Variable Rate Starter Fertilization Based on Soil Attributes

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Univ. of Minnesota

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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).
  - Instead the primary goal is to maximize yield and profit while minimizing risk.

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Justification continued

- Widespread adoption of variable rate fertilization and availability of variable rate controllers has raised new 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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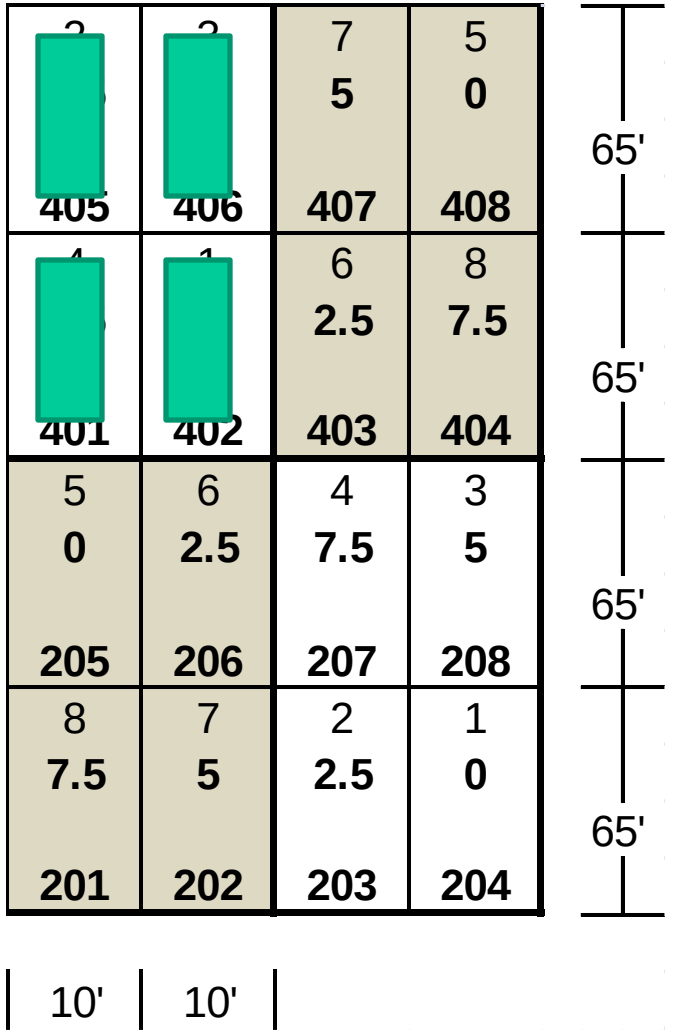
Experimental design

