Developing Liquid Starters for Corn Production in the Midwest

Jeffrey Vetsch, Researcher 4

Univ. of MN Southern Research and Outreach Center

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https://nutrientstewardship.org/4rs/

4RS
4R Principles
Benefits of Using the 4Rs
Implementation
Sustainability

RESOURCES
4R Pocket Guide
4Rs of Nutrient Stewardship
4R Farmers & The Lake
4R Micronutrient Webinars

What are the 4Rs

RIGHT SOURCE
Matches fertilizer type to crop needs.

RIGHT RATE
Matches amount of fertilizer type crop needs.

RIGHT TIME
Makes nutrients available when crops needs them.

RIGHT PLACE
Keep nutrients where crops can use them.

Where do liquid starters fit in 4R management?

- Crops: corn, small grains, soybean, sugar beets
- Nutrients applied: N, P, K, S, Zn, other micros
  - Crop response can be affected by placement, nutrient and rate
- Tillage system: no-till, reduced till, strip-till (band method)
- Crop rotation: corn after corn or small grains vs soybean
- Soil characteristics: poorly drained, well drained, pH
- Broadcast P rates affect starter response to N, P & S
- Soil test P levels: low, medium/optimum or very high

Liquid starter fertilizer placement options

Liquid starter placement at Waseca (2004-06)

Fluid NPKS Placement[1/]	3-Yr Avg. Corn Yield
	bu/ac
Control	186
2×0	196
2×2	195
LSD (0.10) =	7

[1/] Averaged across 4 NPKS rates of application (Waseca, 2004-2006).

- **Corn after soybean (2 yr) or corn silage (1 yr)**
- High to very high Bray P1
- Surface dribble as good as stream injected behind coulter
- Yield response to NPKS
- N&P in pop-up also increased yield in this study (data not shown)
- Randall and Vetsch. 2006. Fluid Journal
- FFF funding

Liquid starter placement at Waseca (2007-09)

Starter Treatment			Grain	
Placement	APP	UAN	Yield	Moisture
	gal/A	lb N/A	bu/A	%
control	0	0	184	24.2
In-furrow	5	0	190	24.1
2 × 0	5	0	186	24.2
“	5	15	192	23.8
“	5	30	190	23.8
“	5	45	187	23.5
LSD (0.10):			*4*	*NS*

- **Corn after corn (3-yr)**
- Very high Bray P1
- Surface dribble with extra N as good as popup
- N&P in pop-up also increased yield
- Randall and Vetsch. 2010. Fluid Journal
- FFF funding

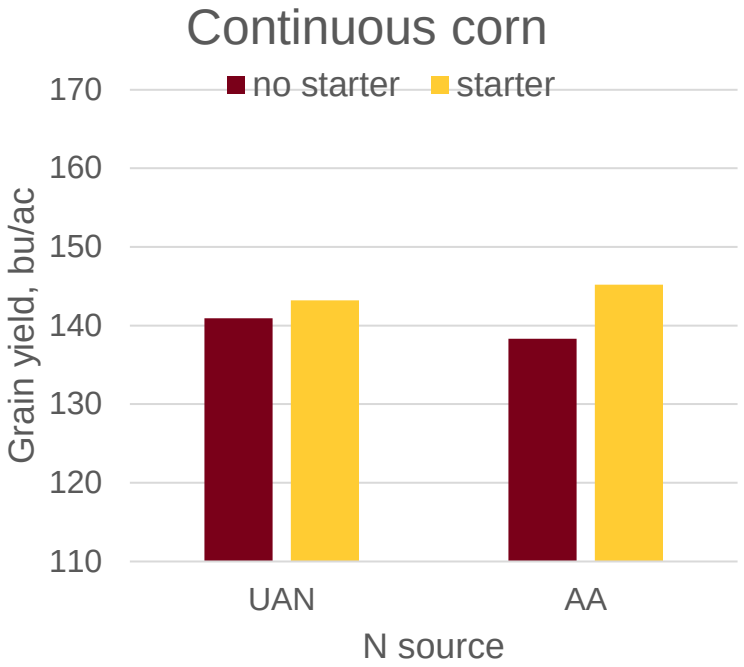
Liquid starter placement by nutrient (N-P-S-Zn)

