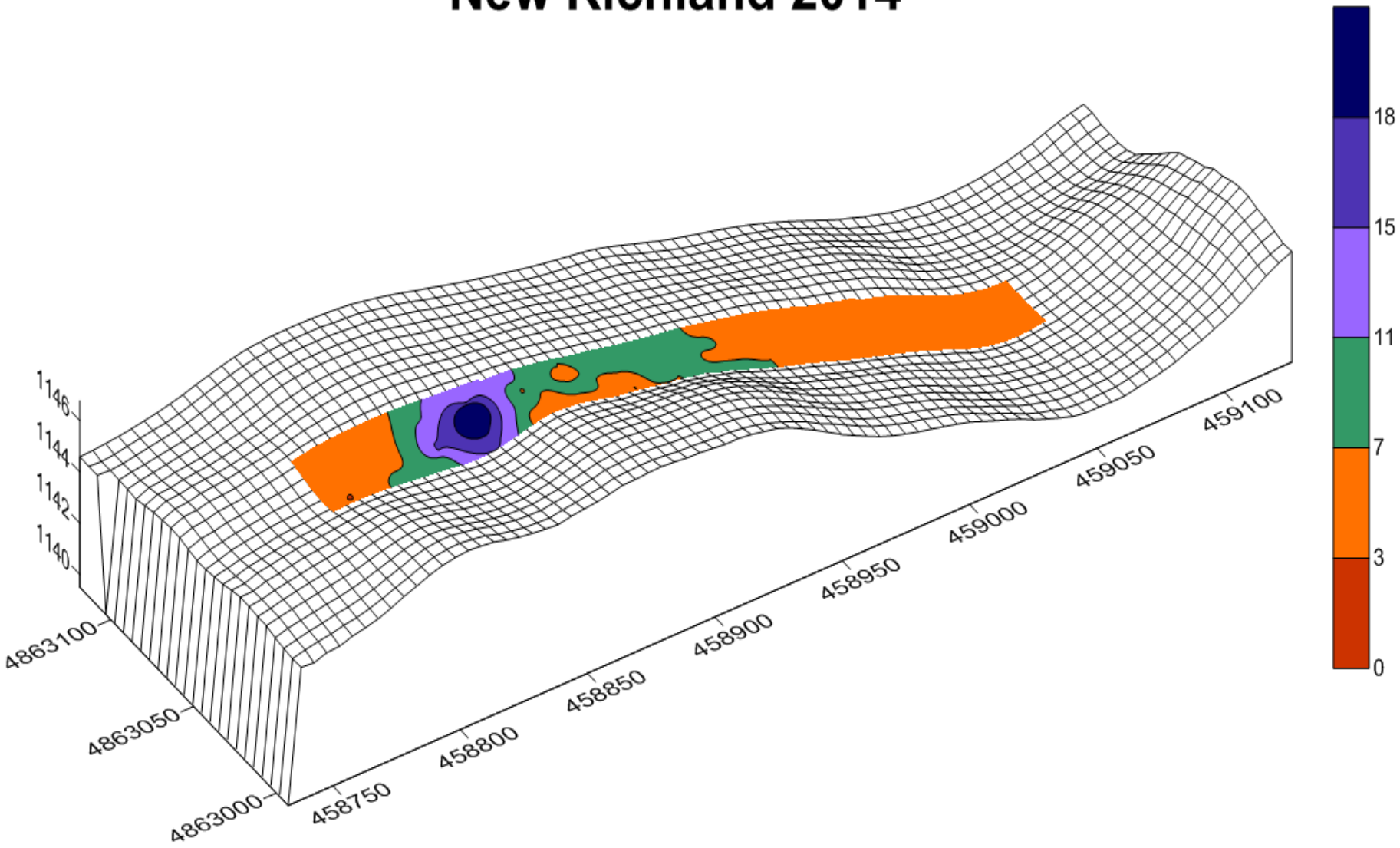
# New Richland 2014

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