- 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.
- 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
- Broadcast-apply N, K, S and Zn as needed to optimize corn production, incorporate with 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
- Farmer cooperator managed: weeds and pests as needed along with the rest of field
- At V5, harvest 8 whole plants for yield, P conc., P *uptake; NDVI (GreenSeeker™ sensor); 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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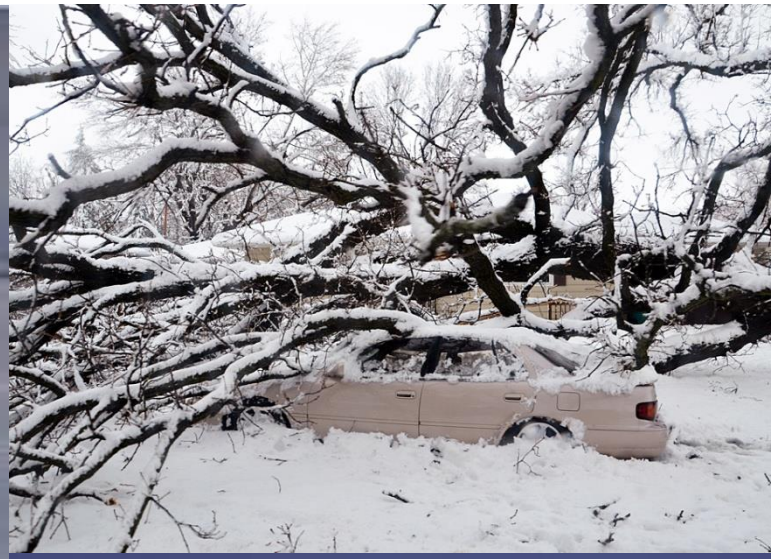
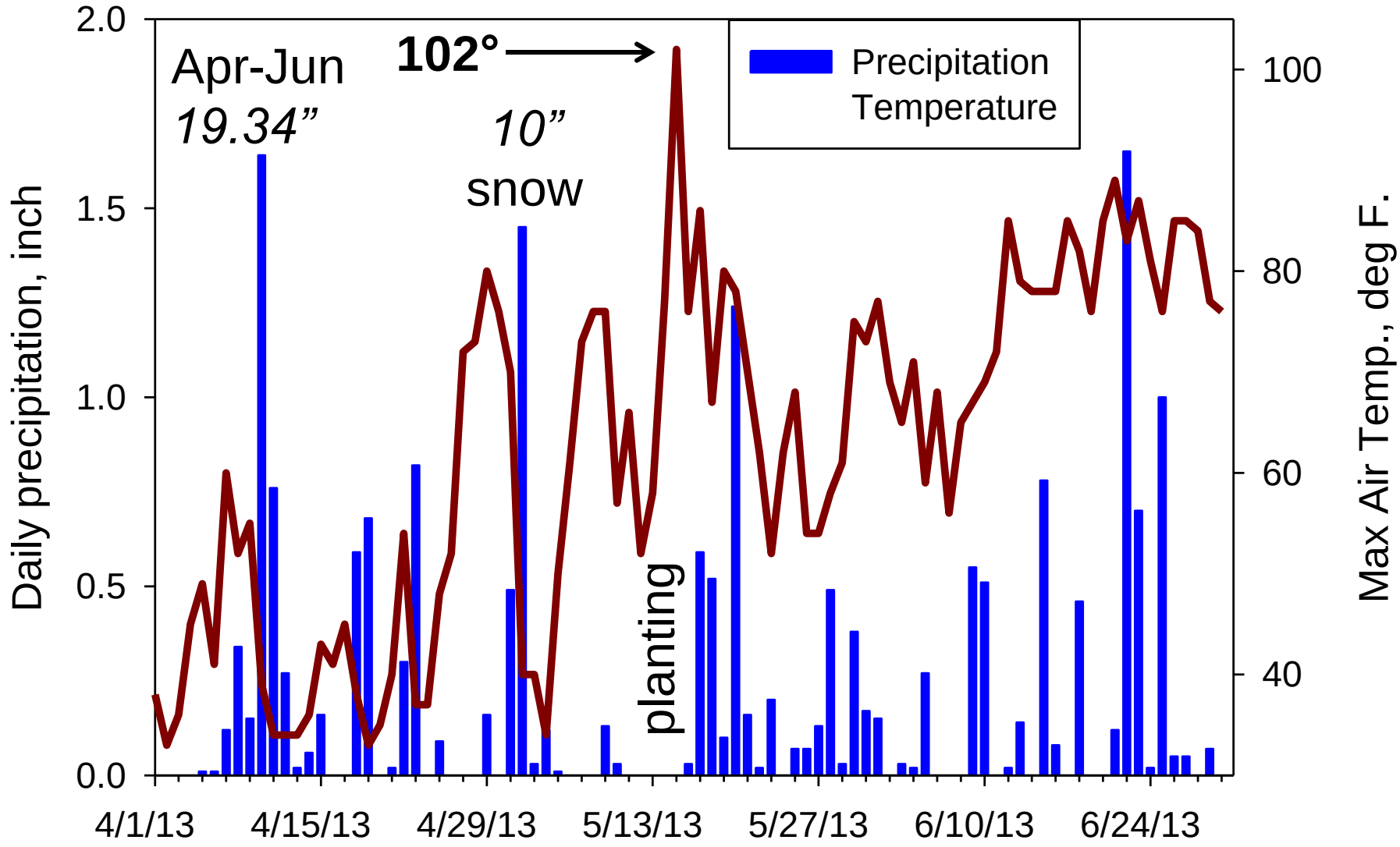
May 2, 2013 SC and SE Minnesota



2013 "Spring" weather at Waseca



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Summary of soil test attributes

				pH			Olsen-P		
Loc.	SOM	Bray	K	Min	Avg	Max	Min	Avg	Max
	%	--- ppm ---					-----ppm -----		
G12	5.8	25	209	5.9	6.8	7.8	4	14	27
S12	5.0	19	208	6.4	7.6	8.0	4	13	28
NR13	5.7	16	251	6.2	7.3	7.8	5	10	29
W13	3.3	12	176	6.1	7.2	8.0	4	7	36
J13	5.8	27	171	5.3	5.8	6.5	6	19	38