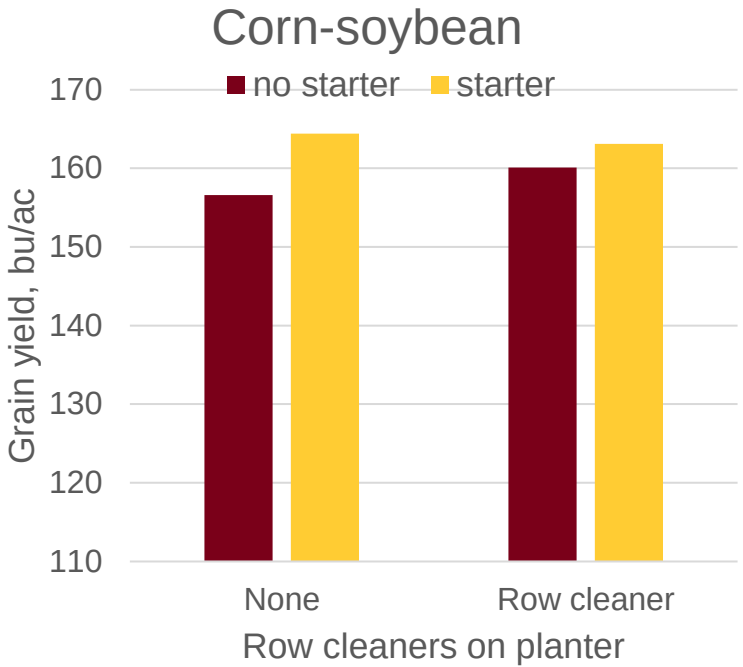
Starter Treatment			Grain
Placement	Products	Rate	Yield
			bu/ac
control	None	None	196
In-furrow	APP	5 gal	200
In-furrow	APP+Zn	5+¼ lb	199
In-furrow	APP+Zn	5+½ lb	197
Surf. Band	APP+ATS	5+2 gal	205
Surf. Band	APP+ATS+Zn	5+2+¼	201
9-site average		*LSD (0.10):*	*3*

- **Corn after beans**
- 8 of 9 sites very high Bray P1
- DTPA Zn ranged 0.4–1.8 ppm
  - 3 of 9 sites had DTPA Zn=0.4 ppm
- 2 of 9 + yield response to Zn
- 1 of 9 – yield response to Zn
- 2 of 9 + yield response to APP
- 3 of 9 + yield response to APP+ATS, compared to APP alone
- 5 of 9 + yield response to APP+ATS, compared to control

Vetsch 2010 AFREC (MN) funding

In-furrow starter interactions with N source and management of no-till corn (Vetsch and Randall. 2000. Agron, J).



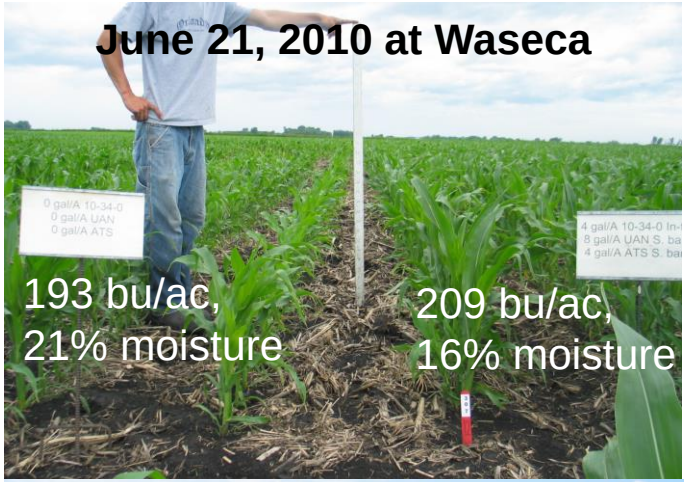


Corn yield as affected by N management in strip-till at Waseca.