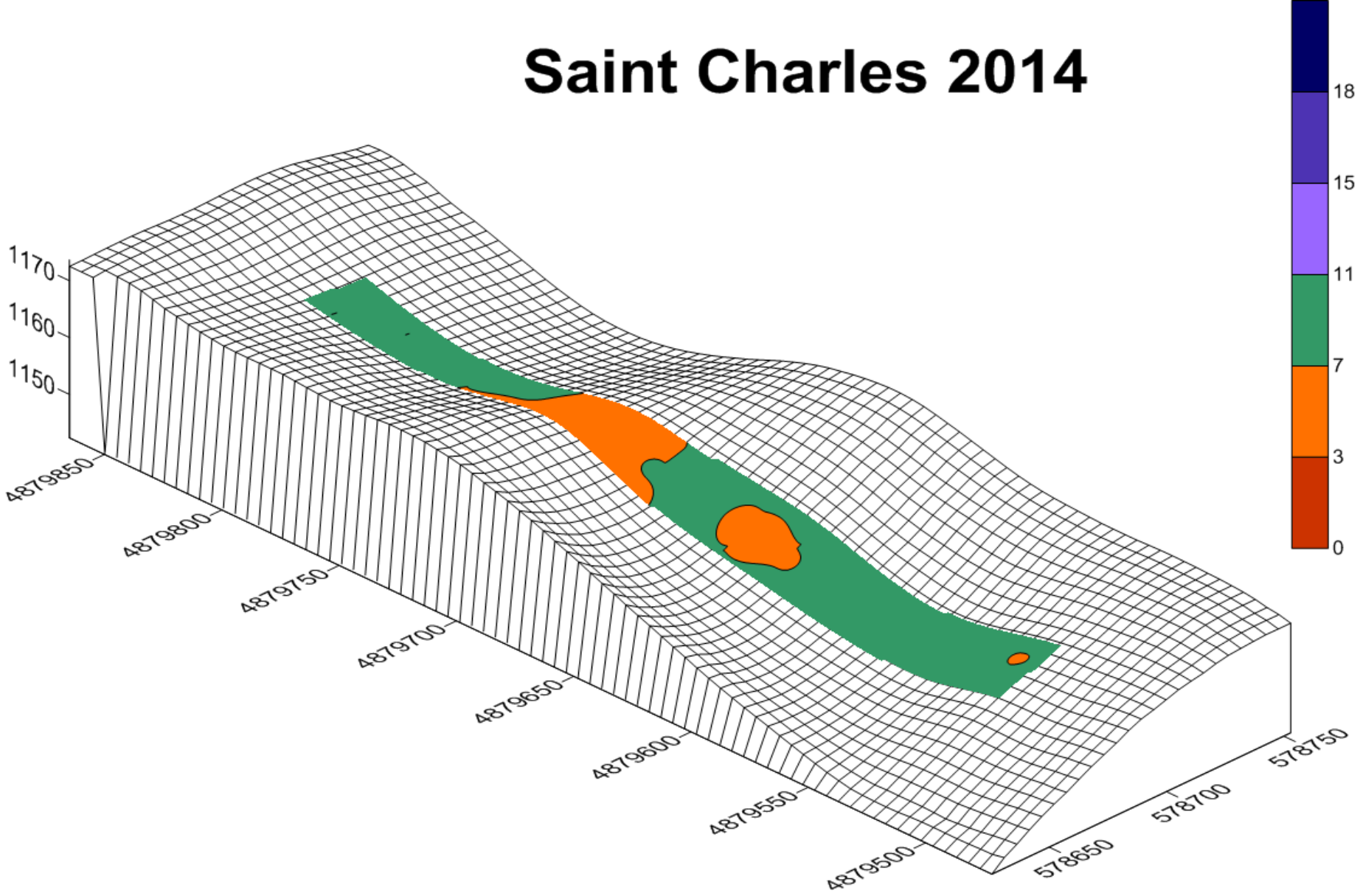
# Saint Charles 2014