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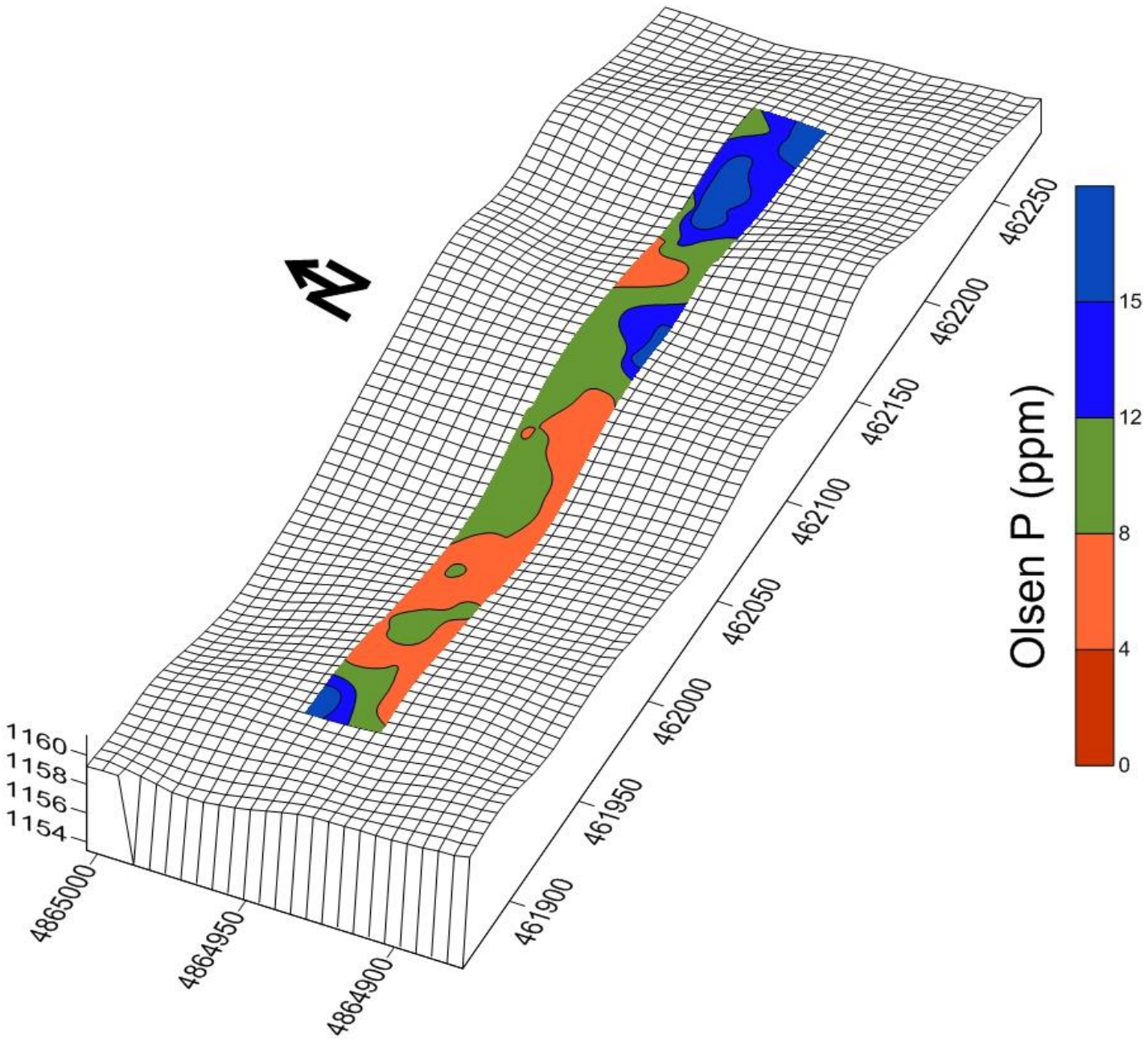