Time of application, N source, inhibitors and N rate (lb/ac)				Yield
Fall AA	Preplant†	Planting UAN	Sidedress UAN	(bu/A)
None	None	None	None	111
w/N-Serve				161
Without				161
	AA			**168**
	Urea w/NBPT			**166**
	Urea w/NBPT	Dribble, 20		**172**
			Coulter Inj.	**166**
		Dribble, 20	Coulter, 80	**170**
		Coulter, 20	Coulter, 80	**170**
		Dribble, 40	Coulter, 60	160
		Coulter, 40	Coulter, 60	163
		Broadcast, 40	Coulter, 60	**174**
† w/NBPT as Agrotain			LSD (0.10):	8

Effects of liquid starter fertilizer on V6 continuous corn.

Starter Fertilizer Rate				Dry matter yield, V6	
APP	UAN	ATS		2012	2013
---------- gal/acre ----------					%
0	0	0		100	100
0	0	2		107	117
0	0	4		131	117
0	8	0		145	165
0	8	2		184	175
0	8	4		184	180
4	0	0		144	161
4	0	2		151	170
4	0	4		153	167
4	8	0		193	184
4	8	2		187	187
4	8	4		200	207



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AFREC
Agricultural Fertilizer Research & Education Council

Effects of liquid starters on corn grain moisture and yield, plant height and height CV at Waseca (clay loam, poorly drained).

Effects of starters	Grain H_2O	Grain Yield	Plant height	CV of height
	%	bu/A	inch	%
APP (10-34-0) in-furrow				
None	17.8 a	209 a	31.4 b	7.9 a
4 gal/A	17.3 b	210 a	34.0 a	6.8 b
UAN (28-0-0) surface dribble band				
None	17.7 a	209 a	31.3 b	**8.3 a**
8 gal/A	17.3 a	210 a	34.1 a	**6.4 b**
ATS (12-0-0-26) surface dribble band				
None	17.8 a	207 b	31.9 c	7.4 a
2 gal/A	17.4 a	211 a	32.7 b	7.6 a
4 gal/A	17.4 a	211 a	33.6 a	7.0 a

- APP in-furrow
  - did not affect grain yield (very high STP sites, not high pH).
  - reduced grain moisture in 3 of 4 yr and for the 4–yr avg.
- UAN as a surface band
  - reduced grain moisture in 2 of 4 yr.
  - reduced CV of plant height (4-yr avg)
- ATS in a surface band
  - reduced grain moisture in 2 of 4 yr
  - increased grain yield in 1 of 4 yr (4 bu/A avg. across yr)

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Effects of liquid starters on corn grain moisture and yield, plant height and height CV at Rochester (silt loam, well drained).

Effects of starters	Grain H_2O	Grain Yield	Plant height	CV of height
	%	bu/A	inch	%
APP (10-34-0) in-furrow				
None	19.1 a	219 a	31.1 b	6.6 a
4 gal/A	18.5 a	219 a	33.4 a	6.2 a
UAN (28-0-0) surface dribble band				
None	19.0 a	218 a	31.7 b	6.5 a
8 gal/A	18.6 a	220 a	32.7 a	6.2 a
ATS (12-0-0-26) surface dribble band				
None	19.0 a	218 a	31.9 a	6.7 a
2 gal/A	18.7 b	219 a	32.3 a	6.2 a
4 gal/A	18.7 b	220 a	32.5 a	6.2 a

- APP in-furrow
  - Increased grain yield 1 of 4 yr and decreased 1 of 4 yr (high STP sites, not high pH).
  - reduced grain moisture in 2 of 4 yr
- UAN as a surface band
  - reduced grain moisture in 2 of 4 yr.
  - Increased corn grain yield in 1 of 4 yr
- ATS in a surface band
  - reduced grain moisture (4-yr avg.)
  - increased grain yield in 1 of 4 yr

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Summary of liquid starters in continuous corn

- Generally, starter fertilizers containing N, P and S applied as UAN, APP, and ATS increased early growth and reduced plant to plant variability in a reduced tillage system.
- N, P and S starter fertilizers often reduced grain moisture at harvest.
- Yield responses to fluid starters were inconsistent during this study period, however drought increased yield variability in 2 of 4 yr at Waseca.
- Responses were more likely on poorly drained glacial till soils.
- **NOTE: S yield response may be reduced with high rates of MAP, DAP or TSP as they often contain up to 1.5 to 2% S.**
  - Ex: Applying 150 lb P_2O_5/ac as MAP or DAP supplies about 5–6 lb S/ac.