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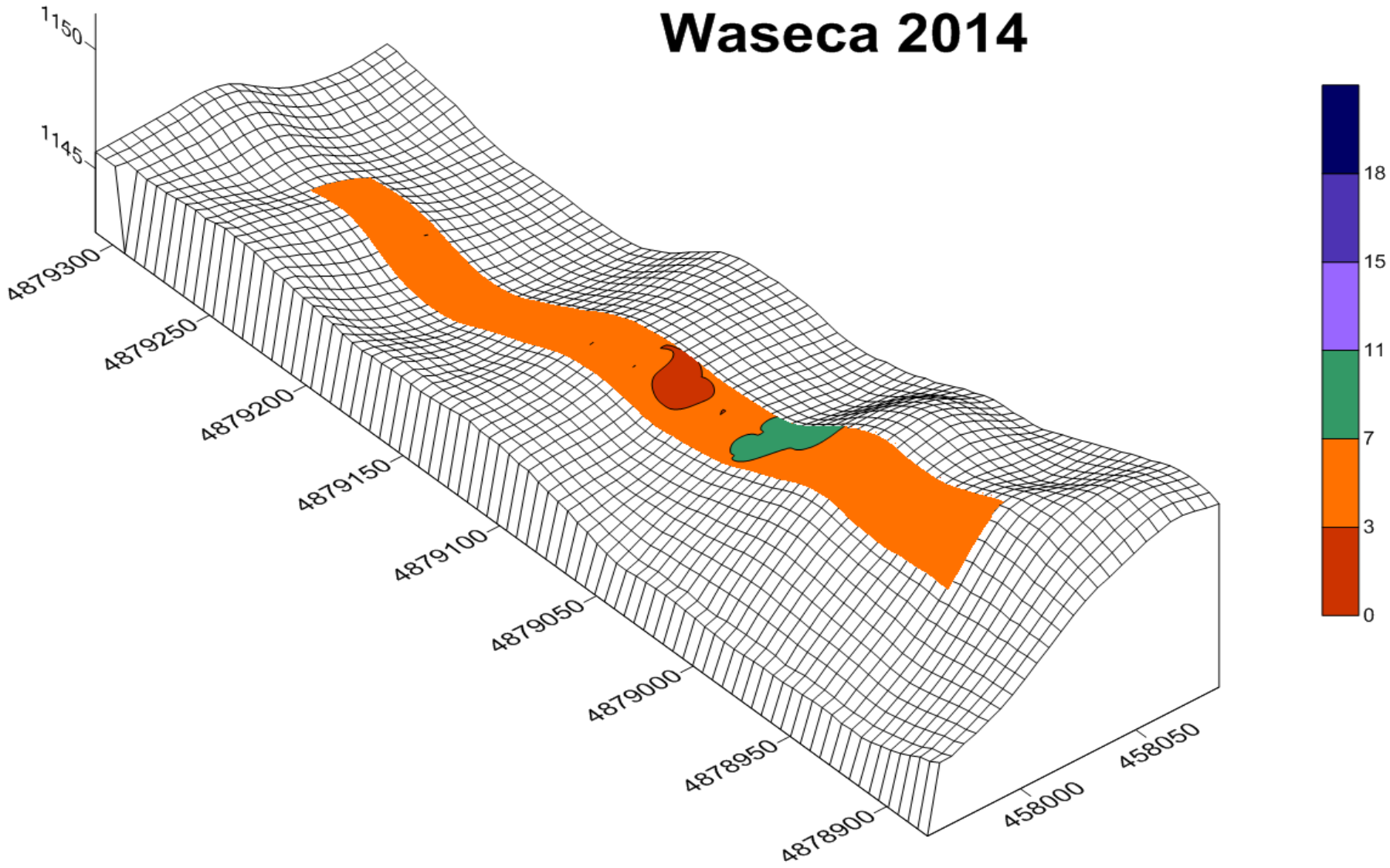
# Waseca 2014

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# Statistical significance of treatment main effects for V5 corn plants by location (2014).