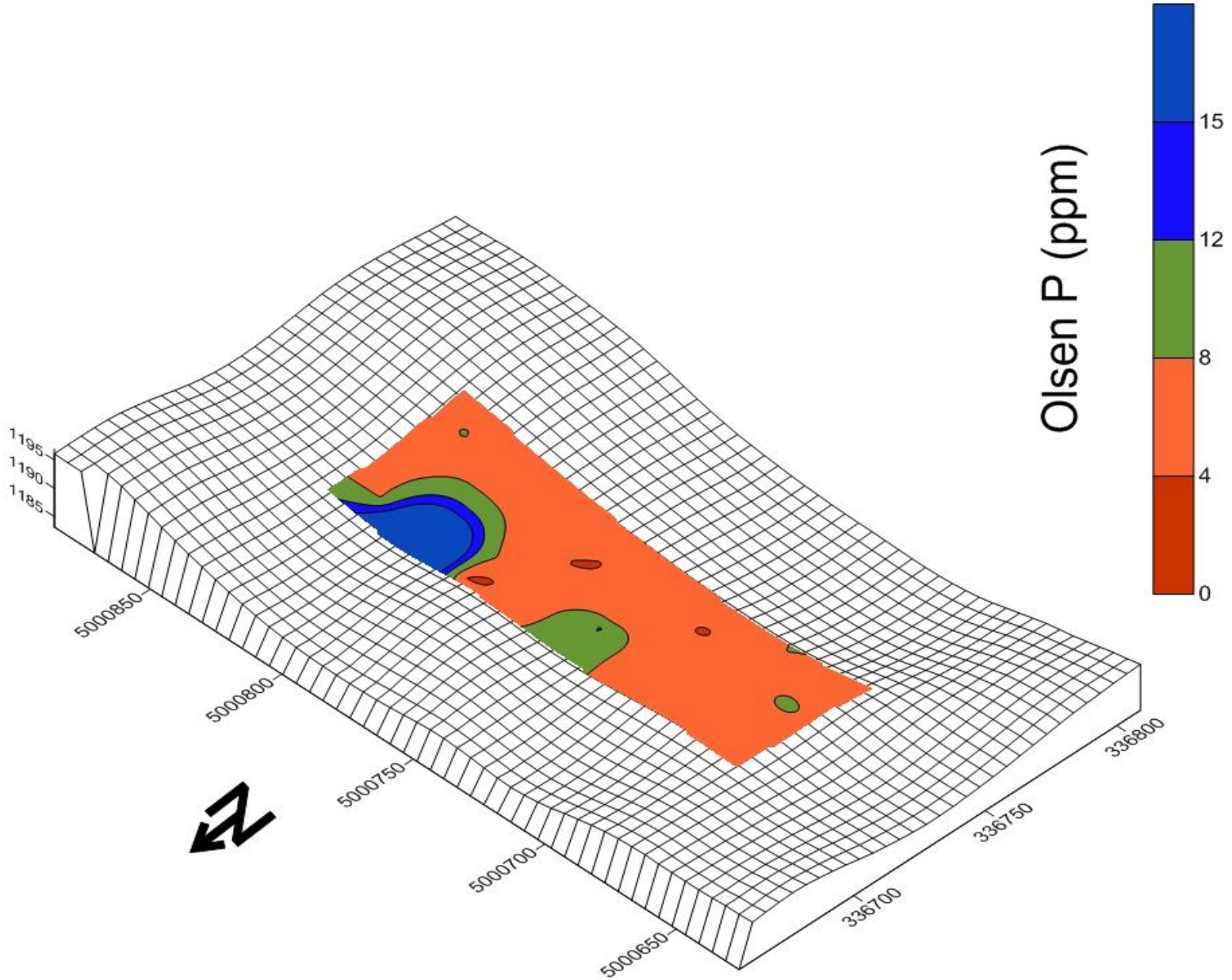
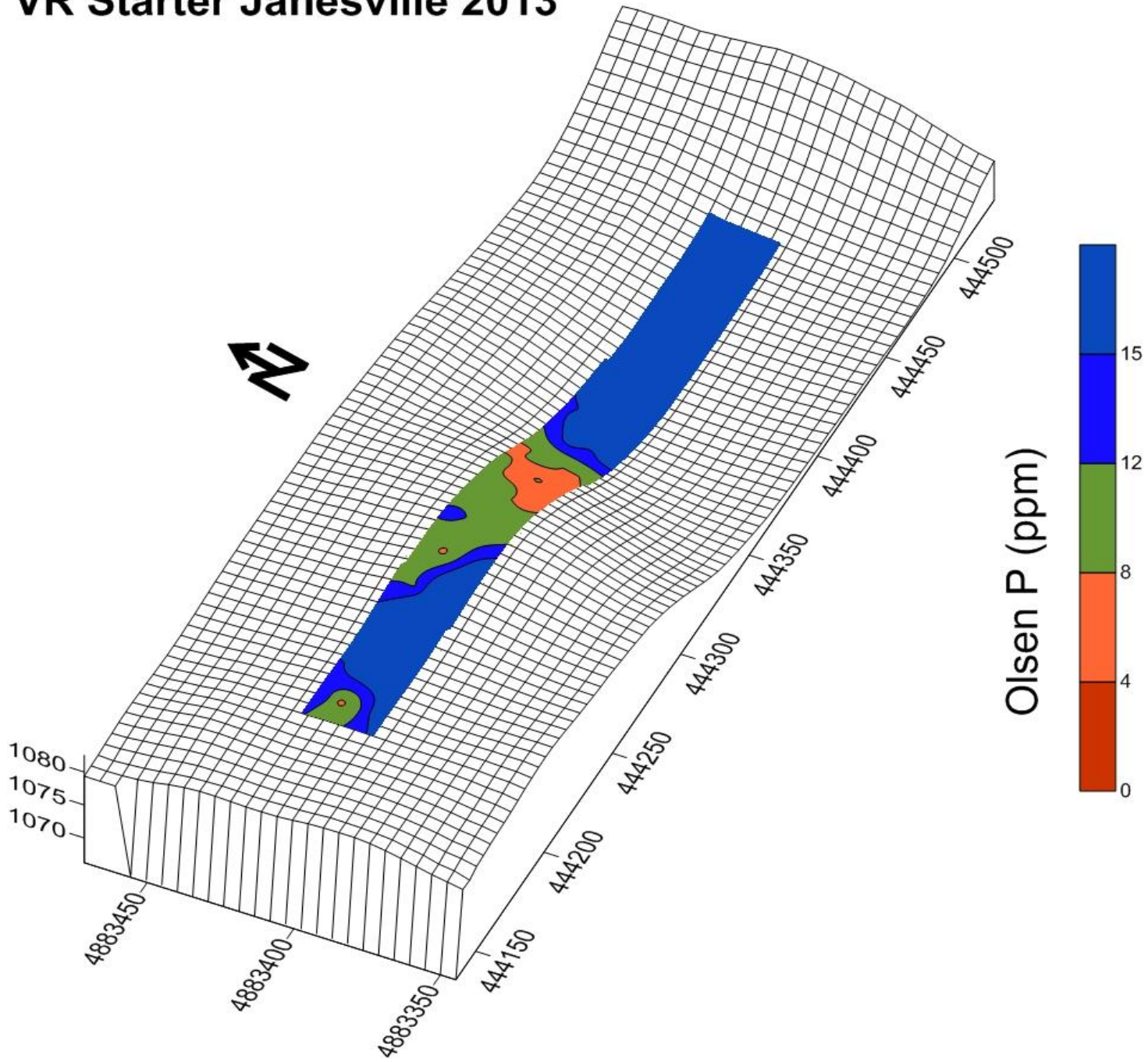
VR Starter New Richland 2013