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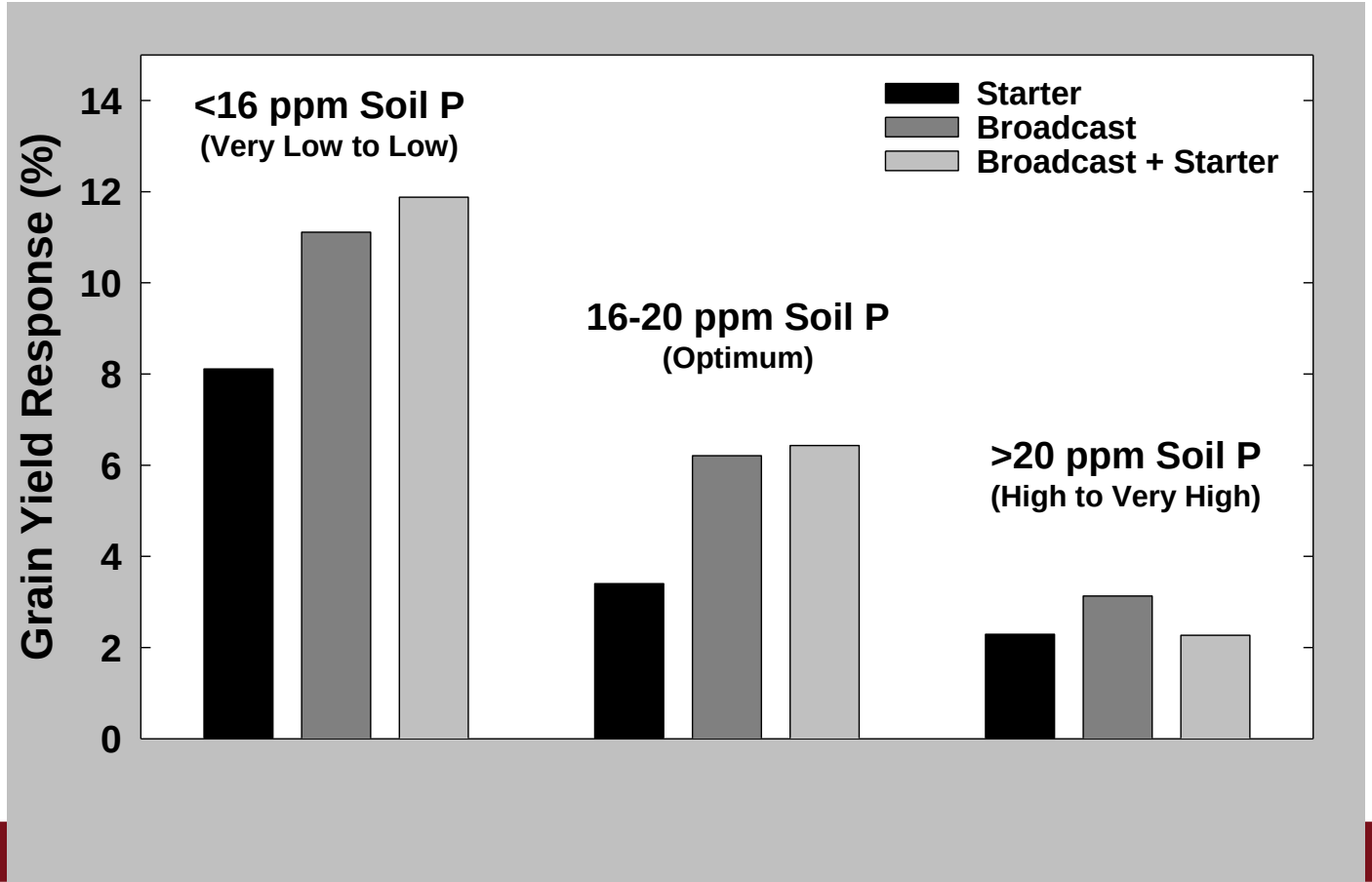
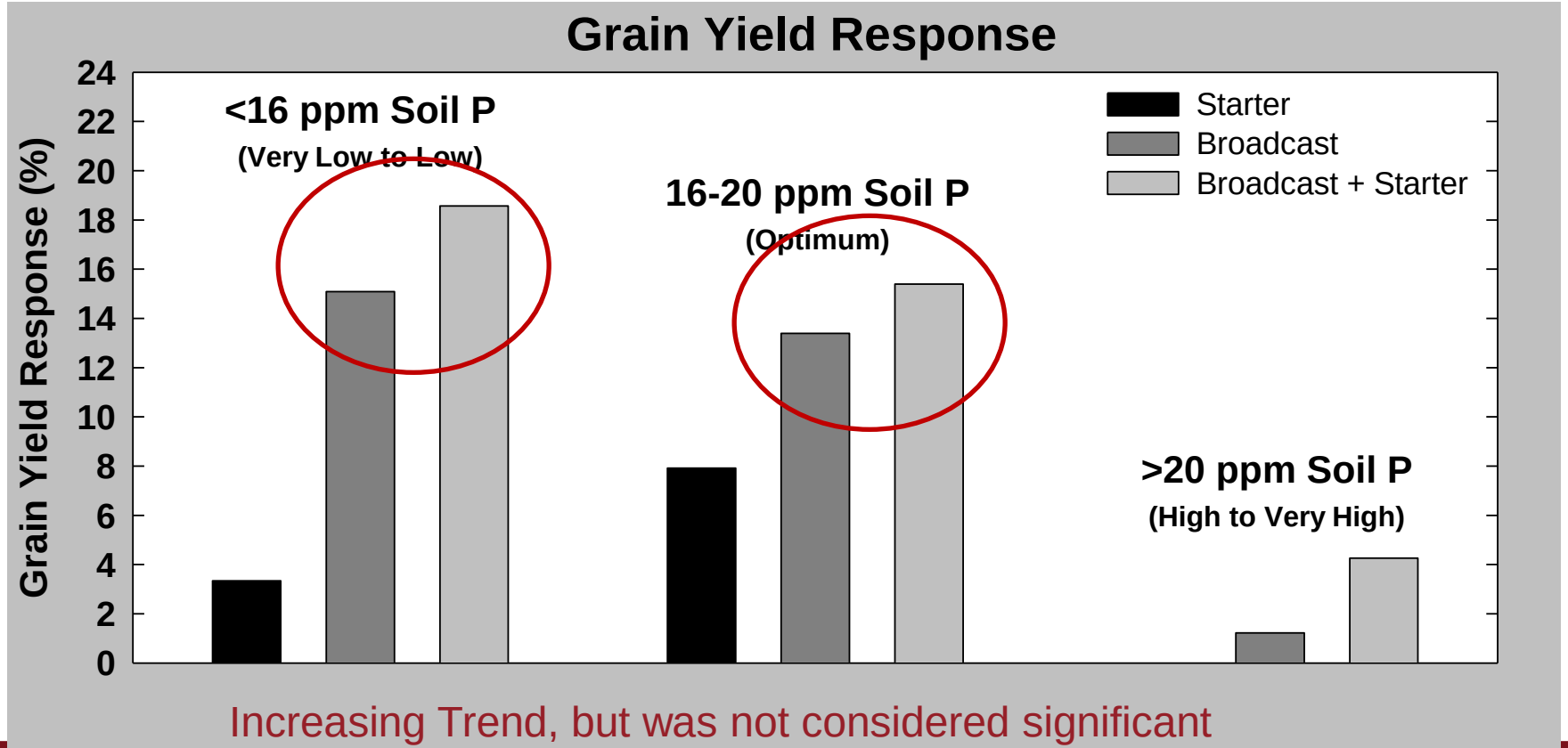
Corn yield response to liquid starter with or without broadcast P fertilization (Kaiser and Mallarino, 2005)