| Parameter | Location | Broadcast P | Starter P | Bdct*Starter |
|---|---|---|---|---|
| | | ----------P > F---------- | | |
| V5 Plant Mass | New Richland | **0.001** | **0.017** | 0.583 |
| | St. Charles | **0.007** | **0.002** | 0.271 |
| | Waseca | **0.016** | **<0.001** | 0.578 |
| Plant P conc. | New Richland | **<0.001** | 0.382 | 0.526 |
| | St. Charles | **<0.001** | 0.092 | 0.314 |
| | Waseca | **<0.001** | 0.916 | 0.925 |
| Plant P uptake | New Richland | **<0.001** | **0.029** | 0.873 |
| | St. Charles | **<0.001** | **<0.001** | 0.110 |
| | Waseca | **0.001** | **<0.001** | 0.390 |

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# Summary: V5 whole plants

- Broadcast P increased V5 plant mass, P concentration and P uptake at all sites in 2014, a cool and very wet spring.
- Starter (APP) increased V5 mass and P uptake at all sites in 2014.

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# Significance of treatment main effects for grain yield and moisture by location (2014).

| Parameter | Location | Broadcast P | Starter P | Bdct*Starter |
|---|---|---|---|---|
| | | ----------P > F---------- | | |
| Grain Yield | New Richland | **0.002** | 0.158 | 0.247 |
| | St. Charles | 0.348 | 0.972 | 0.125 |
| | Waseca | **0.005** | **0.032** | 0.279 |
| Grain Moisture | New Richland | 0.250 | 0.932 | 0.560 |
| | St. Charles | 0.353 | 0.086 | 0.586 |
| | Waseca | 0.089 | **0.012** | 0.072 |

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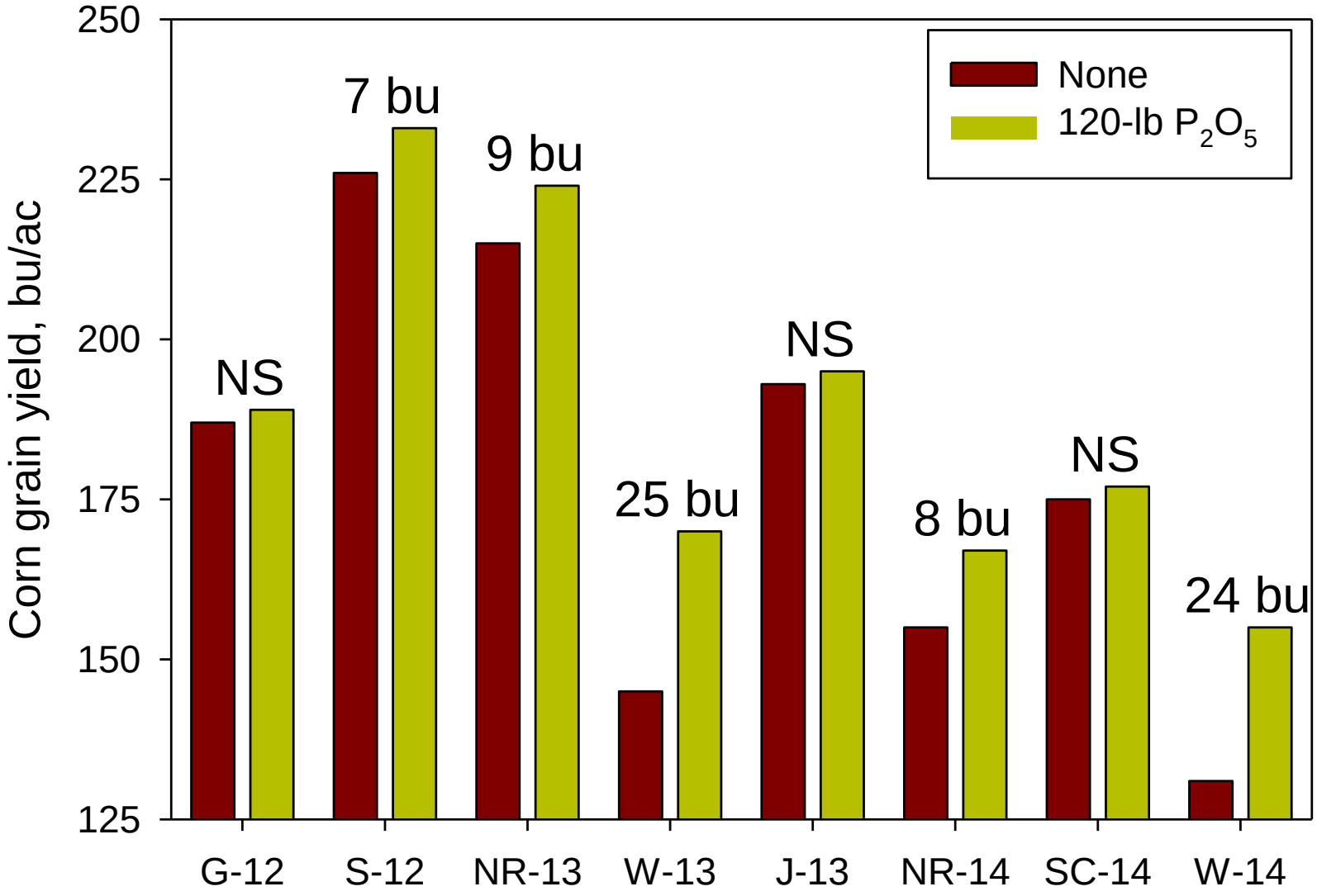
# Corn yield as affected by broadcast P