VR Starter Willmar 2013



VR Starter Janesville 2013



Statistical significance of treatment main effects for V5 corn plants by location.

Parameter	Location	Broadcast P	Starter P	Bdct*Starter
		----------P > F----------		
V5 Plant Mass	Gaylord	NS	NS	NS
	Stewart	NS	NS	NS
	New Richland	NS	**<0.001**	NS
	Willmar	**0.045**	**0.015**	NS
	Janesville	**0.004**	**<0.001**	0.079
V5 P Uptake	Gaylord	NS	NS	NS
	Stewart	NS	NS	NS
	New Richland	**0.007**	**<0.001**	NS
	Willmar	**0.011**	**0.043**	NS
	Janesville	**0.001**	**<0.001**	NS

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Summary: V5 whole plants

- Plant populations were NOT affected by treatments (data not shown).
- Early growth of corn (V5 plant mass) and P uptake were not affected by treatments in 2012, a very warm spring.
- Broadcast P increased V5 mass in 2 of 3 sites and P uptake in 3 of 3 sites in 2013, a very cool and wet spring.
- Starter (APP) increased V5 mass and P uptake in 3 of 3 sites in 2013.

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

Parameter	Location	Broadcast P	Starter P	Bdct*Starter
		----------P > F----------		
Grain Yield	Gaylord	0.090	NS	**0.050**
	Stewart	**0.050**	NS	NS
	New Richland	**0.004**	**0.029**	NS
	Willmar	**<0.001**	NS^	NS^
	Janesville	NS	NS	NS
Grain Moisture	Gaylord	NS	0.051	NS
	Stewart	NS	NS	NS
	New Richland	NS	**0.007**	NS
	Willmar	0.053	NS	NS
	Janesville	**0.031**	**0.003**	**0.049**