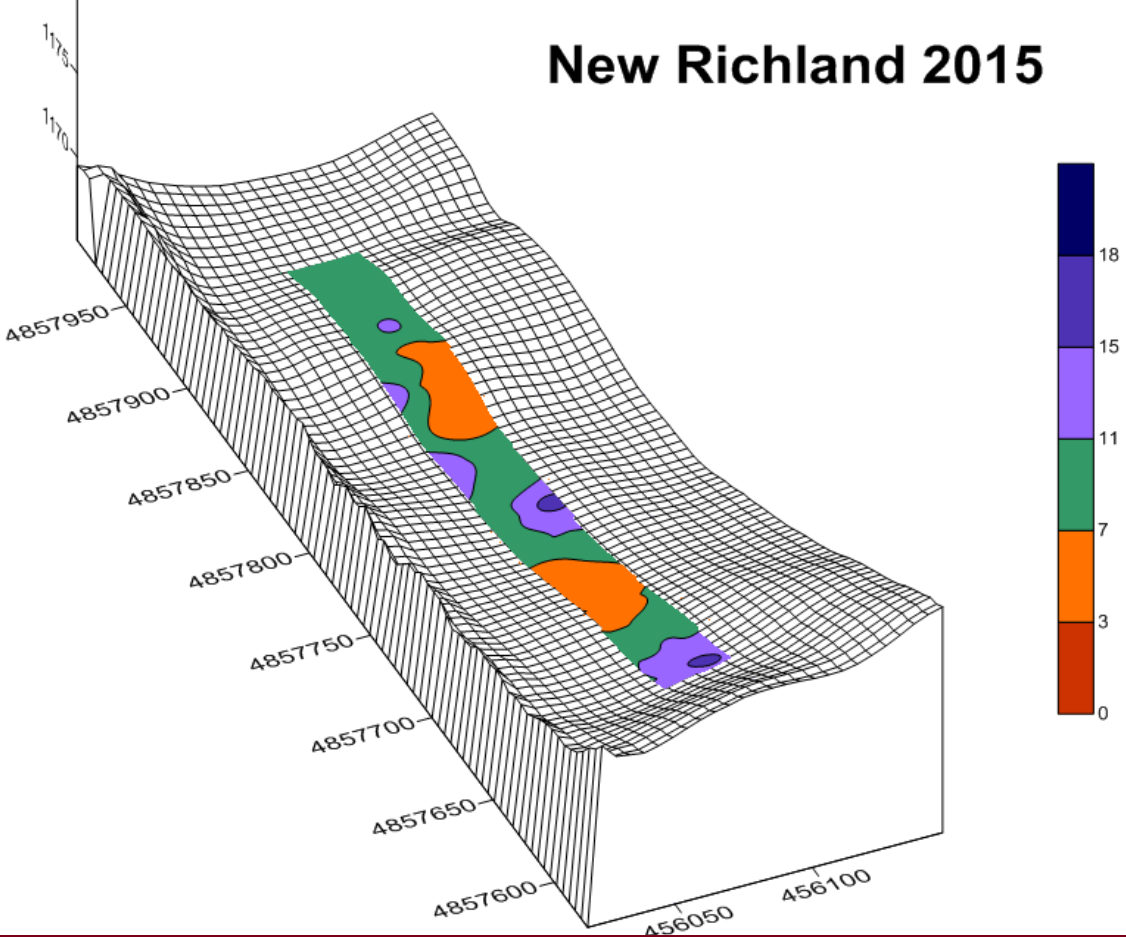


Effect of residual fertilizer P application on next year soybean yield (Kaiser and Mallarino, 2005)