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# Main effects summary for grain yield

- Broadcast P increased grain yields at 2 of 3 sites in 2014 and 5 of 8 sites overall.
  - Yield response ranged from 7 - 25 bu/ac.
- Starter fertilizer as APP increased grain yields in 1 of 3 sites in 2014 and 3 of 8 sites overall.
  - Yield response ranged from 17-23 bu/ac in 2014.
- Significant broadcast P × starter P interaction at one site.

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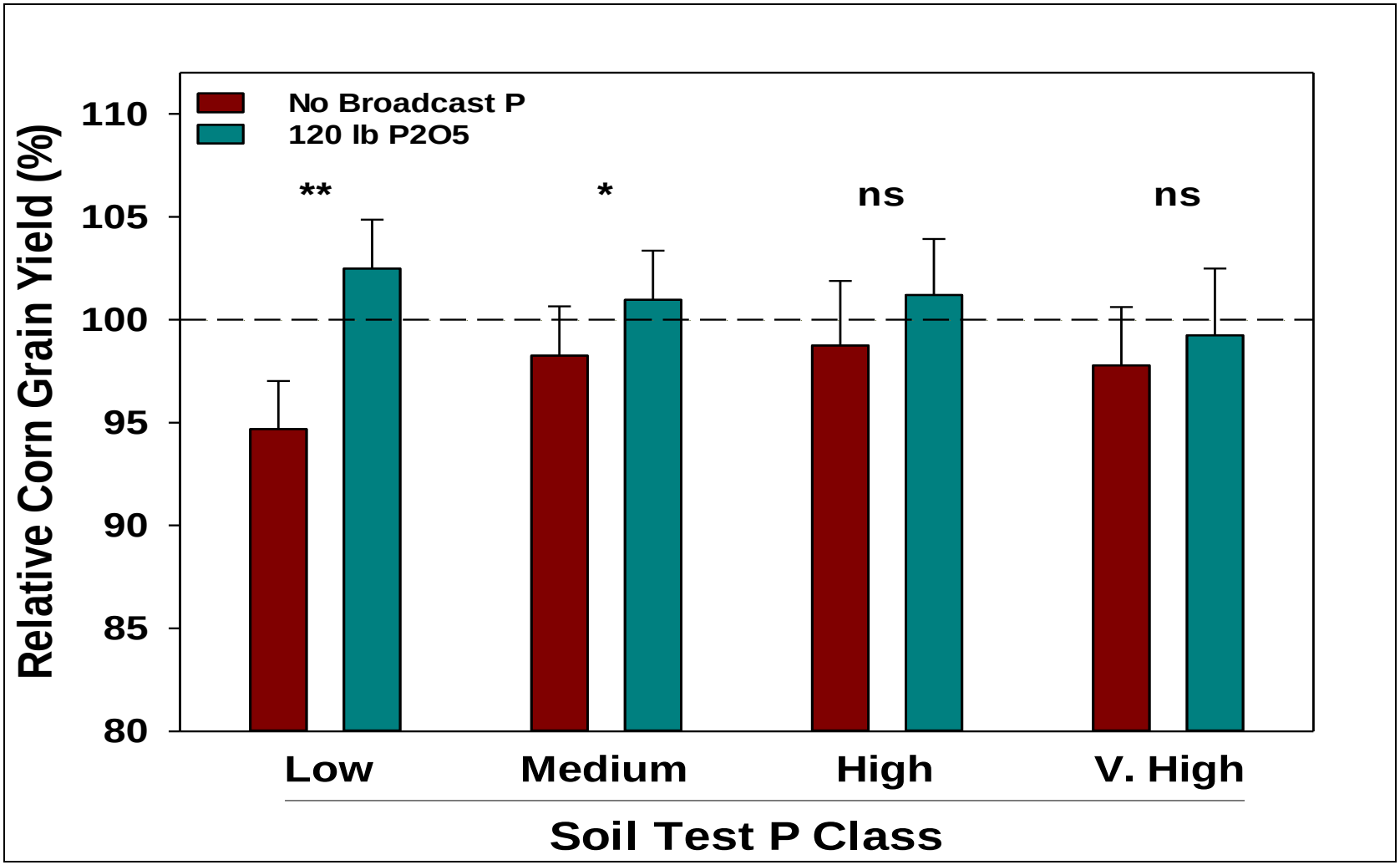
Relative yield as affected by treatment main effects across locations.

| Treatment Effects | P Soil Test Used to Delineate Zones: Olsen P | Bray P |
|---|---|---|
| **Soil Test P Level or Class** | ---------- relative yield, % ---------- | |
| Low (4-7 ppm Olsen) | 98.6 a | 97.0 a |
| Medium (8-11 ppm) | 99.6 a | 99.8 a |
| High (12-15 ppm) | 100.0 a | 100.5 a |
| Very High (16+ ppm) | 98.5 a | 100.0 a |
| **Broadcast Rate** | | |
| 0 lb $P_2O_5$/ac | 97.4 b | 97.4 b |
| 120 lb | 101.0 a | 101.3 a |
| **Starter (APP, 10-34-0) Rate** | | |
| 0 gal/ac | 97.3 b | 97.2 b |
| 2.5 gal | 99.0 ab | 99.3 a |
| 5.0 gal | 100.2 a | 100.6 a |
| 7.5 gal | 100.2 a | 100.2 a |
| **Interactions, (*P* > *F*)** | | |
| Level×Broadcast Rate | **0.04** | **0.05** |
| Level×Starter Rate | 0.50 | 0.29 |
| Broadcast Rate×Starter Rate | **0.09** | **0.10** |