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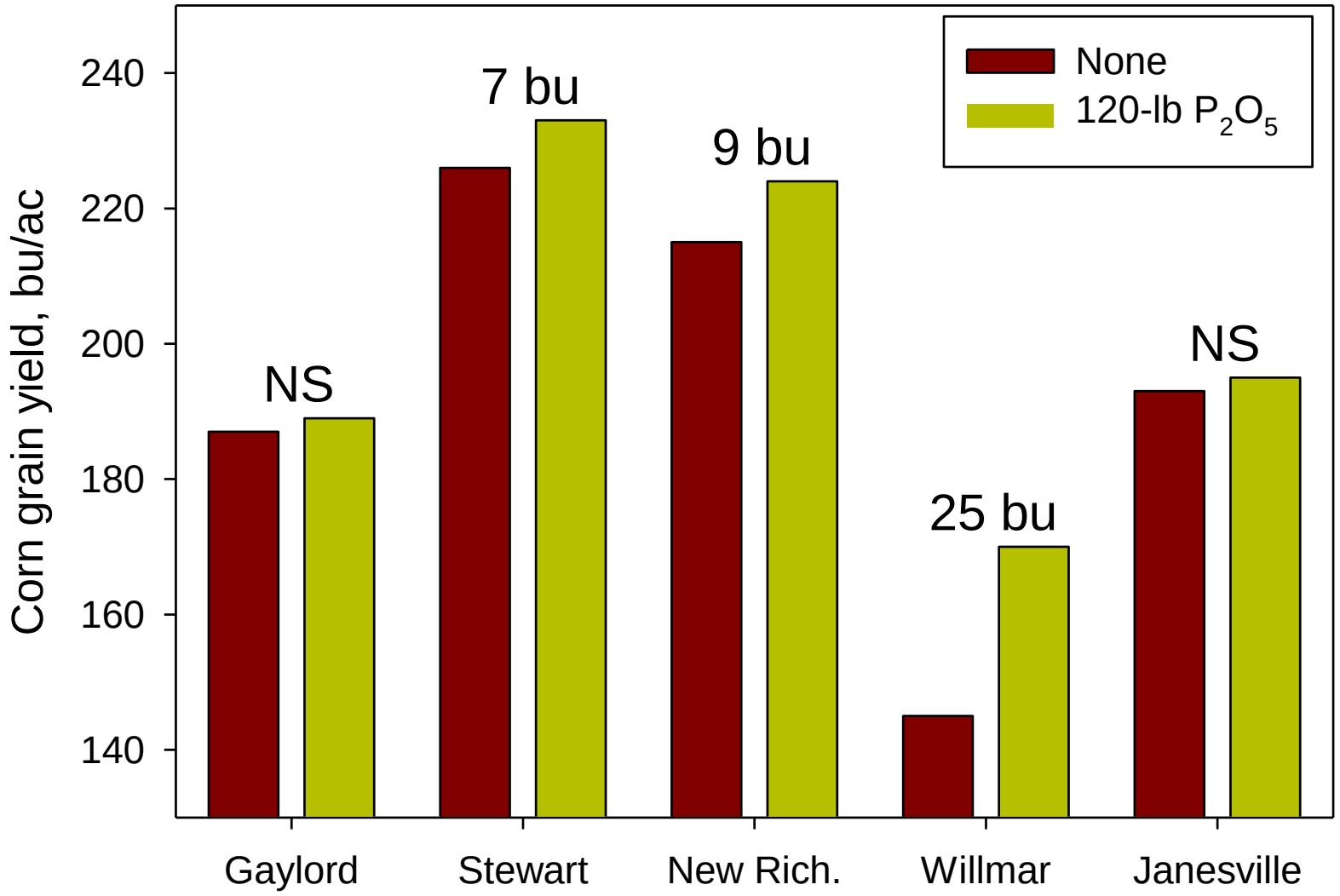
Corn yield as affected by broadcast P