Increasing Trend, but was not considered significant

New Richland 2015



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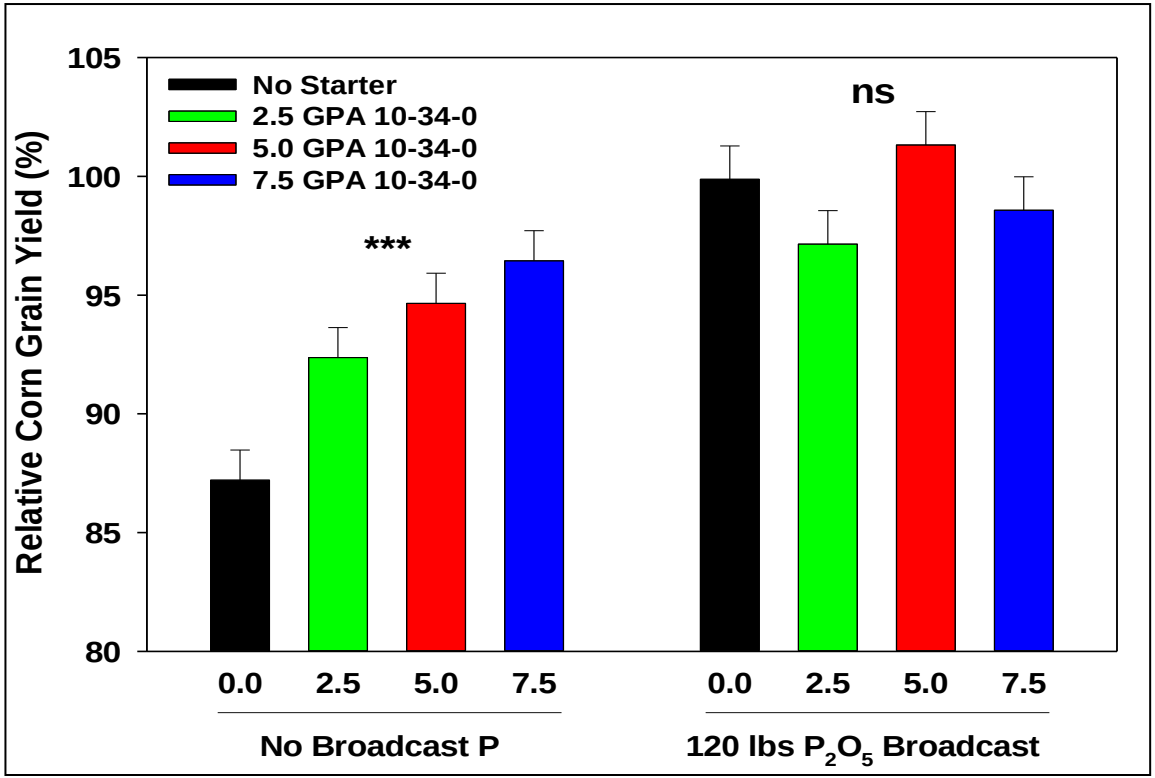
Relative yield as affected by the interaction between broadcast and starter P rates.