# Relative yield as affected by the interaction between soil test P class and broadcast P.

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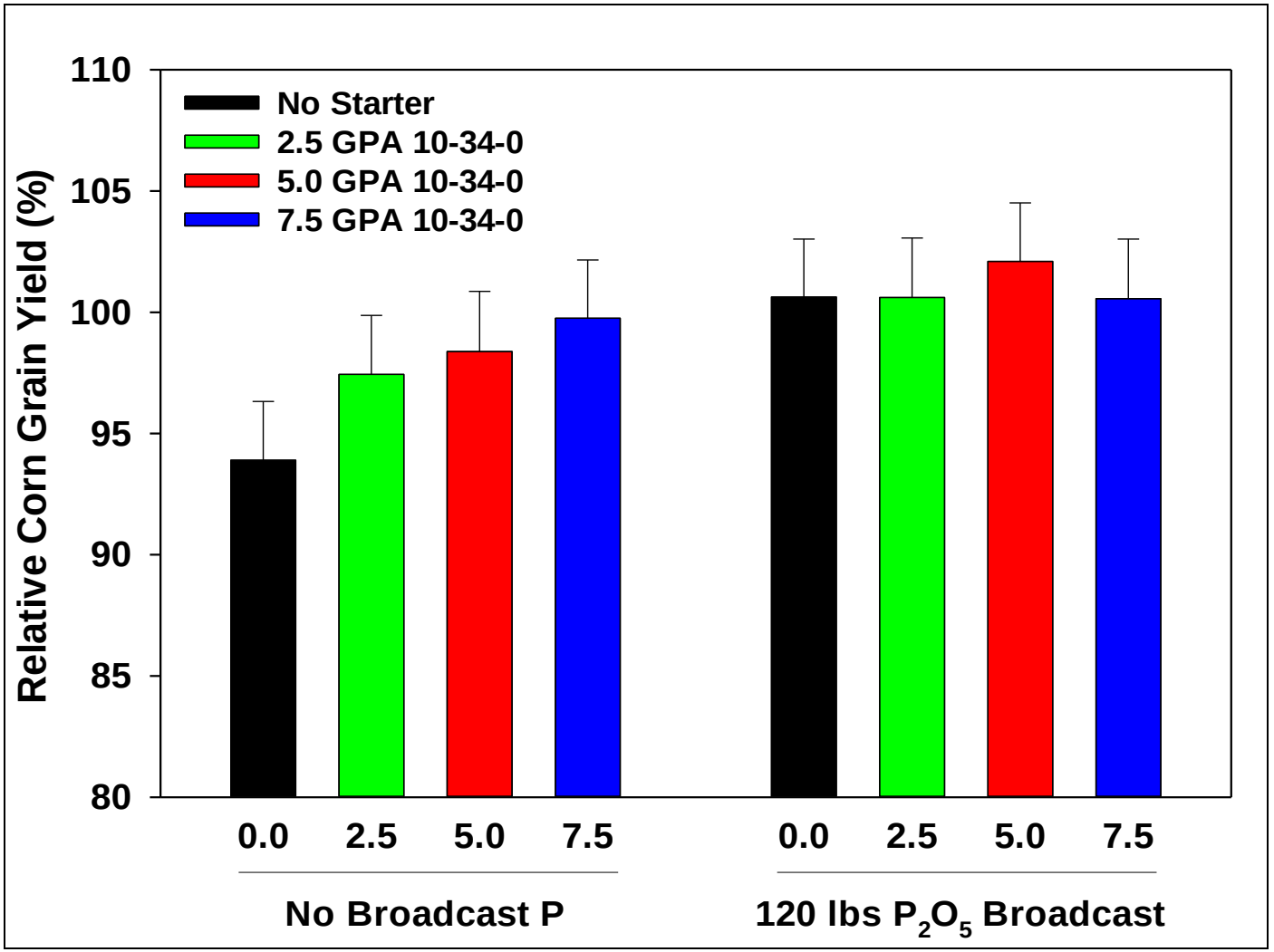
# Relative yield as affected by the interaction between broadcast and starter P rates.

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# Summary for relative yield across sites.

- Broadcast P increased relative yields about 3.5 percentage points.
- 5 and 7.5 gal/ac of APP increased grain yields about 3 percentage points compared with 0 gal/ac of APP.
- A significant STP level/class × broadcast P rate interaction showed: broadcast P increased yields only at Low and Medium STP levels.
- *A significant (α=0.10) broadcast* × starter P interaction showed: APP increased yields only when broadcast P was not applied