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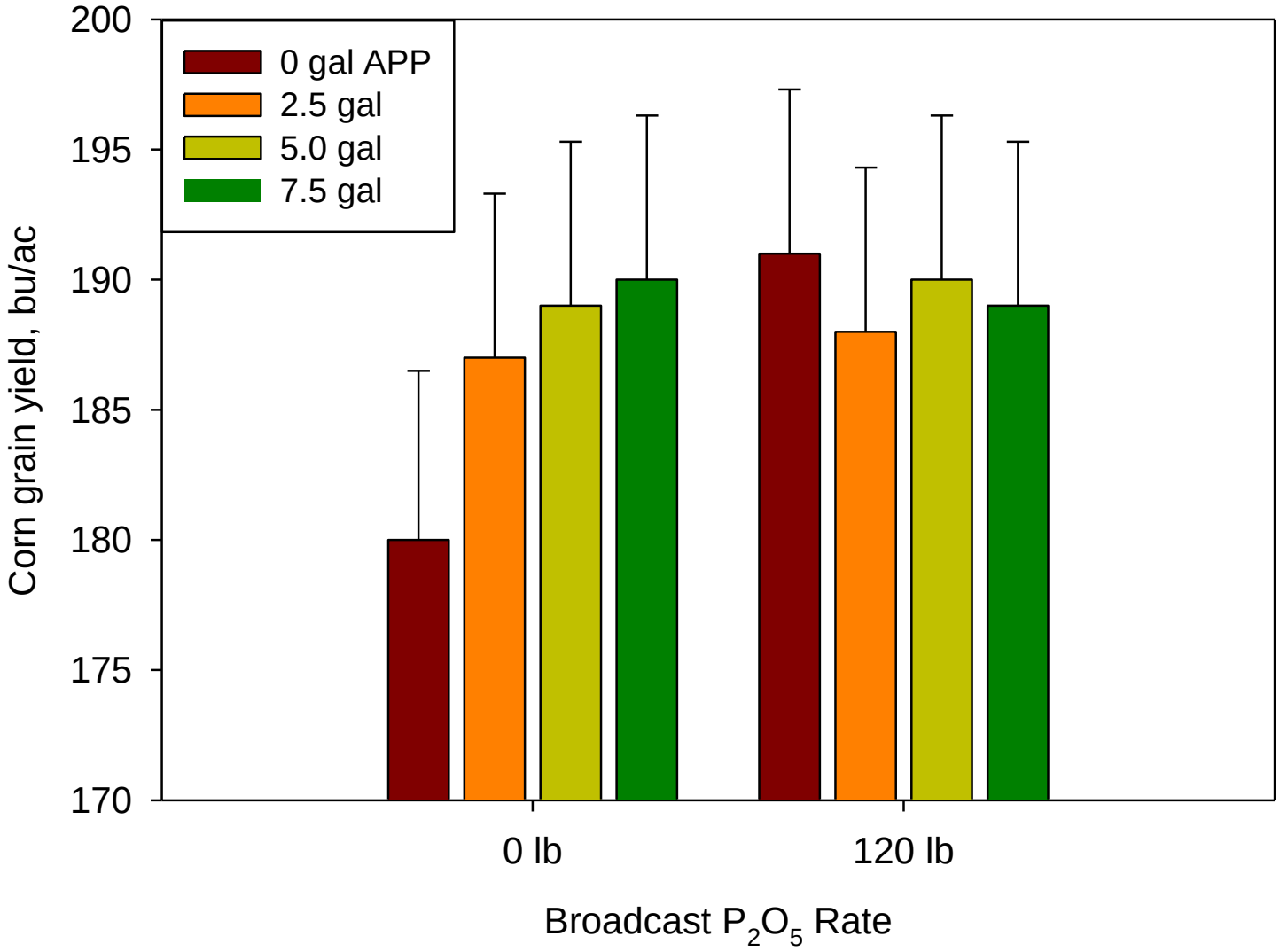
Grain yield at Gaylord in 2012



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Summary: corn grain yield

- Broadcast P increased grain yields at 3 of 5 *sites (α=0.05).*
  - Yields were 7, 9, and 25 bu/ac greater at Stewart, New Richland and Willmar, respectively.
- Starter (APP) increased grain yields at 1 of 5 sites.
  - 5-10 bu/ac at New Richland
- APP increased grain yields (7-10 bu/ac) at Gaylord when no broadcast P was applied.