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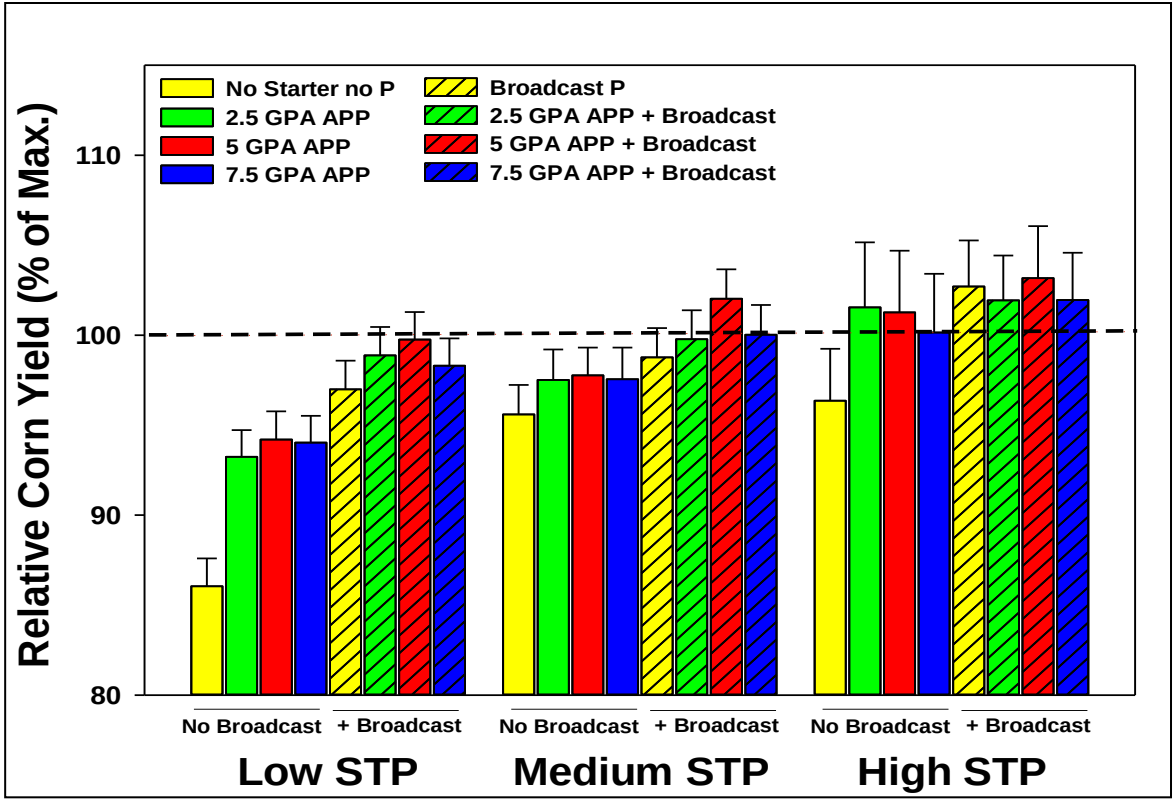
Relative yield as affected by broadcast and starter P rates across soil test P classes.



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Summary of N+P starter with vs without broadcast P

- **Iowa data:** When STP was very low, low or optimum
  - Starter alone provided 50-75% of the corn yield response to P
  - Broadcast produced greater corn yields than starter alone
  - Broadcast + starter not significantly greater
  - Next year soybean yield greater with broadcast
- **Iowa data:** When STP was high or very high
  - Starter produced yields equal to broadcast
  - IMPLICATIONS for when fertilizer prices are high

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Summary of N+P starter with vs without broadcast P

- **MN data:** When STP was low (4–7 ppm Olsen)
  - Starter alone increased yields but not as much as broadcast
  - Starter + broadcast had greatest yields
  - No starter rate response
- **MN data:** When STP medium (8-11 ppm Olsen)
  - Starter produced yields equal to broadcast
  - Starter + broadcast had greatest yields
- **MN data:** When STP high (>12 ppm Olsen)
  - Starter produced yields equal to broadcast
  - IMPLICATIONS for when fertilizer prices are high

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Summary: Where do liquid starters fit in 4R mgt?

- Tillage system: no-till, reduced till & strip-till corn
  - N, P & S applied surface dribble or N&P in-furrow
- Crop rotation: corn after corn/small grains vs soybean
  - N, P & S for corn after corn/small grain surface dribble
- Soil characteristics: poorly drained and high/low pH
  - N, P & S surface dribble on poorly drained soils; N&P in-furrow for high (>7.5) or low (<5.6) pH soils
- High rates of broadcast P often reduce starter P response
- Soil test P levels: low, medium/optimum or high - very high
  - In-furrow starter + broadcast P produces greatest yield on low and medium/optimum P testing soils.
  - $20 of in-furrow N&P starter = $100 of MAP/DAP on high P testing soils

Acknowledgments and contact info

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Jeffrey Vetsch

Researcher 4

Southern Research and Outreach Center

jvetsch@umn.edu

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