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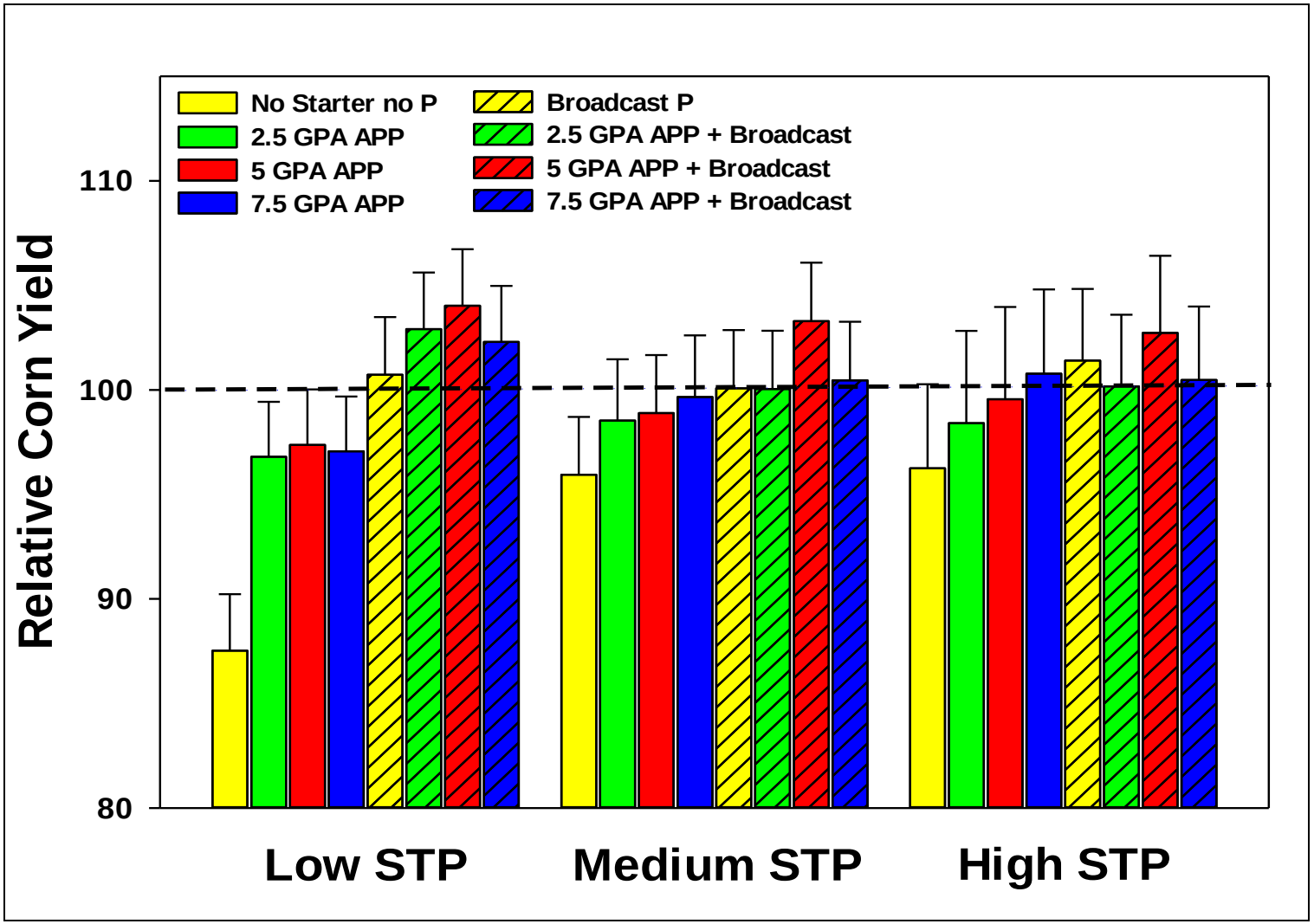
# Relative yield as affected by broadcast and starter P rates across soil test P classes.

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# QUESTIONS

Jeffrey Vetsch
Univ. of Minnesota
Southern Research and Outreach Center
jvetsch@umn.edu
http://sroc.cfans.umn.edu/People/Staff/JeffreyVetsch/index.htm