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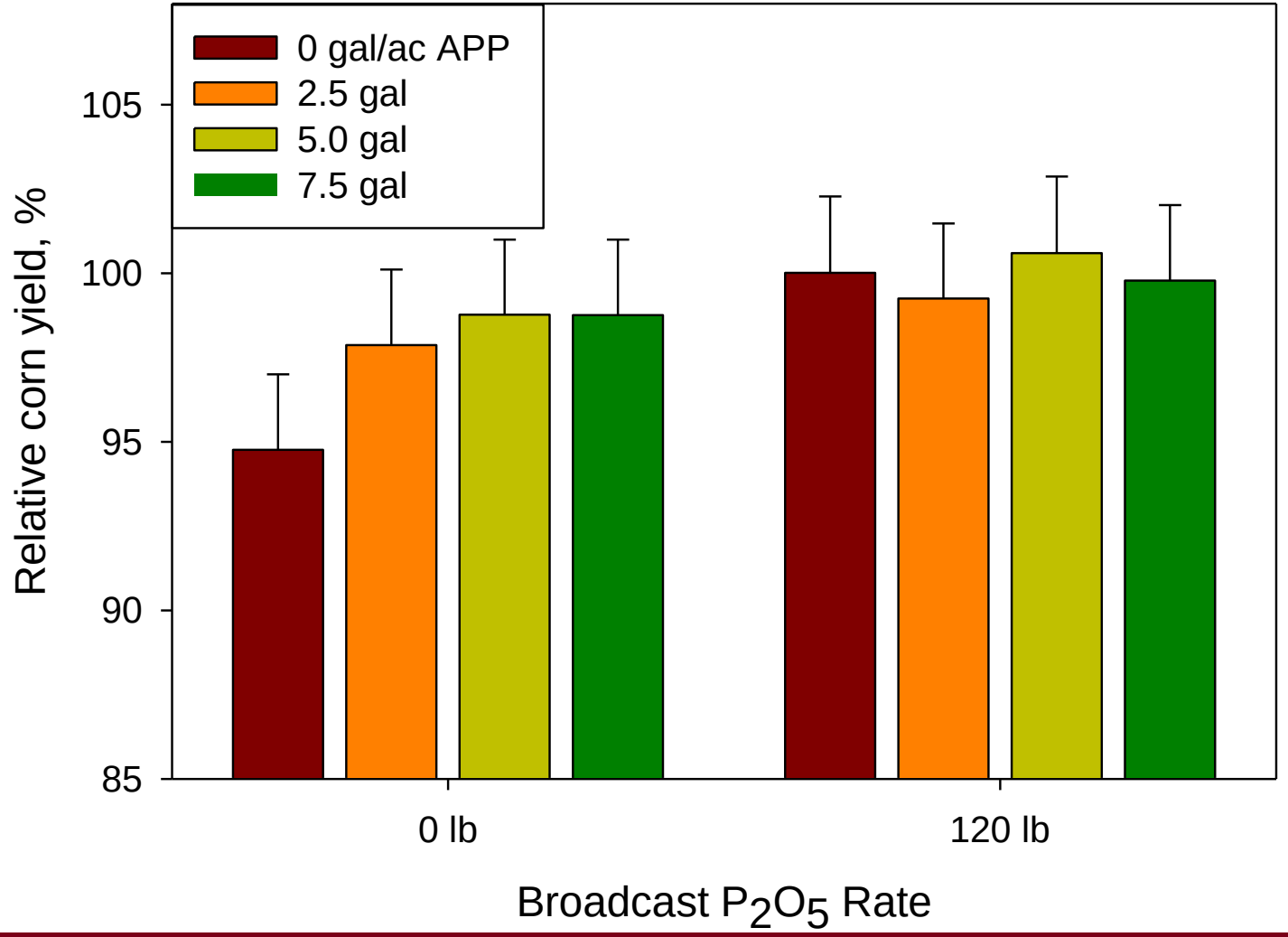
Relative yield as affected by treatment main effects including soil test P levels, when analyzed across locations (Willmar excluded).

	P Soil Test Used to Delineate Zones	
Treatment Effects	Olsen P	Bray P
Soil Test P Level	---------- relative yield, % ----------	
Low	98.0 a	*97.9 a*
Medium	98.8 a	*97.9 a*
High/Very High	99.4 a	*99.5 a*
Broadcast Rate		
0 lb P_2O_5/ac	97.5 b	97.1 b
120 lb	99.9 a	99.8 a
Starter (10-34-0) Rate		
0 gal/ac	97.4 b	97.1 b
2.5 gal	98.6 ab	98.4 ab
5.0 gal	99.7 a	99.3 a
7.5 gal	99.3 a	99.0 a
Interactions, (*P* > *F*)		
Broadcast Rate*Starter Rate	**0.013**	0.110

Relative yield as affected by broadcast and starter P across locations.



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Summary: relative yield

- Broadcast P increased relative yields about 2.5 percentage points (Willmar site excluded).
- 5 and 7.5 gal/ac of APP increased grain yields about 2 percentage points compared with 0 gal/ac of APP
  - 2.5 gal/ac was intermediate
- A significant broadcast P rate*starter rate interaction showed:
  - APP increased grain yields when no broadcast P was applied.

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QUESTIONS

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